

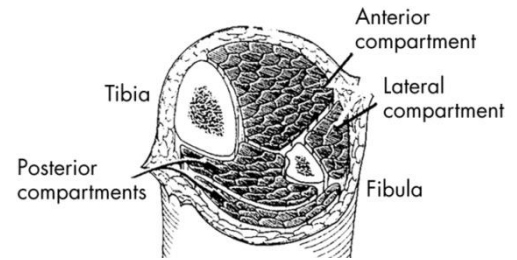
## Compartment Syndrome/Acute Joint Dislocation

- **What is a compartment?**

- Area surrounded by fascia and contains muscles, bones, nerves and vessels.

- **What is the tissue pressure normally?**

- Resting compartment pressure: 10-12 mmHg.
- Pressure difference between the tissues in the compartment and capillary bed is what drives the gas exchange/diffusion. Therefore, when there is an increase in the tissue in the compartment, an ischemia occur.



- **Artery>arteriol>capillary bed (diffusion/exchange)>venule> vein**

- ◆ **Pathophysiology:**

- risk factor → leads to :
- Elevated tissue pressure → leads to :
- Absence of diffusion at the capillary bed ( **blood stays intravascular – no diffusion** ) → leads to :
- Cell damage and swelling ( **as ischemia reaction** ) → leads
- Further increase in tissue pressure → leads to :
- Lack of oxygenation
- Vicious circle



to :

**NB : acute leg ischemia has same outcome but different pathophysiology → in Ex the main difference is absent of pulse in Acute leg ischemia and the pulse become stronger in early phases and disappear in very late stage**

- ◆ **Threshold pressure:**

- > 30 mm Hg (rigid), (Intracompartment pressure)
- Less than 30 mm Hg difference between compartment pressure and diastolic pressure (clinically relevant)

- ◆ **Risk factors (local):**

- Trauma, crush, fracture (open مهمه/closed)
- Injection → of any fluids inside the compartment ex : wrongly placed IV line
- Bleeding → in hemophilia pt
- Prolonged vascular occlusion (reperfusion injury)
- Burns
- Venomous bite → because it cause tissue edema
- Intra-osseous fluid replacement
- IV fluid extravasation
- Tight bandage
- Post-surgery → especially in ortho surgeries → because of the ischemia in the soft tissues

- ✓ **Notes:**

- The risk with open fracture is higher than others, as it requires a high energy force.
- Reperfusion injury is when the blood flow ceases transiently, the flow of the blood the second time can cause leakage of the arterioles → increases intracompartment pressure.

Group A1

- Burns → fluid collection in third space (interstitial) → increases pressure of the compartment
- Post-surgery: bleeding, DVT (reperfusion injury)
- Heavy weight lifters (body builders) might be a risk factor

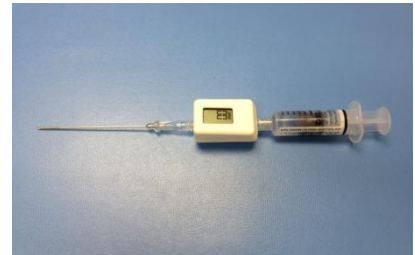
✓ NB : the skin gets its blood supply from vessels outside the fascia So it will not be affected by Compartment syndrome

◆ **Risk factors (general):**

- Head injury → decreased consciousness!
  - Decreased consciousness → late diagnosis
  - Hypotension → because it increases the difference pressure between the intracompartment and the diastolic pressure
- ✓ **Note** : Unconscious patients can't alert you when they feel pain (due to compartment syndrome)

◆ **Diagnosis:**

- Early:
  - Pain!!! → Exam before giving analgesia
  - Pain increase with stretching the involved compartment
  - Presence of risk factor
  - High index of suspicion
  - Measurement of compartment pressure is high ( measure all the compartments in the suspected limb )
  - The affected limb will be stiff
- Late:
  - Paresthesia
  - Paralysis
  - Pallor
- Severely high pressure:
  - Pulselessness (RARE!)
- Tight, woody compartment مهمه – يشبه الخشب بقسوته
- Tender compartment
- Measurement:
  - Rarely necessary
  - Must be done at area of highest expected pressure → close to the injury site
  - May give false low result مهمه



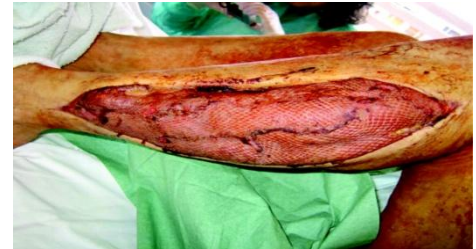
◆ **Management:**

- Initial (undeveloped CS - > 30 difference pressure ):
  - Maintain normal blood pressure → to maintain the difference
  - Remove any constricting bandage
  - Keep limb at heart level → do not raise NOR put it down
  - Regular close monitoring (15-30 minute intervals)
  - Avoid nerve blocks, sedation and strong analgesia to obtain patients feed back → to allow reevaluation مهمه جدا

- Fully developed CS ( <30 difference pressure )
  - Maintain normal blood pressure
  - Remove any constricting bandage
  - Keep limb at heart level
  - Diuresis to avoid kidney tubular injury if late
  - **Urgent surgical decompression (Fasciotomy)**
  - Muscle injury → release of myoglobin → toxic to kidney → Acute Tubular Necrosis ( MCQ)

#### ◆ **Fasciotomy:**

- Releasing the compartment fascia → **all the compartments in the affected limb** مهمه
- Allows swollen muscles to expand in volume
- Results in decreased compartment pressure
- Avoids further damage
- Does not reverse already occurred damage
- Ideally should be done as soon as diagnosis is made
- Should be done as long as there is still viable tissue
- Should not be done if there is no expected viable tissue, Otherwise infection is likely
- Debridement of all necrotic tissue is necessary مهمه
- Second and third look surgeries are often required → So it done in stages not once → Stop if you sure that you removed all the necrotic tissues
- Closure of skin is usually achieved after swelling has subsided
- Skin grafting is often required



#### • **Indications:**

- Within 6 hours of total ischemia time ( Warm ischemia ( في درجه حراره الغرفه العاديه وليس في ثلج ) (ex: arterial embolism)
- Significant tissue injury
- Worsening initial clinical picture
- Delayed presentation with a picture of developed CS
- Absolute Compartment pressure >30 mmHg or <30 mm Hg difference from diastolic pressure
- Is a prophylactic procedure
- Does not reverse injury to permanently damaged tissue
  - So better to have a low threshold!

*NB : if the pt come too late ( > 6 H ) the muscles will be dead and the fasciotomy will introduce infection so do not do it اعرفها للمعلومه فقط*

#### ✓ **Notes:**

- The goal of fasciotomy is prevent further damage and not to regain the function of the affected cells (reperfusion injury)
- The ischemic muscles and nerves will be affected after one hour of the ischemia; however permanent damage will occur after 6-8 hours.

- **Complications:**

- Myonecrosis>Myoglobinemia>Myoglobinuria>Kidney tubular damage
- Loss of function of the involved compartment:
  - Flexion contracture
  - Paralysis
  - Loss of sensation
- After 6 H : The muscle will be replaced by a fibrous tissue (irreversibly damaged limb is not amputated). However, it's prone to infection if it was cut open. → **So avoid fasciotomy**
- Leg:
  - Anterior compartment:
    - Drop foot
  - Deep posterior compartment:
    - Clawed toes
    - Loss of sensation in the sole
- Forearm:
  - Volar compartment:
    - Volkmann contracture

✓ **Notes:** Volkmann's ischemic contracture is a permanent flexion contracture of the hand at the wrist, resulting in a claw-like deformity of the hand and fingers. مهمه

## "Acute Joint Dislocation"

### ◆ Joint stability:

- Bony stability
  - Shape of the joint (ball and socket ( **more stable** ) vs. round on flat ( **less stable** ) )
- Soft Tissue:
  - Dynamic stabilizer: Tendons/Muscles
  - Static stabilizer: Ligaments ± meniscus/labrum
- Complex synergy leading to a FUNCTIONAL and STABLE joint
- Acute joint dislocation / It takes higher energy to dislocate a joint with bony stability than a joint with mainly soft tissue stability
- Connective tissue disorders may lead to increased joint instability due to abnormal soft tissue stabilizers. مهمه
- Dislocation of a major joint should lead to considering other injuries. → **So it is IMP to investigate**



✓ **Notes:**

- Shoulder is round on flat (the glenoid surface persay is flat, however the labrum on top of the surface renders it a round-like structure) → prone to dislocation.
- Connective tissue disorders: lax ligaments.
- Some joints have different positions in which they can be easily dislocated. (i.e. ball-throwing position → risk for shoulder dislocation)

Group A1

- At risk group:
  - Major trauma victims
  - Athletes and sport enthusiasts
  - Connective tissue disorder patients مهمه
- When a joint is subjected to sufficient force in certain directions it might sustain a fracture, a dislocation or a fracture dislocation → depend on the - age : (( young : mostly ligament )) (( old : mostly bone )) - and the type of the injury )
- Different joints have different force vectors اتجاه القوه that may lead to a dislocation → So ask about the mechanism of the injury
- A joint might dislocate in different directions
- A joint dislocation is described by stating the location of the distal segment
  - *Anterior shoulder dislocation*: anterior displacement of the humeral head relative to the glenoid
  - *Posterior hip dislocation*: posterior displacement of the femoral head relative to the acetabulum

• **Dislocation:**

- Total loss of contact between the articular surfaces of the joint

• **Subluxation:**

- Partial loss of contact between the articular surfaces of the joint

• ***Acute joint dislocation***

- ***Chronic joint dislocation***: Example of chronic joint dislocation is DDH. Obviously, a recurrent joint dislocation is NOT a chronic joint dislocation.

◆ **Diagnosis:**

- History of a traumatic event (major trauma or any trauma with the limb in high risk position)
- Pain and inability to use the limb
- Deformity
- Shortening of the limb
- Malalignment
- Malrotation
- Should check for other injuries (distracting injury)
- Should always check the distal neurovascular status. ( IMP in OSCE )
- Should check for compartment syndrome
- Shortening is a hint in diagnosing DDH.

◆ **X-rays:**

- Should be done urgently without delay if dislocation is suspected
- Two perpendicular views of the involved joint

- Occasionally, special views are required such as the axillary view for shoulder dislocation
- X-rays to the joint above and below

◆ **Management principles:**

- Must rule out other injuries
- Pain relief
- Urgent reduction
- Check stability and safety zone
- Check neurovascular status after reduction
- X-rays after reduction
  - CT is indicated in the Hip dislocation
- Protect the joint
- Rehabilitation
- Follow for late complications

✓ **Notes :**

- Safety zone: The range of motion with stability (no danger of dislocation) For example, 10 degrees flexion and 20 degrees extension. If the patient goes beyond that, the joint will get unstable and might be dislocated.
- Neurovascular status should be checked before and after the reduction. This goes for the x-rays as well.

◆ **Reduction:**

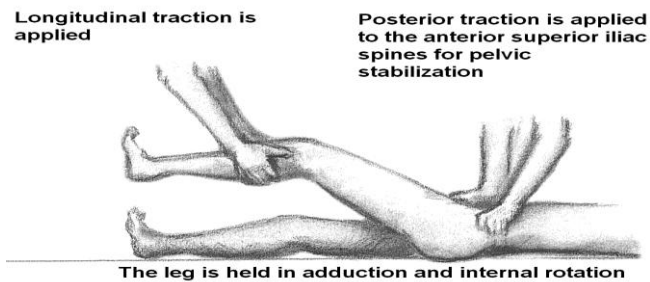
- Monitor vitals
- IV analgesia (opiod)
- IV sedation (to relax the muscles)
- Gradual traction to distract the joint
- Realignment and rotation to reduce the joint based on direction of dislocation
- A palpable clunk well be felt
- Check ROM and stability of the joint
- Muscle relaxant to allow the traction and distracion.
- Once joint is felt to be reduced, check distal NV status → case pt had normal NV status before the reduction BUT after the reduction he developed NV loss → in this case there might be nerve intrapment → solution : send to the OR and dislocate the joint to release the nerve or the vessels
- If it was intact before but not after, farther urgent management is needed
- If it was not present before but intact after, check again later to confirm
- Observe patients vitals until medications wear out
- Stabilize joint and get X-rays



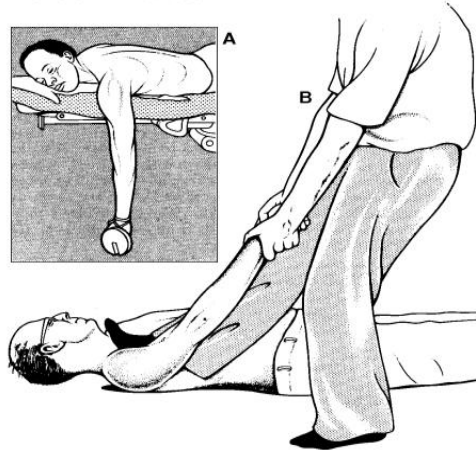
Group A1

- ***If irreducible or partial reduction only:***

- Urgent closed reduction under **general anesthesia** مهمه and possible open reduction if closed reduction fails
- Usually due to
  - Insufficient muscle relaxation → Give GA → it might need open reduction if the GA not working
  - Entrapment of soft tissue
- Fracture dislocation → Open reduction (obviously!)



TWO METHODS FOR A DISLOCATED SHOULDER



- ***Special considerations:***

- A fracture dislocation is usually reduced in an open fashion in the operating room
- Must confirm concentric reduction on the x-rays, otherwise an open reduction should be performed مهم

**NB : after the reduction do Xray to check the location and detect any complications**



◆ **Early Complications:**

- Heterotopic ossification
- Neurological injury (reversible or irreversible)
  - Ex : in shoulder : Axillary nerve - in hip : sciatica nerve - in elbow : radial artery
  - Knee ( patella ) : tibial artery
- Vascular injury
- Compartment syndrome
- Osteochondral fracture/injury
- **Note:** Heterotopic Ossification=Myositis Ossificans → common in pt with severe injuries – It prevented by movement

◆ **Late complications:**

- Stiffness
- Heterotopic ossification
- Chronic instability
- Avascular necrosis → Death of the bone cells due to vascular supply destruction → may caused by effusion and severe bleeding in the bone
- Osteoarthritis ( result from Avascular necrosis )
- **Note:** Avascular Necrosis in hip dislocation mostly.

• **Special considerations:**

- **Hip joint:**
  - Posterior dislocation is commonest
  - Major trauma with hip flexed (dashboard injury)- direct truma
  - Sciatic nerve injury common
  - High incidence of late avascular necrosis
  - An orthopedic emergency!! → because of early Avascular necrosis

NB : in hip joint dislocation do x ray immediately and consult an orthopedic

Remember : femer neck fracture is EMG because it is risk of Avascular necrosis



• **Shoulder dislocation:**

- Common
- Anterior dislocation is more common
- Patients with seizures prone to posterior dislocation
- May cause chronic instability
- Can result in axillary nerve injury





- **Knee dislocation:**

- Three or more ligaments → it is Emg → because of the risk of peroneal nerve injury and popliteal and tibial artery injury So do (( Ankle brachial index ) -- MCQ
- Severe (high energy) trauma
- May be associated with popliteal artery injury---- Limb threatening
- Very serious emergency- MCQ
- Needs accurate vascular assessment
- May be associated with peroneal nerve injury
- May be associated with fracture/ compartment syndrome
- Most require surgery either early or late or both
- **Note:** Popliteal artery is attached to the posterior of the tibia → anterior dislocation of the tibia will stretch the artery → Intimal injury or rupture.



Bilateral in-situ pinning to cause fusion  
(the growth plate is already damaged  
by SCFE)