

Orthopaedic Emergencies

2. Compartment Syndrome

Miss Joanna Richards MBChB BSc MRCS
Trauma & Orthopaedic Registrar
Birmingham Orthopaedic Training Programme



Module Overview

- Lecture 1: Introduction

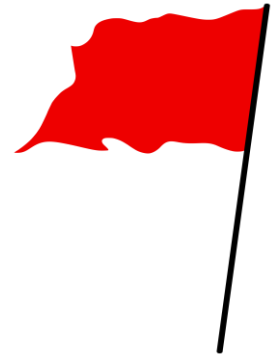
- Lecture 2: Compartment Syndrome

- Pathoanatomy
- Causes
- Presentation
- Muscles and movements
- Compartment pressure measurement
- Treatment
- Individual Limb Compartments
- Complications
- Atypical Presentation

- Lecture 3: Cauda Equina Syndrome



Compartment Syndrome



- **Acute compartment syndrome**
 - Due to a raised pressure with a closed fascial compartment causing local tissue ischaemia and hypoxia due to reduced perfusion
 - Most often after tibial, forearm fractures, high energy wrist fractures and crush injuries
 - **ORTHOPAEDIC EMERGENCY**
- **Chronic compartment syndrome**
 - Pain and swelling caused by exercises, particularly those with repetitive motions.
 - Usually relieved by ceasing exercise and not usually dangerous

Pathoanatomy

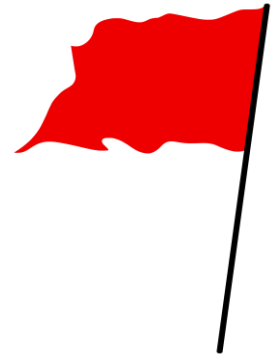
- Local trauma and soft tissue destruction
 - Bleeding and oedema
 - Increased interstitial pressure within compartments
 - Vascular occlusion
 - Reduced perfusion
 - Myoneural ischaemia
 - Muscle necrosis if not treated with ischaemic contractures as long term sequelae

Causes

- Trauma
 - Fractures
 - Crush injuries
 - Contusions
 - Gun shot wounds
- Tight casts, dressings, external wrapping
- Extravasation of IV infusion
- Burns
- Post ischaemic swelling
- Bleeding disorders
- Arterial Injury



Presentation



- Clinical diagnosis; high index of suspicion
- Symptoms
 - Pain out of proportion to clinical situation
 - Despite adequate analgesia
 - 6 P's- pain, pain, pain, pain, pain, pain
- Examination
 - Pain with passive stretching of affected compartment muscles
 - Most sensitive prior to onset of ischaemia
 - Swelling
 - Parasthesia and hypoesthesia
 - Paralysis
 - Late; full recovery rare
 - Absent peripheral pulses
 - Very late; amputation may be inevitable

Compartment Muscles and Movements Eliciting Pain

Limb	Compartment	Muscles	Passive stretch test
Arm	Anterior	Biceps, brachialis, coracobrachialis	Elbow extension
	Posterior	Triceps, anconeus	Elbow flexion
Forearm	Volar	FCR, Pronator teres, pollicis longus, FDS, FCU, FDP	Wrist extension, supination
	Dorsal	ECU, extensor digiti minimi, extensor digitorum, supinator	Wrist flexion, pronation, wrist abduction
	Mobile wad	Brachioradialis, ECRL, ECRB	Forearm extension, wrist flexion, ulna deviation
Thigh	Anterior	Quadriceps, sartorius	Knee flexion
	Posterior	Hamstrings	Knee extension
	Medial	Adductors, gracilis	Hip abduction
Leg	Anterior	Tib ant, EHL, EDL, Peroneus tertius	Ankle/ toe plantaflexion
	Deep posterior	Tib post, FHL, FDL, popliteus	Ankle/ toe dorsiflexion
	Superficial posterior	Gastrocnemius, plantaris, soleus	Ankle dorsiflexion
	Lateral	Peroneus brevis and longus	Inversion of foot



Compartment Pressure Measurement

- Required if clinical suspicion of compartment syndrome in
 - Polytrauma patient
 - Unreliable/ obtunded patient
 - Inconclusive physical examination
- **Not required if clinically compartment syndrome**
 - Urgent decompression needed with fasciotomies



Treatment

- BOAST 10: Diagnosis and Management of Compartment Syndrome of the Limbs
- Circumferential dressings should be released to skin
- Limb elevated to heart level
- Measures to maintain normal blood pressure
- Re-evaluate patients within 30 minutes
- Uncertainty: measure compartment pressures
- Persistence of symptoms: urgent surgical decompression within 1 hour of decision to operate





BRITISH ORTHOPAEDIC ASSOCIATION &
BRITISH ASSOCIATION OF PLASTIC, RECONSTRUCTIVE & AESTHETIC
SURGEONS

AUDIT STANDARDS for TRAUMA

OPEN FRACTURES

December 2017



Background and Justification

Open fractures may require timely multidisciplinary management. The consequences of infection, can be great both for the individual patient and the community. Trauma networks and hospitals require the appropriate pathways and infrastructure, to manage these patients, to enable optimum recovery and to minimise the risk of infection.

Inclusions: All patients with open fractures of long bones, hind foot or midfoot (excluding hand, wrist, forefoot or digit).

Standards for Practice Audit:

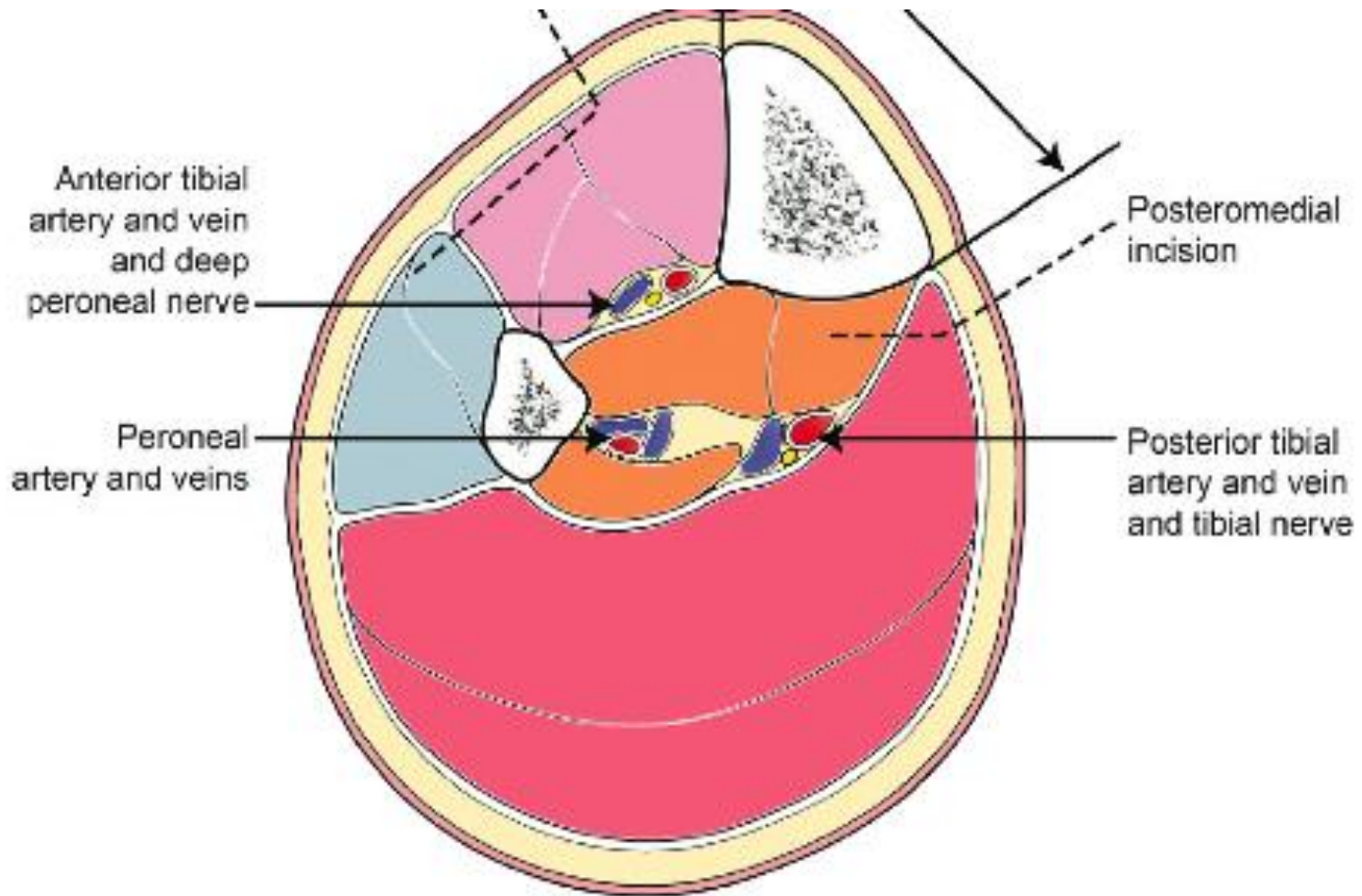
1. Patients with open fractures of long bones, hind foot or midfoot should be taken directly or transferred to a specialist centre that can provide Orthoplastic* care. Patients with hand, wrist, forefoot or digit injuries may be managed locally following similar principles.
2. Intravenous prophylactic antibiotics should be administered as soon as possible, ideally within 1 hour of injury.
3. There should be a readily accessible published network guideline for the use of antibiotics in open fractures.
4. The examination of the injured limb should include assessment and documentation of the vascular and neurological status. This should be repeated systematically, particularly after reduction manoeuvres or the application of splints. Management of suspected compartment syndrome should follow [BOAST guidelines](#).
5. The limb should be re-aligned and splinted.
6. Patients presenting with arterial injuries in association with their fracture should be treated in accordance with the [BOAST for arterial injuries](#).
7. In patients where an initial "Trauma CT" is indicated there should be protocols to maximise the useful information and minimise delay:
 - The initial sequence should include a head to toes scanogram. This should be used with clinical correlation to direct further specific limb sequences during that initial CT examination.
 - There should be a local policy on the inclusion of angiography in any extremity CT related to open fractures.
8. Prior to formal debridement the wound should be handled only to remove gross contamination and to allow photography, then dressed with a saline-soaked gauze and covered with an occlusive film. 'Mini-washouts' outside the operating theatre environment are not indicated.
9. All trauma networks must have information governance policies in place that enable staff to take, use and store photographs of open fracture wounds for clinical decision-making 24 hours a day.
10. Photographs of open fracture wounds should be taken when they are first exposed for clinical care, before debridement and at other key stages of management. These should be kept in the patient's records.
11. The formation of the management plan for fixation and coverage of open fractures and surgery for initial debridement should be undertaken concurrently by consultants in orthopaedic and plastic surgery (a combined orthoplastic approach).
12. Debridement should be performed using fasciotomy lines for wound extension where possible (see overleaf for recommended incisions for fasciotomies of the leg)
 - Immediately for highly contaminated wounds (agricultural, aquatic, sewage) or when there is an associated vascular compromise (compartment syndrome or arterial disruption producing ischaemia).
 - within 12 hours of injury for other solitary high energy open fractures
 - within 24 hours of injury for all other low energy open fractures.
13. Once debridement is complete any further procedures carried out at that same sitting should be regarded as clean surgery; i.e. there should be fresh instruments and a re-prep and drape of the limb before proceeding.
14. Definitive soft tissue closure or coverage should be achieved within 72 hours of injury if it cannot be performed at the time of debridement
15. Definitive internal stabilisation should only be carried out when it can be immediately followed with definitive soft tissue cover.
16. When a decision whether to perform limb salvage or delayed primary amputation is indicated, this should be based on a multidisciplinary assessment involving an orthopaedic surgeon, a plastic surgeon, a rehabilitation specialist, the patient and their family or carers.
17. When indicated, a delayed primary amputation should be performed within 72 hours of injury.
18. Each trauma network should submit appropriate data to the TARN, monitor its performance against national standards and audit its outcomes.
19. All patients should receive information regarding expected functional recovery and rehabilitation, including advice about return to normal activities such as work and driving

Operative Treatment

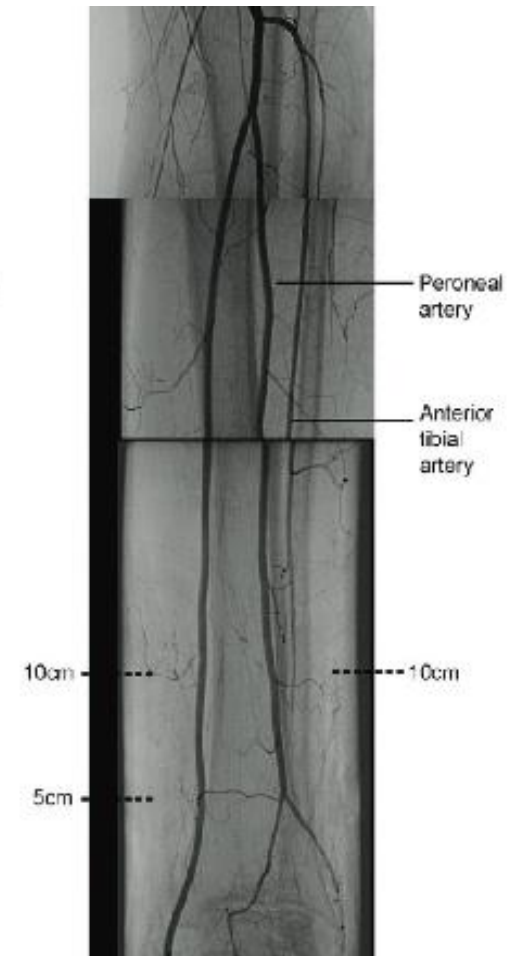
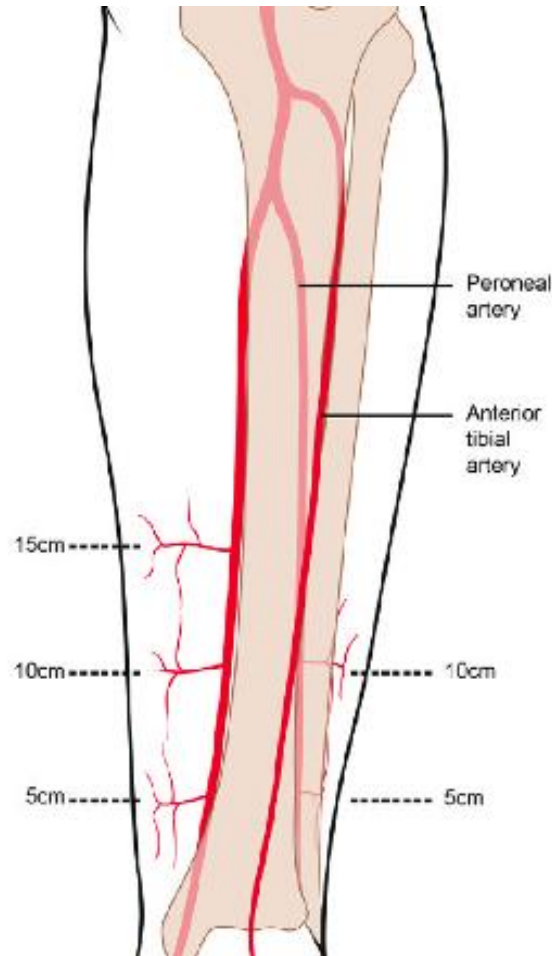
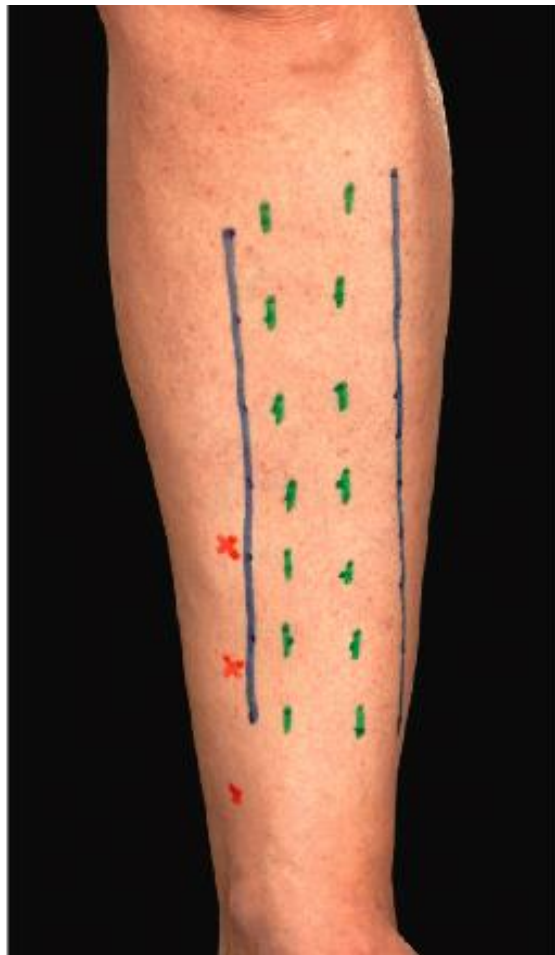
- Immediate open fascial decompression of all involved compartments with account taken for reconstructive options
- Excise necrotic muscle
- Re-exploration at 48 hours (earlier if indicated)
- Lower leg fasciotomies: 2 incision 4 compartment decompression (BOAST for Open Fractures)
- Nil consensus for foot compartment syndrome management
- Late presentation (> 12 hours): high complication risk with surgery ? Non operative management



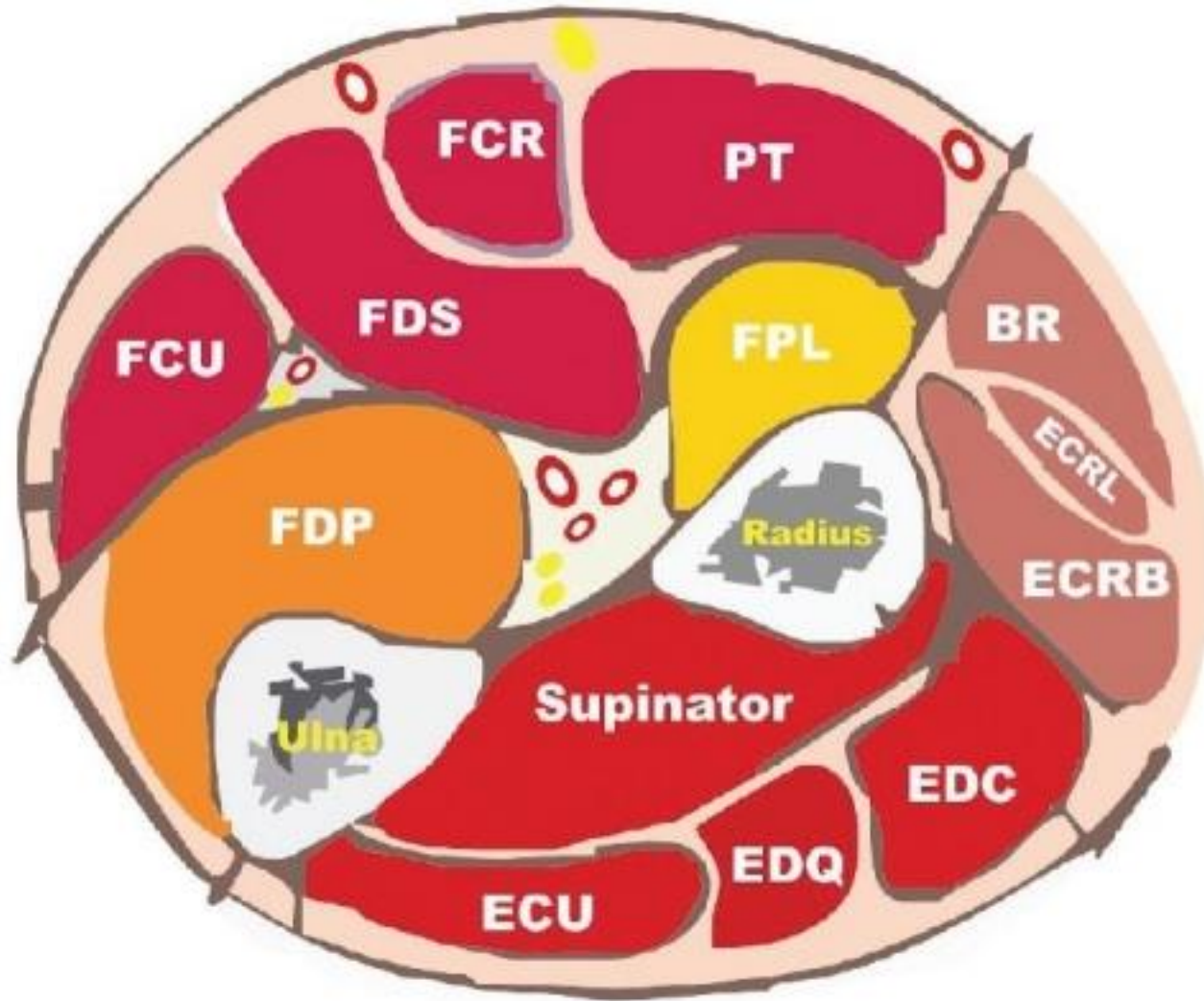
Leg Compartments (BOAST for Open Fractures)



Leg Fasciotomies (BOAST for Open Fractures)



Forearm Compartments



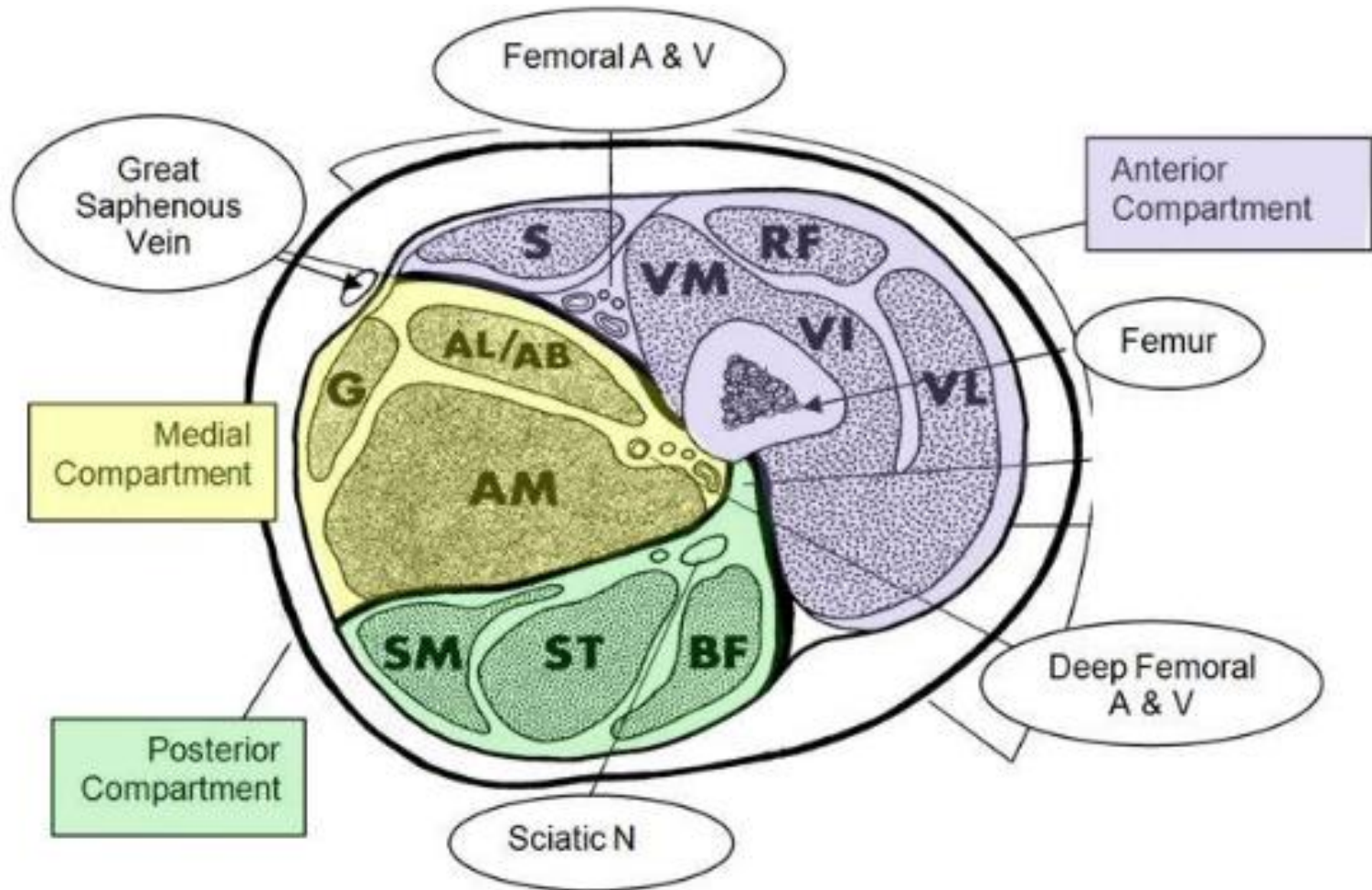
Forearm Fasciotomies



Forearm Fasciotomies

- Volar compartment most commonly affected
- Volar incision:
 - Volar and dorsal compartment decompression
 - Commence radial to FCU and extend to medial epicondyle +/- carpal tunnel
- Dorsal incision
 - Mobile wad and dorsal compartment decompression
 - 2cm distal to lateral epicondyle and extend towards wrist in midline

Thigh Compartments

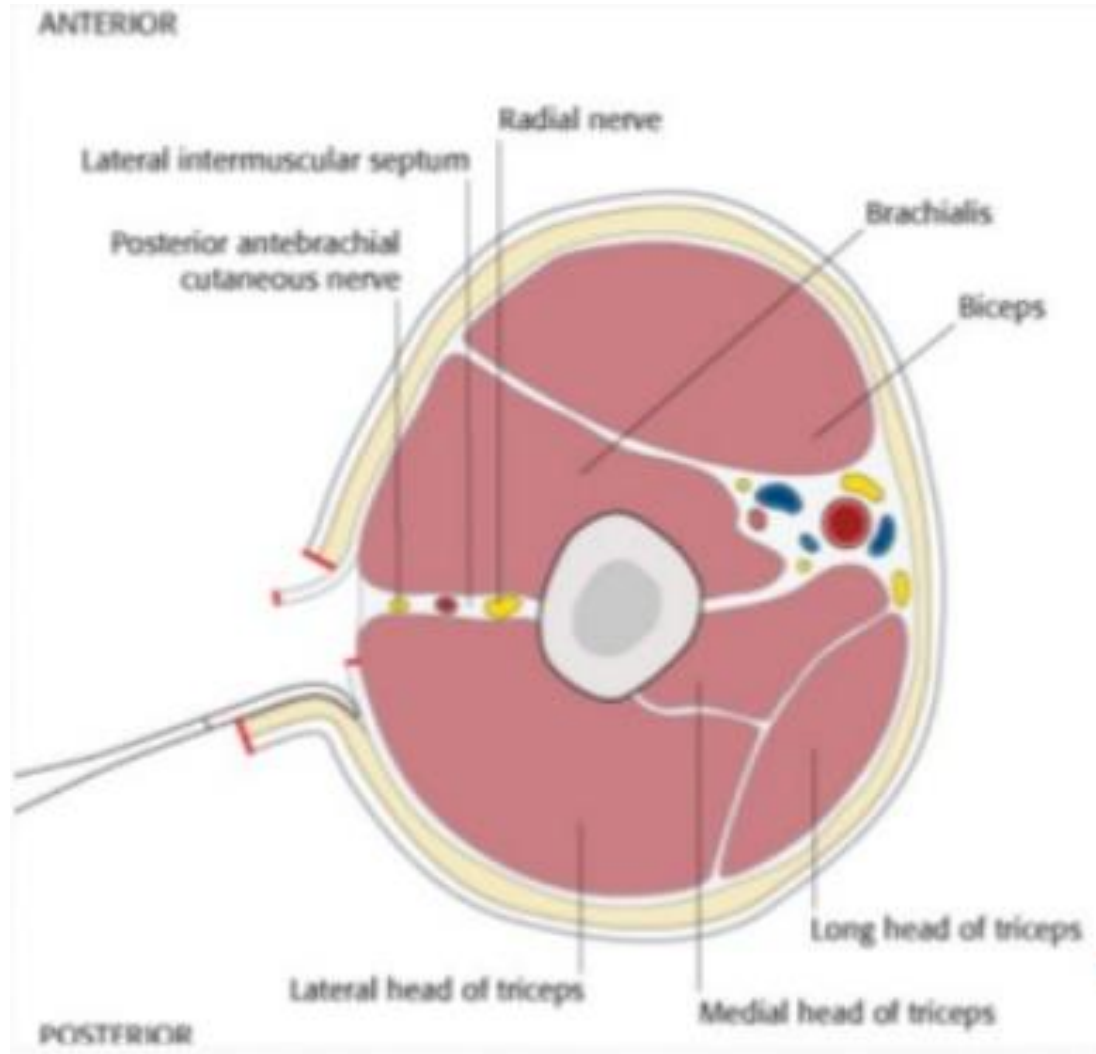


Thigh Fasciotomies

- Anterior and posterior compartments
 - Anterolateral incision over length of thigh
 - Incises fascia lata to decompress anterior compartment
 - Incise lateral intermuscular septum (deep to vastus lateralis) to decompress posterior compartment
- Medial compartment
 - Medial incision



Arm Compartments

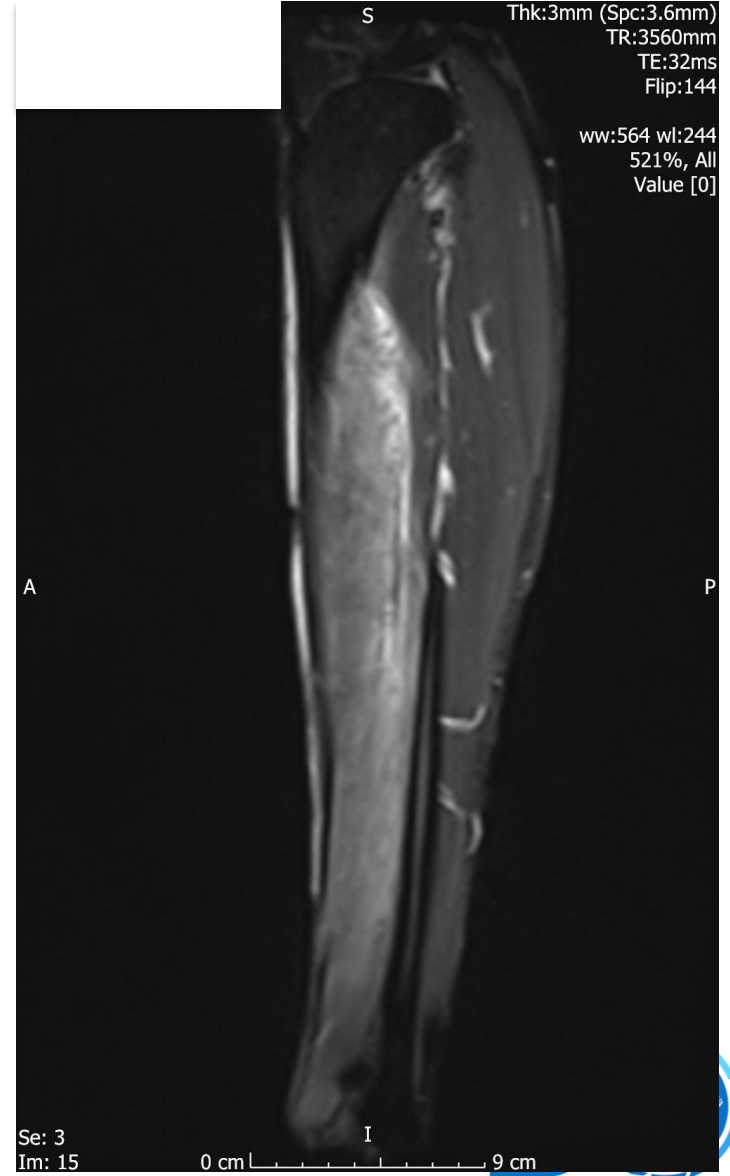
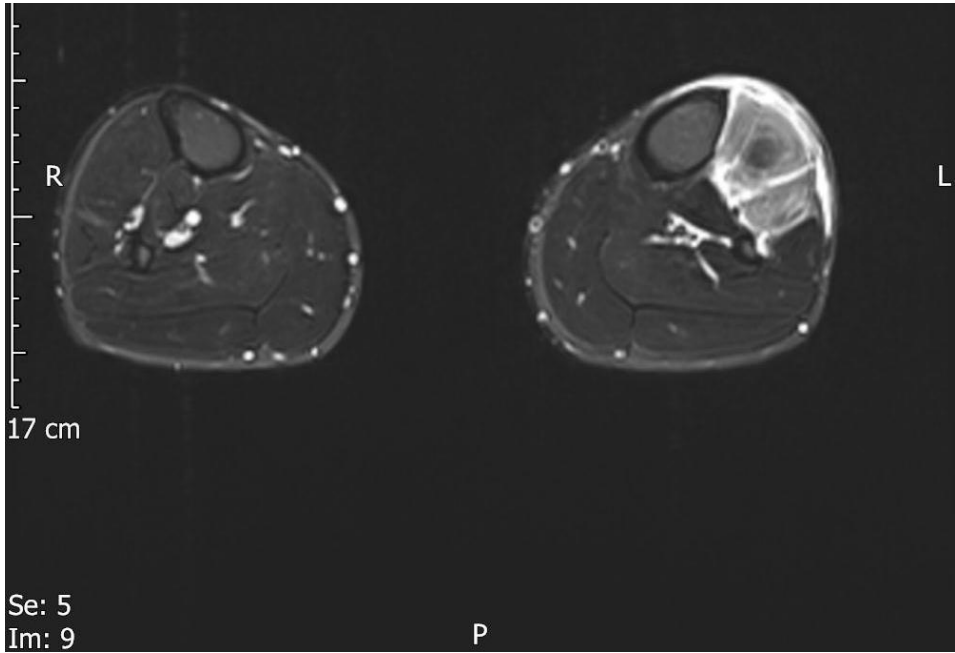


Complications

- Ischaemic contractures due to muscle necrosis
- Infection
- Sensory deficit
- Decreased strength/ muscle function
- Myositis ossificans
- Pain

Atypical Presentation

- 24yo male
- Reported some pain; gradual onset and appeared comfortable
- Parasthesia with foot drop
- Tense anterior compartment
- Raised CK
- Acute myositis/ fasciitis appearance consistent with acute compartment syndrome on MRI



References

- British Orthopaedic Association Standards for Trauma for Open Fractures and Guideline 10
- Acute compartment syndrome. Who is at risk. M. McQueen, P Gaston, C. M. Court Brown *Journal of Bone and Joint Surgery* March 2000 82.B; 2; 200-203
- Standards for the Management of Open Fractures of the Lower Extremity (BAPRAS)
- www.orthobullets.com



Thank you!

Presentation available on
<https://www.bon.ac.uk>

