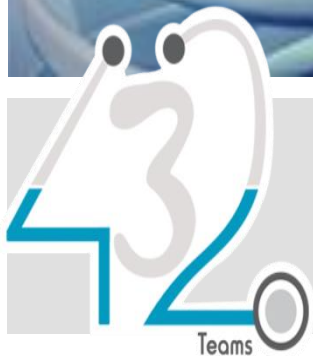


Orthopedics

432 Team

3

Compartment Syndrome & Acute Joint Dislocations



1st Edition:

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Color Code:

Slides

431 team work

Doctor's Notes

Arabic Words

Team Notes

Books' notes

Important

Other Sources

Objectives

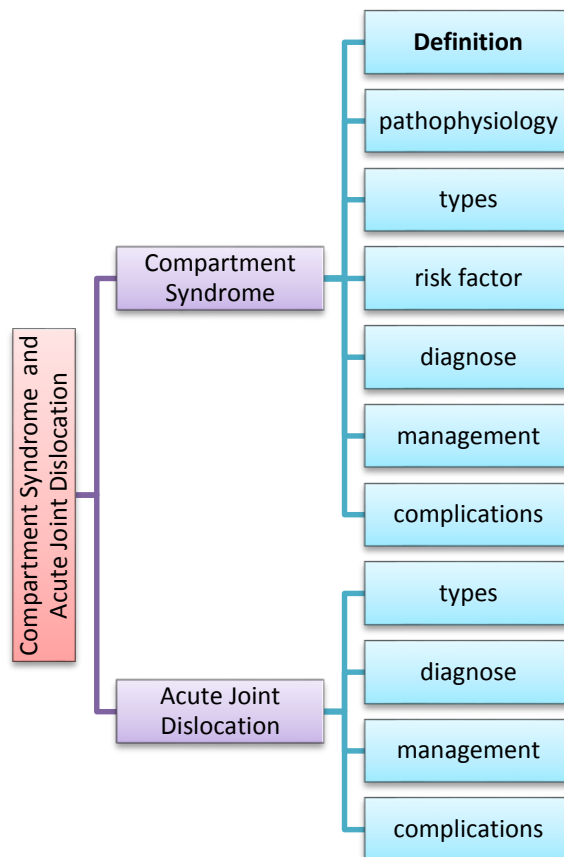
Objectives of Compartment Syndrome:

1. To explain the pathophysiology of CS
2. To Identify patients at risk of developing CS
3. To be able to diagnose and initially manage patients with CS
4. To be able to describe the possible complications of CS

Objectives of Acute Joints Dislocations:

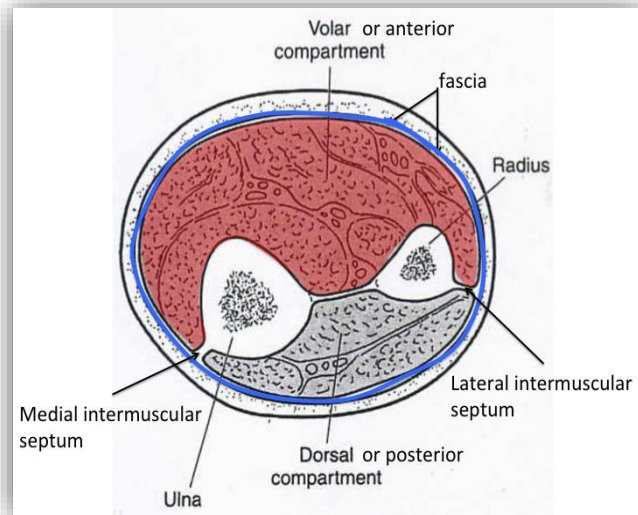
1. To describe mechanisms of joint stability
2. To be able to diagnose patients with a possible acute joint dislocation
3. To be able to describe general principles of managing a patient with a dislocated joint
4. To describe possible complications of joint dislocations in general and in major joints such as the shoulder, hip and knee

Mind Map



Fascial Compartments

Fascial compartment: Is a section within the body that contains muscles and nerves and surrounded by fascia.



For example: the forearm has two compartments, an anterior and a posterior compartment, both of them have a separate nerves and blood vessels that supply the compartment.

- BP 120/80 ± 10
- Normally the **pressure of the compartment should be lower than the diastolic pressure by at least 30 mmgh.**
- Normal diastolic pressure is around 80 mmgh, so the compartmental pressure should be <50 mmgh.

Compartment Syndrome

What is compartment? (حيز / غرفة / مقصورة)

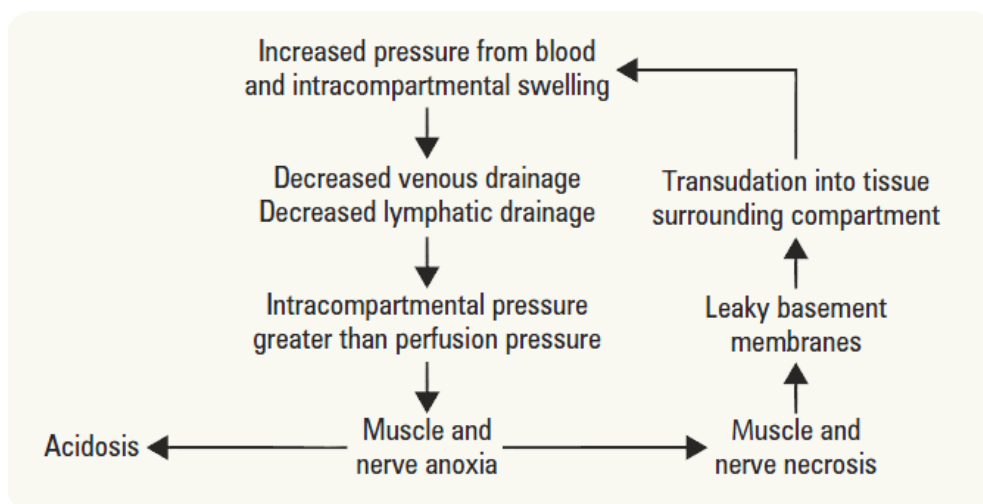
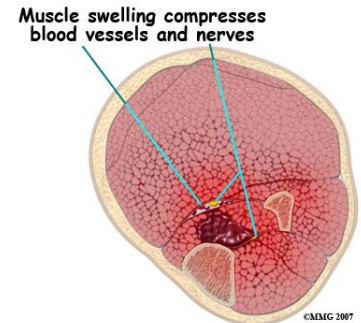
- **Definition:** Compartment syndrome develops when there is **excessive, sustained** increase of local tissue pressure in a closed compartment.
- **Common sites for having compartment syndrome** are forearm and leg
- **Normal blood flow is impaired** (usually at the level of artery and arteriole)
- **Artery-arteriole-capillary-venule-vein.**
- **Tissue perfusion failing** (all process of oxygenation and remove waste product are affected).

Types:

- 1- Acute compartment syndrome.
- 2- Chronic exertional compartment syndrome.

Pathophysiology of compartment syndrome:

Compartment syndrome develops because of the pressure of the compartment becomes **VERY HIGH** so that the process of exchange becomes affected. Therefore, when the blood reaches the capillary and tries to expel wastes, the high pressure of the compartment prevents it, **the result is surrounding tissue unable to get oxygen supply (hypoxia) and when hypoxia develops, the body reacts with inflammation, inflammation on the other hand adds to the pile of increased pressure within the compartment and making matters worse.**



In short: the capillaries are compressed and preventing any perfusion of the surrounding tissue to occur.

- Bare in mind that only the capillaries are affected in the slight increase of compartment pressure above 50 mmgh.
- The arteries will continue pumping blood toward the distal parts unless the compartment pressure matches the diastolic pressure of 80 mmgh or above, which happens in very late presentations and you see distal pulse getting weak or even not palpable at all.
- The difference between acute leg ischemia and compartment syndrome is that acute leg ischemia have a complete block of blood supply from the artery while in compartment syndrome we rarely see complete block. **(So you will rarely see “Pulseless” as a sign of Compartment Syndrome).**

Risk factors (causes):

Edema > Elevated tissue pressure > tense tissues > impaired diffusion/ hypoxia > cell damage > more swelling > more hypoxia. Vicious circle.

Local Causes:

- **Trauma:** crush (the worst), Open or Closed fracture.
 - ✓ A person got his leg crushed by an accident, what will happen? There will be cell damage > Leakage of cell fluid > Edema > Compression > Blood supply and oxygenation becomes compromised > some cell may die > dead cells leak their fluid > more edema > more pressure. And so on!
- **Burns:** the pressure comes outside of the compartment “Edema” but the edema itself may apply an outside pressure on the compartment, thus **we do not do Fasciotomy in burns, we do Escharotomy.**
- **Injection:** injections may mistakenly go inside the compartments thus increasing pressure.
- **Bleeding** within the compartment for any cause for example patient with hemophilia or trauma
- **Prolonged vascular occlusion (reperfusion injury):** Tissue Damage caused by return of blood flow after a period of ischemia.
 - ✓ It's a big mistake to put a tourniquet above the wound instead of direct pressure because there will be muscle damage, also it might cause acute renal failure because of myoglobin release by muscles.
- **Venomous bite**
- **Intra-osseous fluid replacement**
- **IV fluid extravasation** when fluid enters the compartment it may increase the pressure causing compartment syndrome
- **Tight bandage**
- **Post-surgery:** The most important symptom of CS is PAIN.
 - So a patient after surgery will not feel pain because of anesthesia thus we have to check him for compartment syndrome repeatedly.

General cause:

- **Hypotension:** Patient after road traffic accident may develop hypovolemia that leads to hypotension, which initiate hypoxia, inflammation, edema and finally compartment syndrome.
- **Head injury.**

Diagnosis:

- **Early:** Most important sign is PAIN. It increases while stretching the involved compartment. For example if you want to check the posterior compartment of the leg you will do dorsiflexion. The pain will be increased when there is Compartment syndrome.
 - Presence of Risk Factors: like tibia fracture DM and hypertension.
 - Measurement of compartment pressure is high “rarely done”
 - High index of suspicion
- **Late:** we should not reach this stage !
 - 4 Ps: Paralysis, Paresthesia, Pallor and Pulslessness.
 - Pulslessness usually not common, Compartment pressure usually very high.
 - Tight, woody compartment
 - Tender compartment
 - Measurements Rarely necessary, must be done at area of highest expected pressure and may give false low result
- Time window for CS is 6 Hours. But it differs from person to person.
- Skin will not be affected because skin perfusion is extra compartment. So after a very long time of CS “1 day” the skin will still be normal.

Diagnosis: (S/S)

Pallor

Altered perfusion

Diminished pulses or pulselessness

Altered capillary refill

Palpable fullness or tenseness of a compartment, the forgotten "P"

Altered sensibility

Pain on passive muscle stretch

Management:

- **Initial (undeveloped CS):**
 - Maintain normal blood pressure
 - Remove any constricting bandage Ex: Watch, Bandage, Cast
 - Elevate the limb at heart level. We don't want to make it above heart level because we don't want to decrease capillary fill and we don't want to make it below heart level because it will decrease venous return.

- **Regular close monitoring** (15-30 minute intervals).
- Avoid nerve blocks, sedation and strong analgesia to obtain patients feedback.
- **Fully developed CS:**
 - Maintain normal blood pressure.
 - Remove any constricting bandage.
 - Keep limb at heart level.
 - **Diuresis to avoid kidney tubular injury if late.**
 - We do the same above + Check heart and kidney function and we **plan for an emergent surgery "Fasciotomy"**.
- **Fasciotomy:**
 - Releasing the compartment fascia.
 - 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 (**very early**).
 - **If patient present late (we considered late if he present after 6 to 8 hours) do not do fasciotomy because at that time the patient had a necrosis and when you open it you will increase the risk of having infection.**
 - 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.**
 - Second and third look surgeries are often required.
 - Closure of skin is usually achieved after swelling has subsided.
 - Skin grafting is often required.



Indications of fasciotomy:

- 6 hours of total ischemia time.
- 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.

Complications of Compartment Syndrome:

- Myonecrosis > myoglobinemia > myoglobinuria > **kidney tubular damage**
- Loss of function of the involved compartment:
 - Flexion contracture
 - Paralysis
 - Loss of sensation
 - Leg:
 - Anterior compartment: Drop foot we give him splint to protect his toes while walking
 - Deep posterior compartment: Clowed toes and Loss of sensation in the sole
 - Forearm: **Volar compartment** > **Volkman contracture** (Next Image).

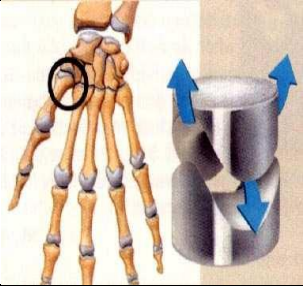

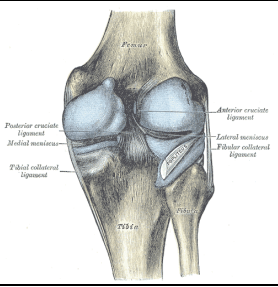
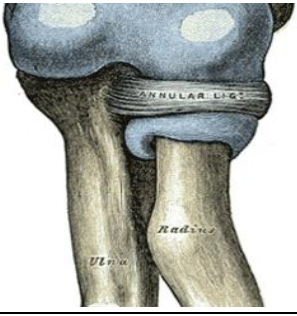
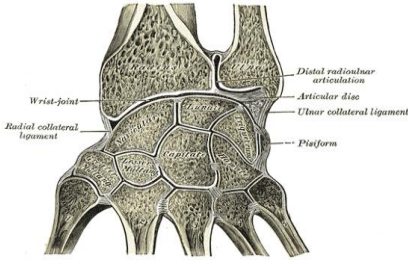
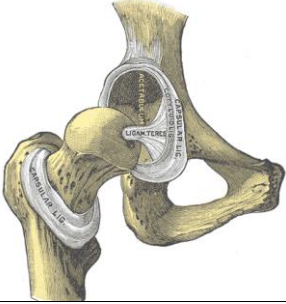


Acute Joint Dislocation

Joint stability:

- **Bony stability:**
 - Shape of the joint (ball and socket **like hip joint and it is a very stable joint** vs round on flat **like shoulder joint**)
- **Soft Tissue:**
 - Dynamic stabilizer: Tendons/Muscles
 - **You can move your patella laterally but when you contract your quadriceps, it comes back to its place.**
 - Static stabilizer: Ligaments ± meniscus/labrum
 - **When you move your leg to valgus or varus it holds its place because of tendons and ligaments mostly. Also in shoulder, what keeps humerus stable in its place is the capsule and the labrum.**
 - Complex synergy leading to a FUNCTIONAL and STABLE joint

Types of joints:

		
<p>Saddle joint (base of the thumb)</p>	<p>Hinge joint (proximal ulna distal humerus)</p>	<p>Condylar (knee joint)</p>
		
<p>Pivot low stability depending on annular ligament</p>	<p>Plane wrist joint</p>	<p>Ball and socket</p>

Joint Dislocations:

- **Dislocation is a Total loss of contact** between the articular surfaces of the joint while **Subluxation is a partial loss of contact** between the articular surfaces of the joint
- There is Acute joint dislocation and Chronic joint dislocation
- It takes higher energy to dislocate a joint with bony stability than a joint with mainly soft tissue stability. Example hip and shoulder
- Connective tissue disorders may lead to increased joint instability due to abnormal soft tissue stabilizers.
- **Dislocation of a major joint should lead to considering other injuries.**
 - Major joints: Anything in spine, Shoulder, Elbow, Wrist, Hip, Knee, Ankle
- When a joint is subjected to sufficient force in certain directions it might sustain a fracture, a dislocation or a fracture dislocation.
- Different joints have different force vectors that may lead to a dislocation
 - So a dislocation depends on the direction of the force and the position of the joint while receiving this force.

- A joint might dislocate in different directions (shoulder).
- 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.
 - When a joint is strained:
 - It may be sprain
 - It may be fracture
 - It may be dislocated
 - It may be fracture and dislocated
- ✓ Damage to the labrum Bankart's lesion, and capsule
- ✓ Damage to the head of humerus



At risk group:

- Major trauma victims especially unconscious patient
- Athletes and sport enthusiasts
- Connective tissue disorder patients

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
- Malalignment
- Malrotation
- Should check for **other injuries** (distracting injury)
- Should always check the distal **neurovascular status**.
 - You have to check it before reducing the dislocation because if you didn't and the patient came later with no sensation or no pulses you will never know whether he had this problem before or after treatment
- Should check for **compartment syndrome**.

- **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. **After reduction you move the limb in all directions till you feel that at a certain level he might dislocate his joint again. Then after that you tell him not to move his limb above this level.**
- Check neurovascular status after reduction.
- X-rays after reduction.
- Protect the joint **for 2 to 3 week to heal and after that send them to physical thereby department.**
- Rehabilitation.
- Follow for late complications.

Management:

- Better with anesthesia. **WHY? Because it is very painful and you can broke the bone if you do it without muscle relaxant.**
- Urgent Closed reduction first
- If fail open reduction

Reduction:

- Monitor vitals.
- IV analgesia (opioid).
- 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.

- Once joint is felt to be reduced, check distal NV status.
- 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.
 - If irreducible or partial reduction only:
 - Urgent closed reduction under general anesthesia and possible open reduction if closed reduction fails, Usually due to insufficient muscle relaxation or Entrapment of soft tissue.

Complications: **The sooner you reduce it the better**

- **Early Complications:**
 - Heterotopic ossification
 - **Muscle or soft tissue calcification**
 - Neurological injury (reversible or irreversible)
 - Vascular injury
 - **Whenever a neurological injury can happen, vascular injury happen**
 - Compartment syndrome
 - Osteochondral fracture/injury
- **Late complications:**
 - Stiffness
 - Heterotopic ossification
 - Chronic instability **especially shoulder joint**
 - Avascular necrosis **it may appear after 4 to 6 month and mostly in femur**
 - Osteoarthritis

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.

➤ Hip joint Dislocation:

- **Posterior dislocation is commonest**
- Major trauma with hip flexed (dashboard injury)
- Sciatic nerve injury common
- High incidence of late avascular necrosis
- **An orthopedic emergency!**



➤ Shoulder Joint Dislocation:

- Common.
- Anterior dislocation is more common
- Patients with seizures prone to posterior dislocation.
 - (Because they can't protect themselves when they fall while having a seizure)
- May cause chronic instability.
- Can result in axillary nerve injury and cause wasting in deltoid muscle and numbness.



➤ Knee Joint Dislocation:

It is could be anterior dislocation or posterior dislocation.

- Three or more ligaments.
- Severe (high energy) trauma.
- May be associated with **popliteal artery injury.**
- May be associate with **peroneal nerve injury**
- Limb threatening.
- **Very serious emergency patient could develop ischemia then hypoxia which finally leads to compartment syndrome.**
- Needs accurate vascular assessment.
- May be associated with fracture/ compartment syndrome.
- Most require surgery either early or late or both.



Summary

- Normally the pressure of the compartment should be lower than the diastolic pressure by at least 30 mmHg.
- Compartment syndrome develops when there is excessive, sustained increase of local tissue pressure in a closed compartment.
- The most important symptom of CS is PAIN, increases while stretching.
- Complications of Compartment Syndrome:
 - Kidney tubular damage.
 - Loss of function of the involved compartment.
- Hip joint Dislocation:
 - Posterior dislocation is commonest.
 - An orthopedic emergency!

1) A patient with extravasation of IV contrast is at greatest risk for which of the following complication:

- A. urticaria
- B. hypertension with reflex bradycardia
- C. seizure
- D. compartment syndrome

2) What is the Normal diastolic pressure of the compartment ?

- A. less than 50
- B. less than 90
- C. less than 110
- D. less than 120

Q1=D

Q2=A

