Compartment Syndrome: What does the literature show?

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Why is Acute Compartment Syndrome Important?

- It’s a clinical emergency.
- If left untreated, it can lead to severe morbidity and mortality.
- It triples the average length of stay and doubles the cost of the hospital stay.
  - Schmidt, AH. J Orthop Trauma 2011.
Pathophysiology

- elevated intra-compartmental pressure (ICP) leading to microvascular compromise → ischemia and cell death
- tissue pressure within an enclosed space exceeds the capillary perfusion pressure
Pathophysiology

- Skeletal muscle and nerve tissue are highly metabolically active → particularly vulnerable to ischemia

- Inclusive approach to surgical treatment
  - Patients with signs of, or significant risk factors for, compartment syndrome should be considered for fasciotomy independent of anatomic location. ***

- Failure of timely diagnosis is the single most important cause of adverse outcomes
Causes of Compartment Syndrome

- Trauma
- Bleeding (think anti-coagulated patient)
- Perfusion after vascular repair or other restoration of perfusion
  - Often get prophylactic fasciotomies
- Burns
- Snake Bites
- Injection Injuries
Overlooked Causes of ACS

- Tight casts/splints
- Continued soft tissue damage from lack of immobilization
- Manipulation
- Surgery
- Improperly placed IVs
Fracture is the Most common cause

- 69% of ACS are associated with a fracture
- 36% Tibial shaft
- 9.8% Distal Radius
- 23% of cases had no fracture
- 10% of these occur in patients on anticoagulants or patients with bleeding disorders

Olson, JAAOS 2005
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Olson, JAAOS 2005
Not Just an Adult Issue

Rate of pediatric tibial fractures with ACS – 11.6%

Highest risk – Age > 14 yrs

Other independent predictor for ACS - MVC
Diagnosis

- Old School: 5 “P’s”
- Pain
- Pallor
- Paresthesia
- Pulselessness
- Paralysis
Diagnosis

- New School: 5P’s
  - Pain
  - Pain
  - Pain
  - Pain with passive stretch
  - Pain out of proportion
Clinical Diagnosis

- Pain out of proportion
  - Increasing analgesic requirement

- Pain with passive stretch

- Hypesthesias and paresthesias
  - First neurologic signs
  - 13% sensitivity
  - Ulmer, 2002

- Muscle paralysis
  - Late sign → often, not a good outcome, even without fasciotomy

- A swollen, tense compartment may not be evident, especially with deep compartment involvement

- Pulse means nothing
Is the physical exam adequate?

- Cadaver model
- Sensitivity 24%  Specificity 55%

Physicians’ Ability to Manually Detect Isolated Elevations in Leg Intracompartmental Pressure

Franklin D. Shuler, MD, PhD; Matthew J. Dietz, MD

Diagnosis

Variation in Diagnosis of Compartment Syndrome by Surgeons Treating Tibial Shaft Fractures

Robert V. O'Toole, MD, Augusta Whitney, BA, Nishant Merchant, BS, Emily Hui, MPH, Jennifer Higgins, MS, Terrence T. Kim, MD, and Carlos Sagebien, MD

- 386 tibial diaphyseal fractures
- Rate (%) of fractures associated with ACS broken down by surgeon (all were orthopaedic trauma trained surgeons)
- Rate ranged from 2% to 24%
- = lack of consensus in practice regarding the diagnosis of compartment syndrome. Even at a highly regarded Level 1 trauma center.
Compartment Pressure Monitoring
ICP measurements should be:

- taken at the level of the fracture as well as at sites up to 5 cm proximal and distal to the injury, to capture the peak ICP value (Heckman et al., 1994).
- measured in the other compartments of the affected limb to ensure that a compartment syndrome is not missed.
Taking Measurements

ICP measurements should be:
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Compartment Syndrome
Related Ischemia

- Tissue damage is not instantaneous
  - Ischemia for 6-8 hrs

- However, the physician/nurse/etc evaluating the patient doesn’t know when the ischemia really started.
Causes of Missed Compartment Syndrome

- Inexperience
  - Lack of knowledge
  - Not examining the patient
  - Confusing clinical picture (post op, no fracture, etc)

- Patient/other factors
  - Level of Consciousness
  - Regional Anesthesia
  - PCA/Prior Nerve Injury

- Must have a high index of suspicion
Indications for fasciotomy are controversial:
- Absolute pressure > 30 mmHg
- ΔP (DBP-Absolute Pressure) < 30 mmHg
Missed Compartment Syndrome

- Muscle infarction
- Muscle contracture
- Secondary deformity
- Weakness
- Neurologic dysfunction

Other sequelae include:
- Infection
- Gram-negative sepsis
- Amputation
- End-organ involvement.
Compartments of the Leg

- Anterior compartment
- Fibula
- Tibia
- Lateral compartment
- Posterior intermuscular septum
- Superficial posterior compartment
- Interosseous membrane
- Deep posterior compartment
- Transverse intermuscular septum
Compartments of the Leg

4 COMPARTMENTS

- Anterior compartment
- Fibula
- Lateral compartment
- Posterior intermuscular septum
- Superficial posterior compartment
- Interosseous membrane
- Deep posterior compartment
- Transverse intermuscular septum
Compartments of the Leg

1 cm lateral to anterior boarders of the tibia
Compartments of the Thigh

- Anterior compartment
- Medial intermuscular septum
- Lateral intermuscular septum
- Medial compartment
- Posterior compartment
Compartments of the Thigh

3 COMPARTMENTS

- Anterior compartment
- Medial intermuscular compartment
- Lateral intermuscular septum
- Medial compartment
- Posterior compartment
Compartments of the Forearm

- Mobile wad
- Radius
- Interosseous membrane
- Volar flexor compartment
- Ulna
- Dorsal extensor compartment
Compartments of the Forearm

3 COMPARTMENTS

- Radius
- Ulna
- Dorsal extensor compartment
- Interosseous membrane
Compartments of the Arm
Compartments of the Arm

2 COMPARTMENTS

- Lateral intermuscular septum
- Humerus
- Posterior compartment
The Treatment for ACS

- FASCIOTOMIES
- NOT elevation
- NOT ice
- NOT wait 30 minutes and see if the pressures decrease
Compartment Syndrome Following Recurrent Ankle Inversion Injury

R Alexander Creighton, MD; Jeremy Kinder, BS; Bernard R Bach, Jr, MD

Orthopedics
Fasciotomies

The choice of single-incision vs dual-incision fasciotomy technique can be based on surgeon preference.
- No difference in infection
- No difference in non-union

Journal of Orthopaedic Trauma, 2013

Analysis of Single-Incision Versus Dual-Incision Fasciotomy for Tibial Fractures With Acute Compartment Syndrome

Jesse E. Bible, MD, MHS, D. Jake McClure, MD, and Hassan R. Mir, MD
Why don’t we do fasciotomies on everyone?
Why don't we do fasciotomies on everyone?

You get a fasciotomy and you get a fasciotomy!
Everyone gets a fasciotomy!
Morbidities of Fasciotomies

- Sensory changes
- Swelling
- Muscle herniations
- Tethered scars
- Cosmesis
- Possible increased incidence of infection
Future Areas of Research

- Near-Infrared Spectroscopy
  - Different absorption characteristics between oxyhemoglobin and deoxyhemoglobin
- Biomarkers
  - BUN, Bicarb, Calcium, Chloride, CK, lactate
- Laser Doppler flowmetry
- Ultrasound
Questions