Compartment Syndrome

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Disclosures

• None relevant

Sources

• OTA Lecture Library, 3rd edition

Objectives

• Define clinical Diagnosis of compartment syndrome

• How it happens and who it happens to

• Diagnostic methods

• Urgent management prior to surgery
Definition

• ‘Increase in hydrostatic pressure in a closed osteofascial space resulting in decreased perfusion of muscle and nerves within the compartment’

• Raised pressure has potential to cause irreversible damage to the contents in that space

Biomechanics

• Simple:
  – Increased compartment pressure overcomes venous/capillary filling pressures which in turn decreases tissue perfusion
  – Arteries usually still flow

Internal vs. External Causes

• Internal:
  – Bleeding
  – Fracture
    • Bleeding, inflammation 2/2 ST irritation
  – Crush/traumatized tissue
  – Burns
    • Increased permeability
  – Post-ischemic/revascularization swelling

• External:
  – Tight dressing
  – Tight cast/splint
  – Prolonged crush
  – Obtunded/intubated patient positioning
But not usually

• IV infiltration

• Snake bites

• These usually occur superficial to fascia
  – Need to be extensive to create that level of
    ‘external’ pressure

Who

• Trauma patients

• Bleeding disorders

• Post-surgical
  – Post-fracture treatment

• Obtunded patients

How to diagnose?

• Clinical diagnosis

• Clinical diagnosis

• Clinical diagnosis

• Clinical diagnosis

• Clinical diagnosis

How to diagnose?

• Start with who to suspect

• Once it’s been seen before - it’s not usually a
difficult diagnosis to make
Mainstays

• Tense/swollen compartment
• Pain out of proportion to level suspected from injury
• Pain with passive stretch of compartment muscles

6 Ps (or 5)

• Pain
• Pallor
• Paralysis
• Pulselessness
• Paresthesias
• Poikilothermia

Pain

• Always
• But difficult in the obtunded/intubated patient

Pallor

• Not always
• Difficult to assess
• Limited to no diagnostic usefulness

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Paralysis

- If real, then possible that irreversible damage already taken place
- Real vs. no motion 2/2 pain
- Real vs. no motion 2/2 nerve injury

Pulselessness

- Very poor diagnostic usefulness
- Either late finding or not at all
- Why:
  - Increased pressure overcomes venous/capillary filling pressure prior to arterial
  - Decreases flow out of artery but pulses remain intact
  - Continued increase in pressure will decrease/stop pulses but usually late finding

Paresthesias

- Can be helpful
- But potentially a late finding as well
- Careful when compartment not tense or not painful
  - Nerve injury

Poikilothermia

- Nothing to discuss here
- Not helpful
Obtunded patients

- Minimal ability to assess pain
- Classic:
  - Intoxicated patient with arm over chair
- Iatrogenic:
  - Poor surgical positioning
- Trauma/ICU patients

Objective data

- Needle measurements:
  - Systems designed of this
    - Stryker, Synthes, etc.
  - Arterial line setup

Needle Measurements

- Positive diagnosis if:
  - Absolute pressure over 30mmHg
  - More than 20mmHg over diastolic
  - BP can be labile in these patients
    - Pain, medications, anesthesias
- Can usually make the system read whatever you want
  - A-line thought to be more reliable

Needle Measurements

- Place needle close to injury
  - Careful not too close to fracture gap
- Deeper compartments likely to have increased pressure first
- Sample multiple sites
  - If done this before, most patients do not tolerate well
  - Obtunded
Needle Measurements

- I haven’t used these in 10 years
- Most use to collect data for documentation (and study)
- Most have already made positive or negative diagnosis and get data to support decision
- It’s a clinical diagnosis

Other objective data

- Laboratory studies
  - A lot written about CK/CPK levels
    - And myoglobin
    - Please do not depend diagnosis on these
    - Misses the point entirely
  - Imaging studies unhelpful for diagnosis but needed to determine cause
  - Pulse oximetry very unlikely to help

Time is important

- Once ischemia starts:
  - Muscle damage:
    - <4 hours remains reversible
    - >8 hours irreversible
    - 4-8 hours mixed

Time is important

- Once ischemia starts:
  - Nerves:
    - 1 hour OK
    - 1-4 hours reversible
    - >8 hours axonotmesis and irreversible
Time is important

- Pressure does not have to worsen to have increase in damage

- Why?
- Body’s response to increased pressure:
  - Decreased peripheral vascular resistance
  - Increased extraction of oxygen
  - Time-limited and system eventually overwhelmed

Time is important

- Muscle damage more than just loss of function

- After 4 hours of ischemia:
  - Myoglobin in urine
    - Kidney failure
  - Muscle cell death leads to increased capillary permeability
    - More swelling
  - Muscle death makes patients ‘sick’ and issues well beyond limb function

Treatment

- Surgical management necessary

- Orthopaedic Emergency:
  - We hate getting the call
  - Almost always not compartment syndrome
  - But always gets our attention

ED Treatment

- Call surgeon
- Splint injury to prevent further soft-tissue irritation/inflammation
- Do not elevate
  - Potentially worse perfusion
- Cautious use of anti-inflammatories
  - Unable to go to surgery
  - Unavoidable delay
  - Unsure of diagnosis
  - Concerns with bleeding and delay in care

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**Exertional Compartment Syndrome**

- Chronic condition
- Transient rise in pressure associated with activity
- Can have pain, weakness, paresthesias
- Diagnose with needle test before/after activity
- Treatment: Surgery vs. activity modification

**Take-Home Facts**

- Open fractures (fascia injury) does not protect from compartment syndrome
- High concern for ‘bad’ fractures
  - Comminuted, wide displacement
  - Multiple fractures of same bone/compartment
  - Multiple fractures about same joint

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**Incidence**

- I believe a lot more rare than literature suggests
  - Tibia fracture incidence 6-10%
  - That’s crazy
- Why?
  - Diagnosis is confirmed for research by an intra-operative and very subjective finding of how much the muscle ‘bulges’
  - Only definitive manner to diagnose is if it was missed and see sequelae
    - Contractures, muscle death, scarring, no sensation/motor function of affected nerves

**Time is Important**

- Most surgeons will not open and release space if believe process is >12-24 hours
- Damage already permanent
- If open at this time, near 80-100% chance of infection
  - Must debride entire compartment

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Bottom Line

• High index of suspicion

• Always evaluate and re-evaluate

• Call when in doubt

• Missed diagnosis can cause an awful outcome