

Indications and Techniques of Lower Extremity Fasciotomy

Case Presentation from Kings County Hospital Center

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PGY-4

Case Presentation

Patient details

- Age: 54 years
- Sex: Male
- PMHx: HTN, polysubstance abuse
- PSHx: Left femoropopliteal bypass 2 months prior to presentation at outside hospital
- Meds: Diovan
- Allergies: Nil
- Social Hx: + smoking, + ETOH, polysubstance abuse

● Presentation:

- To ER on 8/25 s/p fall off bicycle after developing left lower extremity weakness
- Trauma work up by ER – no injuries
- Admitted to medicine for management of polysubstance abuse
- Following morning (12 hrs later) noted by medicine team to have a cold left foot with “decreased” pulses
- CTA of LLE ordered by medical team and vascular surgery consult called

O/E:

- Noted to be in obvious pain.
- HR: 90-100, BP: 160-170/75-100, Sats: 100% RA
- CNS: AAO x 3, very agitated
- RS: CTAB
- CVS: No murmurs
- Abdo: Soft, NT, no pulsatile mass
- Extremities: LLE - Discolored and cold up to ankle

Loss of sensation up to knee

Motor deficit with foot drop

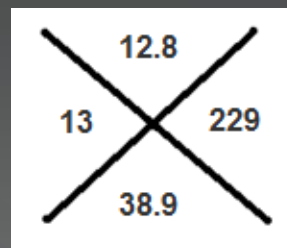
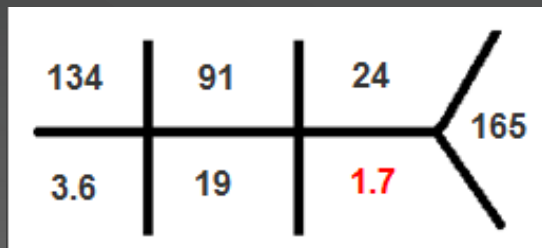
Tense anterior compartment

Pulse exam

LLE – No palpable or dopplerable signals past the femoral

RLE – Palpable femoral pulse, good doppler signals down to DP

● Labs



ETOH < 10

CK: 14,800 --> 15,638

LFTs: WNL

ABG: 7.44 / 35 / 113 / 24 / 0.2

U Tox: Cocaine +, methadone +, opiates +

CT Angio

2261164KI

Contrast: CONTRAST

Gantry: 0°

FoV: 194 mm

Time: ms

Slice: 2.5 mm

Pos: 134.9

FFS

F: B

mA: 307

120 kV

Image no: 56

Image 56 of 424

8/25/2012, 10:19:28 AM

C: 50.0, W: 350.0

RUNOFF 2.5X2.5



2261164KI

Contrast: CONTRAST

Gantry: 0°

FoV: 194 mm

Time: ms

Slice: 2.5 mm

Pos: 122.4

FFS

C: 50.0, W: 350.0

RUNOFF 2.5X2.5

F: B

mA: 279

120 kV

Image no: 51

Image 51 of 424

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L

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3



C: 50.0, W: 350.0

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2261164KI

Contrast: CONTRAST

Gantry: 0°

FoV: 194 mm

Time: ms

Slice: 2.5 mm

Pos: 147.4

FFS

F: B

mA: 353

120 kV

Image no: 61

Image 61 of 424

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C: 50.0, W: 350.0

RUNOFF 2.5X2.5

2261164KI

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FoV: 194 mm

Time: ms

Slice: 2.5 mm

Pos: 164.9

FFS

F: B

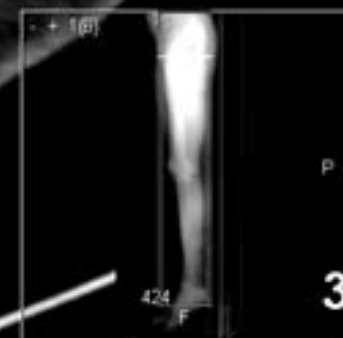
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120 kV

Image no: 68

Image 68 of 424

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2261164KI

Contrast: CONTRAST

Gantry: 0°

FoV: 194 mm

Time: ms

Slice: 2.5 mm

Pos: 209.9

FFS

F: B

mA: 436

120 kV

Image no: 86

Image 86 of 424

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C: 50.0, W: 350.0

RUNOFF 2.5X2.5

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Contrast: CONTRAST

Gantry: 0°

FoV: 194 mm

Time: ms

Slice: 2.5 mm

Pos: 444.9

FFS

F: B

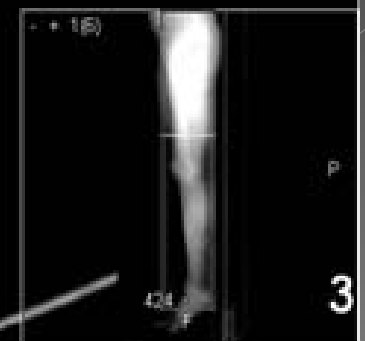
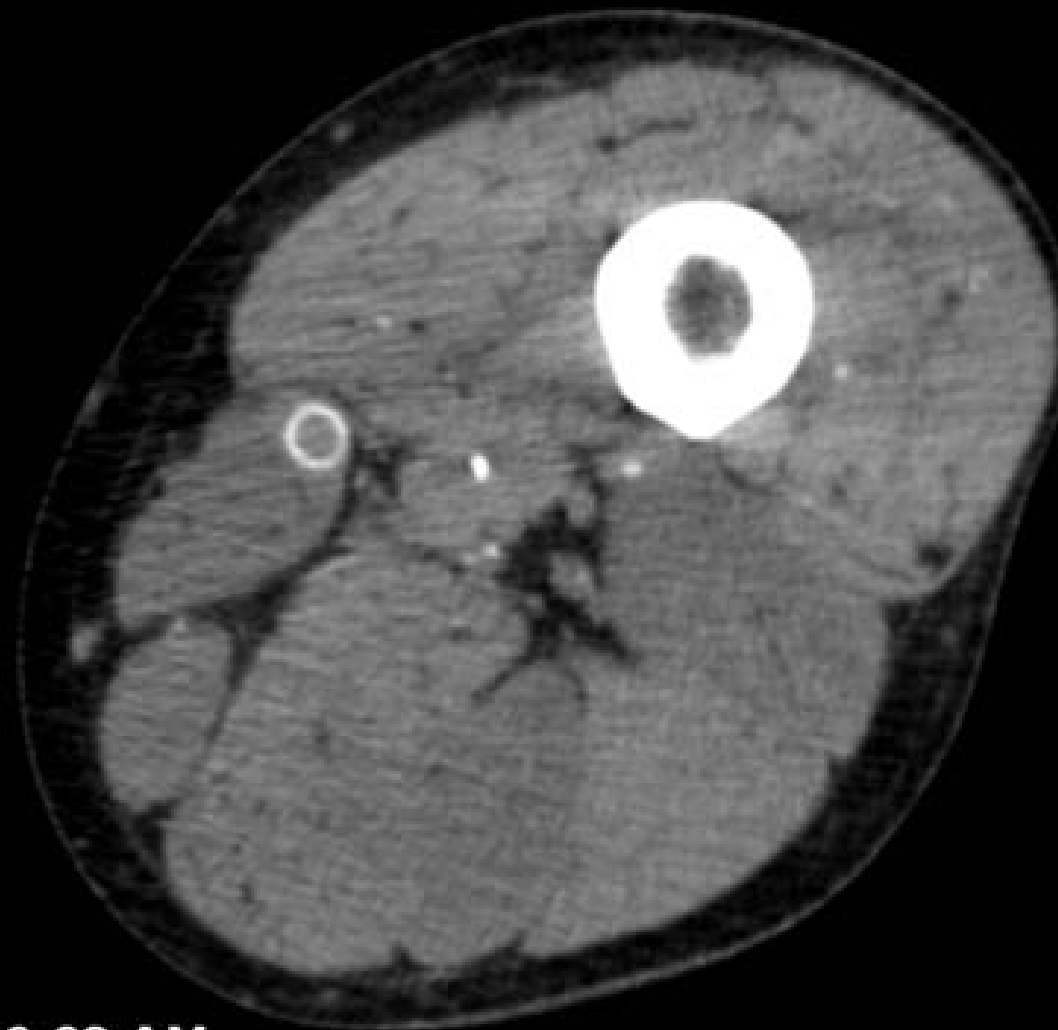
mA: 137

120 kV

Image no: 180

Image 180 of 424

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C: 50.0, W: 350.0

RUNOFF 2.5X2.5

2261164KI

Contrast: CONTRAST

Gantry: 0°

FoV: 194 mm

Time: ms

Slice: 2.5 mm

Pos: 494.9

FFS

F: B

mA: 136

120 kV

Image no: 200

Image 200 of 424

8/25/2012, 10:19:28 AM



C: 50.0, W: 350.0

RUNOFF 2.5X2.5

2261164KI

Contrast: CONTRAST

Gantry: 0°

FoV: 194 mm

Time: ms

Slice: 2.5 mm

Pos: 677.4

FFS

F: B

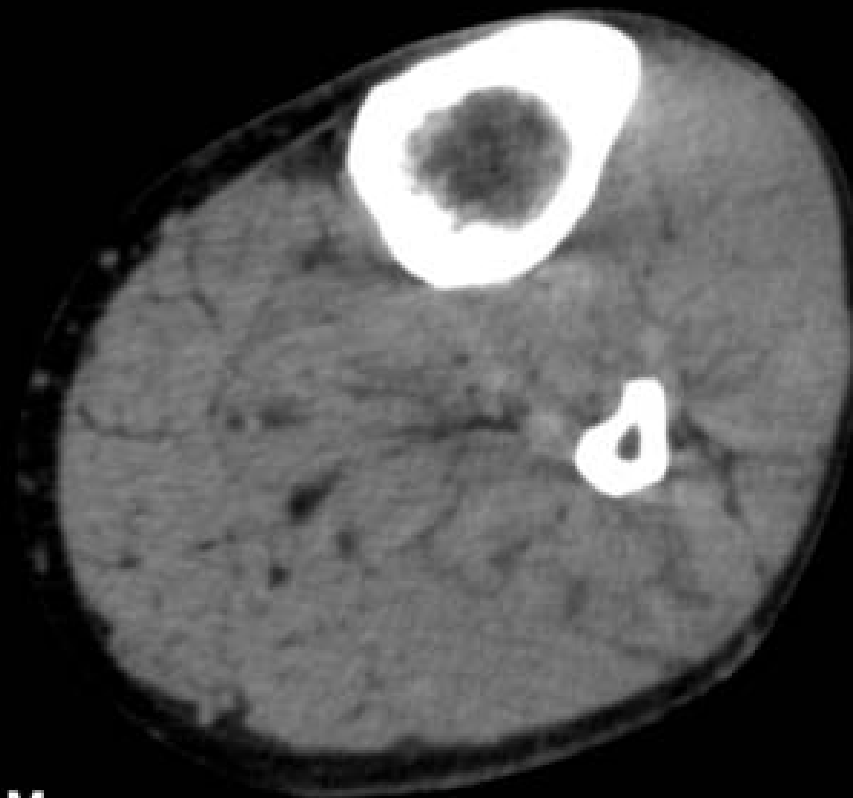
mA: 136

120 kV

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Image 273 of 424

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- Impression: Acute LLE ischemia with compartment syndrome, likely from acute graft thrombosis
- Management: Heparin infusion started and patient taken emergently to OR

- Wide prep from umbilicus to ankle
- Medial approach to the popliteal artery
- Proximal and distal control
- Thromboembolectomy of below knee popliteal artery with Fogarty catheter
- Inadequate back bleeding
- Run off angiogram showing patent AT
- 4 compartment fasciotomy
 - Anterolateral fasciotomy: 15cm long incision lateral to anterior tibial border followed by fascial release and subcut extension
 - Posterior fasciotomy: extension of initial medial approach incision, release of soleal fibers
 - Both showed edematous but viable muscles
- Groin incision
- Native femoral to distal popliteal bypass with PTFE graft
- Completion angio showed flow through new graft with AT run off
- Counter incision on medial lower leg with closure of skin over the graft

● POD #0-2

- Remained intubated
- Continued on heparin drip
- Palpable DP pulse
- Forefoot with ischemic patches
- Rhabdomyolysis
 - CK up to 100,620
 - + urine myoglobin
 - Managed with aggressive diuresis, bicarbonate drip

● POD #3

- CK level plateaued at 24,000
- Noted to have tense fasciotomy sites
- Muscles of posterior compartment more dusky
- Return to OR for fasciotomy extension
 - Extension of lateral fasciotomy – viable edematous muscles
 - Extension of medial skin incision and further release of soleus from tibia – pale boggy muscles in both posterior compartments

● POD #4/1

- Patient extubated
- Continued on anticoagulation
- CK trending down

● POD #5-8/2-5

- Persistent fevers and rising WBC count
- Return to OR for debridement of posterior compartment tissues

● POD #13/10/4

- Sepsis controlled
- Return to OR for knee disarticulation in preparation for AKA. Old graft and patent new graft ligated

● POD #20/17/11

- Return to OR for formal AKA

● Currently awaiting rehab placement

Questions?

Lower Extremity Fasciotomy

Outline

- Indications/contraindications

Acute compartment syndrome – etiology and pathophysiology

- Anatomy

- Techniques

- Complications

Technical and metabolic

- Wound management

History

- 1881 – Volkman: irreversible contractures from ischemic muscle (forearm)
- 1906 – Hildebrand: “Volkman’s ischemic contracture” to describe untreated compartment syndrome
- 1914 – Murphy: concept of tissue perfusion and CS, fasciotomy to prevent contractures
- 1967 – Seddon, Kelly and Whitesides: existence of 4 compartments in the leg and need for 4 compartment decompression

Discussion

- Definition: Fasciotomy is a surgical procedure where the fascia is cut to relieve tension or pressure.
- Indications
 - Acute compartment syndrome
 - Chronic compartment syndrome
 - Prophylactic fasciotomy

Acute Compartment Syndrome (ACS)

- Condition where increased interstitial pressure within a compartment compromises circulation and function of the tissues within that space
- Usually muscle bound by strong, unyielding fascial membrane – extremities
Also in abdominal and thoracic cavities
- Limb-threatening and potentially life-threatening

Etiology of ACS

- Long bone fractures (75% of cases)
Risk factors – Tibial fractures, comminuted fractures, young males, closed fracture-reduction
- Trauma without fracture – Crush injury, severe burns, circumferential bandages, vascular injury, intramuscular hemorrhage in anticoagulated patients
- Non-traumatic causes – Ischemia reperfusion injury, thrombosis, bleeding disorders, nephrotic syndrome, animal envenomations, IM injections

Pathophysiology

- Pressure gradient theory (Whiteside theory)
 - Compromised perfusion when compartment pressure rises to within 10-30 mmHg of diastolic pressure
 - Normal compartment pressure – 0-4 mmHg
 - Rise in compartment pressure → decreased venous outflow → increased venous pressure → decreased AV pressure gradient → shunting of blood away from intracompartmental tissues
 - Inadequate venous drainage → tissue edema → rise in interstitial pressure

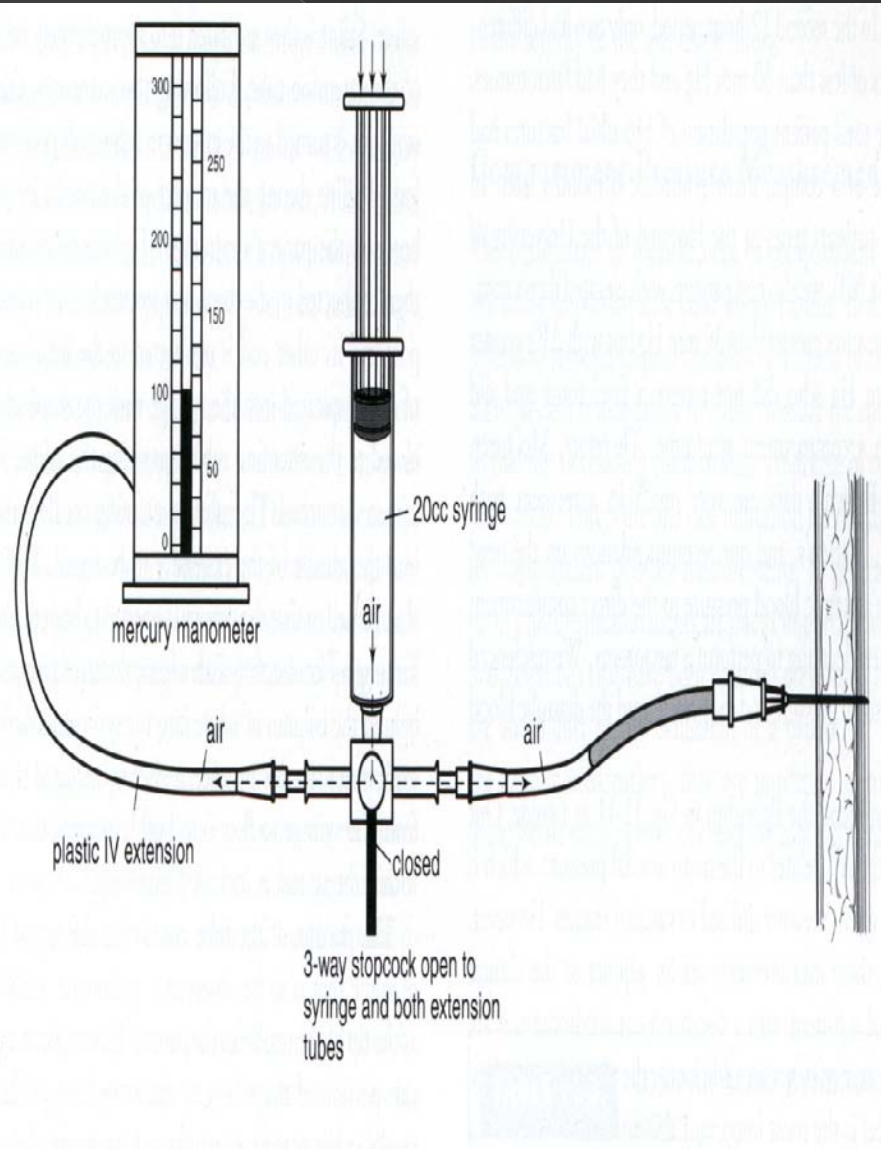
Diagnosis – Clinical Features

- Acute compartment syndrome is a clinical diagnosis
 - High index of suspicion
 - 6 Ps
 - Pain out of proportion
 - Pain with passive stretch
 - Palpably tense compartment
 - Paresthesia
 - Paralysis
 - Pulselessness
- early and important signs
- too late and unreliable

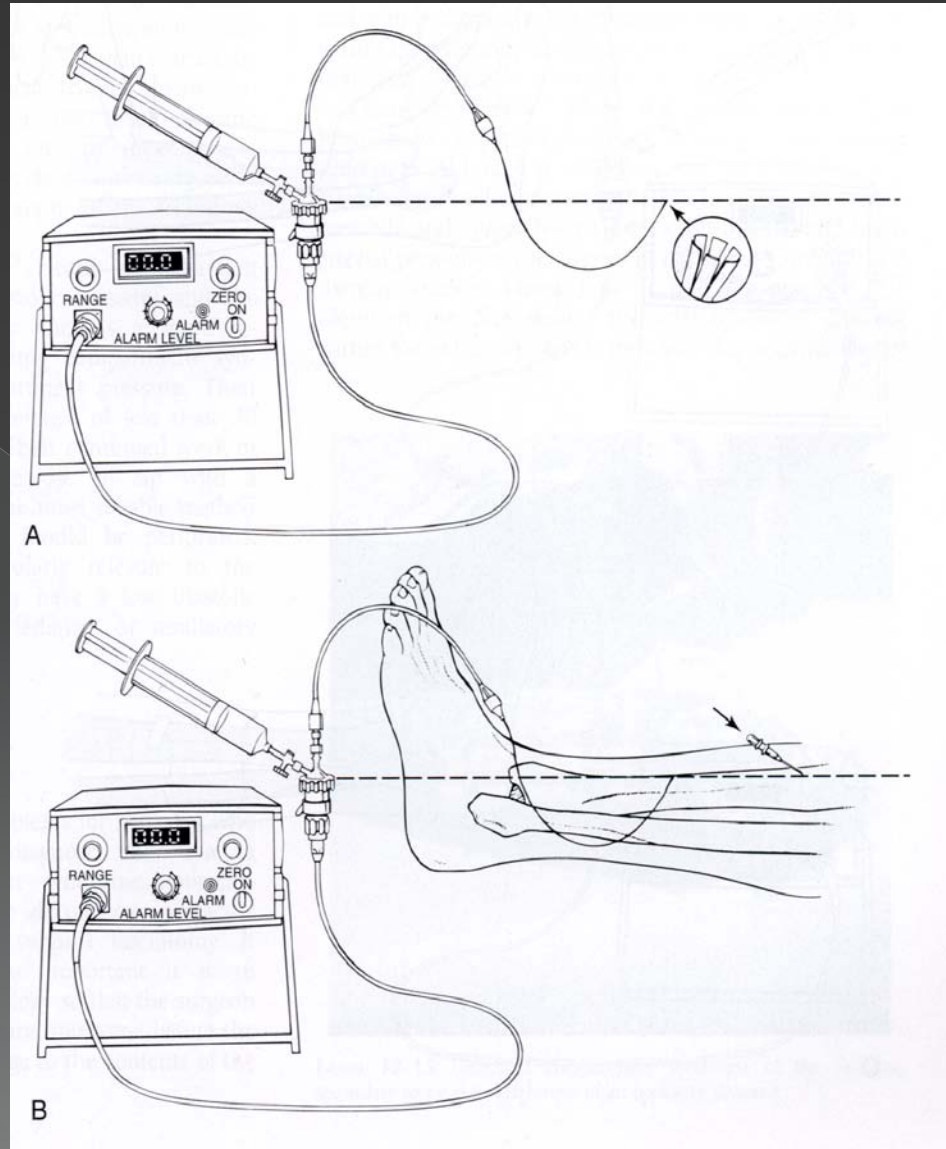
Diagnosis – Pressure Measurement

- Suspected compartment syndrome
- Equivocal or unreliable exam
- Clinical adjunct
- Contraindication
 - Clinically evident compartment syndrome

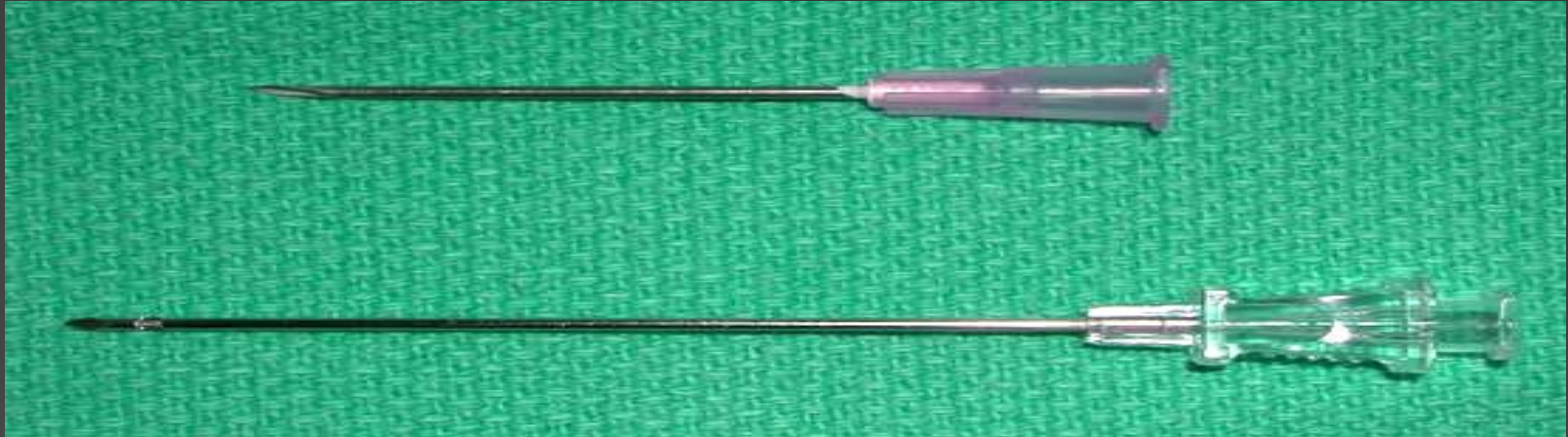
Whiteside Technique



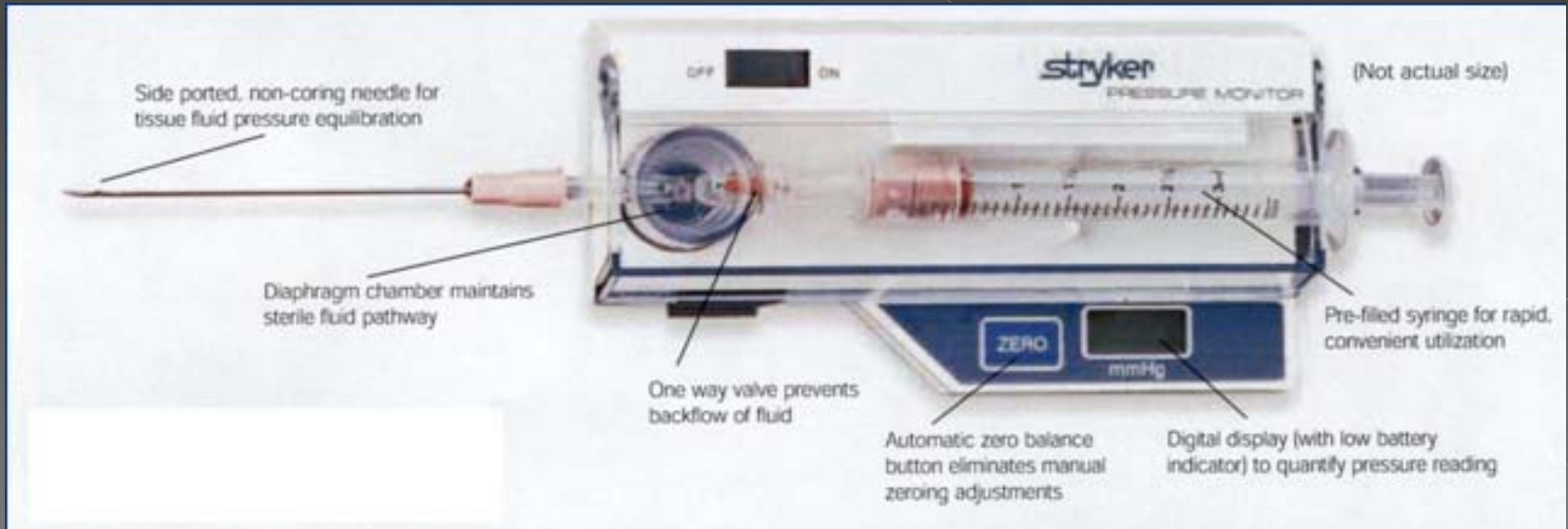
Slit Catheter



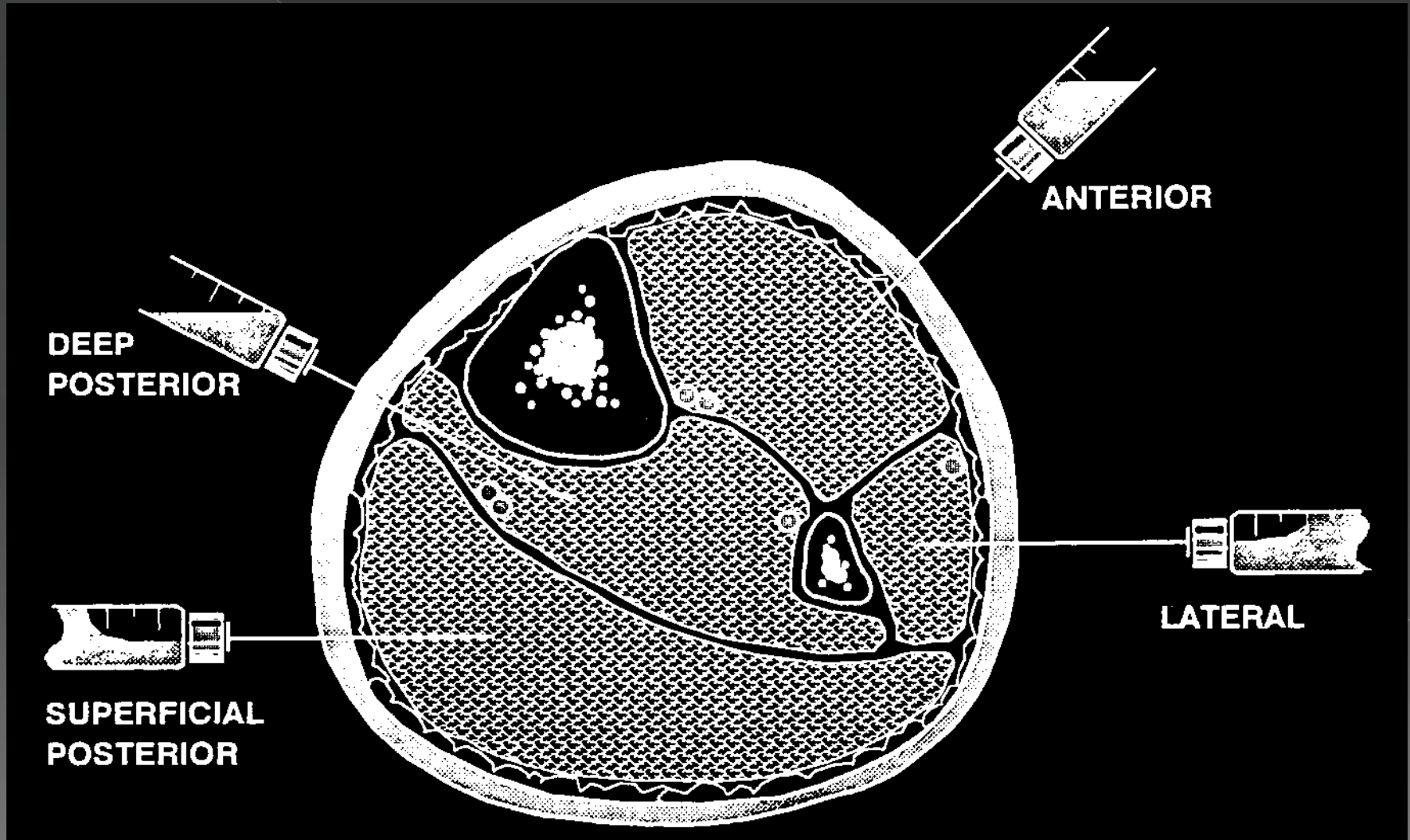
- Simple 18 gauge needle connected to arterial line measurement system



- Handheld manometer



- Measurements must be made in all compartments



Decision making – McQueen JBJSB 1996

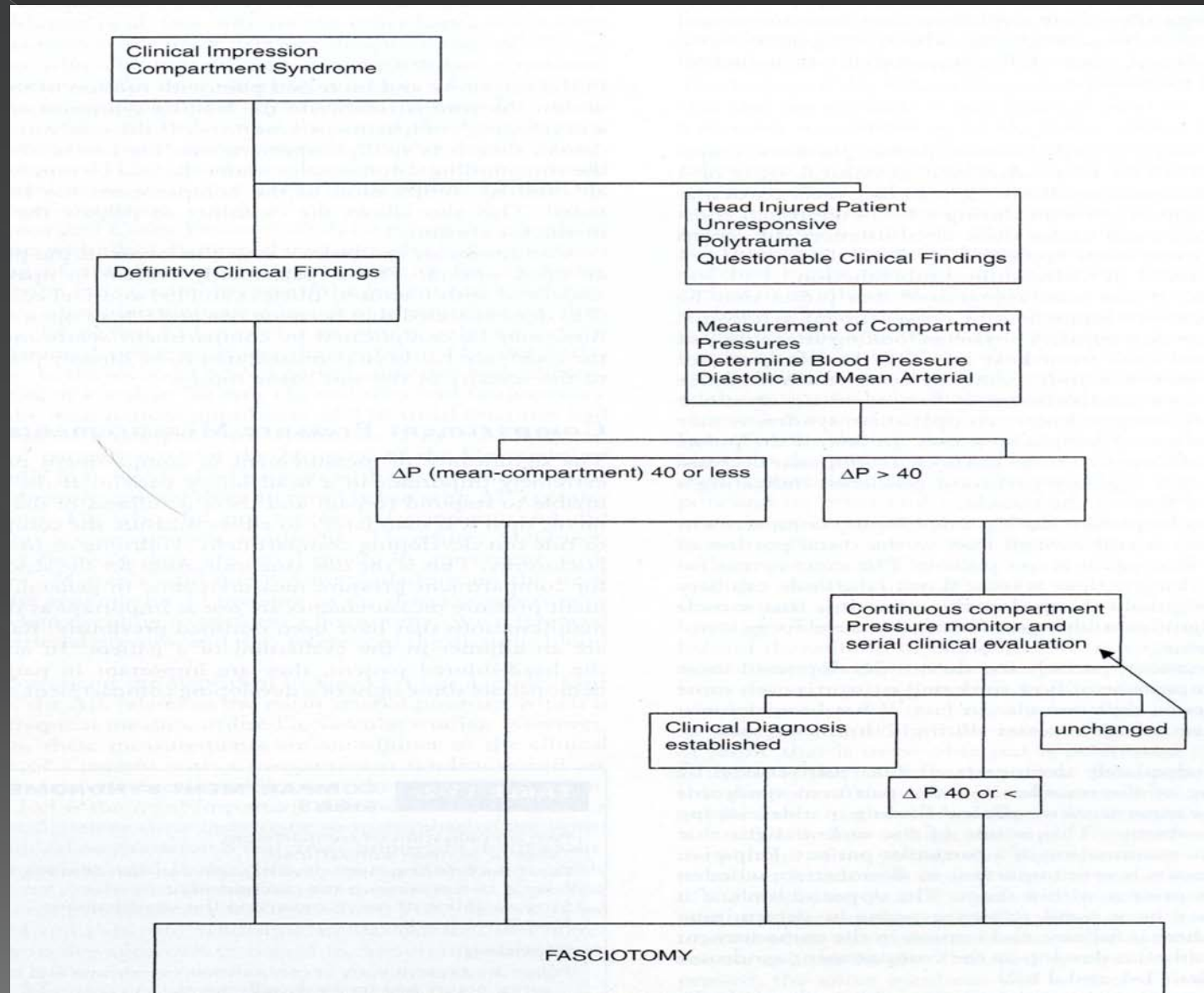


FIGURE 11-11. Algorithm for management of compartment syndrome.

Management

- Medical management/optimization
 - Remove circumferential bandages and casts
 - Fluid resuscitation if hypotensive (to improve perfusion pressure)
 - Maintain limb at the level of the heart (neither elevated nor dependent)
 - Supplemental oxygen administration

- Definitive management is surgical
 - **IMMEDIATE 4 COMPARTMENT FASCIOTOMY**

Chronic Compartment Syndrome (CCS)

- ◉ Also known as “Exertional Compartment Syndrome”
- ◉ Seen in athletes
- ◉ Occurs from repetitive loading or exertional activities
- ◉ Most commonly affects anterior compartment
- ◉ Initial management is non-operative (running on softer surfaces, better orthotics, etc.)
- ◉ Fasciotomy indicated if above fails

Prophylactic Fasciotomy

- Indicated when increased extremity swelling is anticipated in the post-op period
- Performed in conjunction with the index operation
- Vascular procedures
 - Prolonged ischemia time (6 hrs)
 - Acute arterial occlusion with insufficient collaterals
 - Combined traumatic arterial and venous injuries

Prophylactic Fasciotomy (cont.)

- Orthopedic procedures
 - Comminuted fractures
 - Tibial fractures (involving diaphysis)
 - Fractures associated with arterial injuries

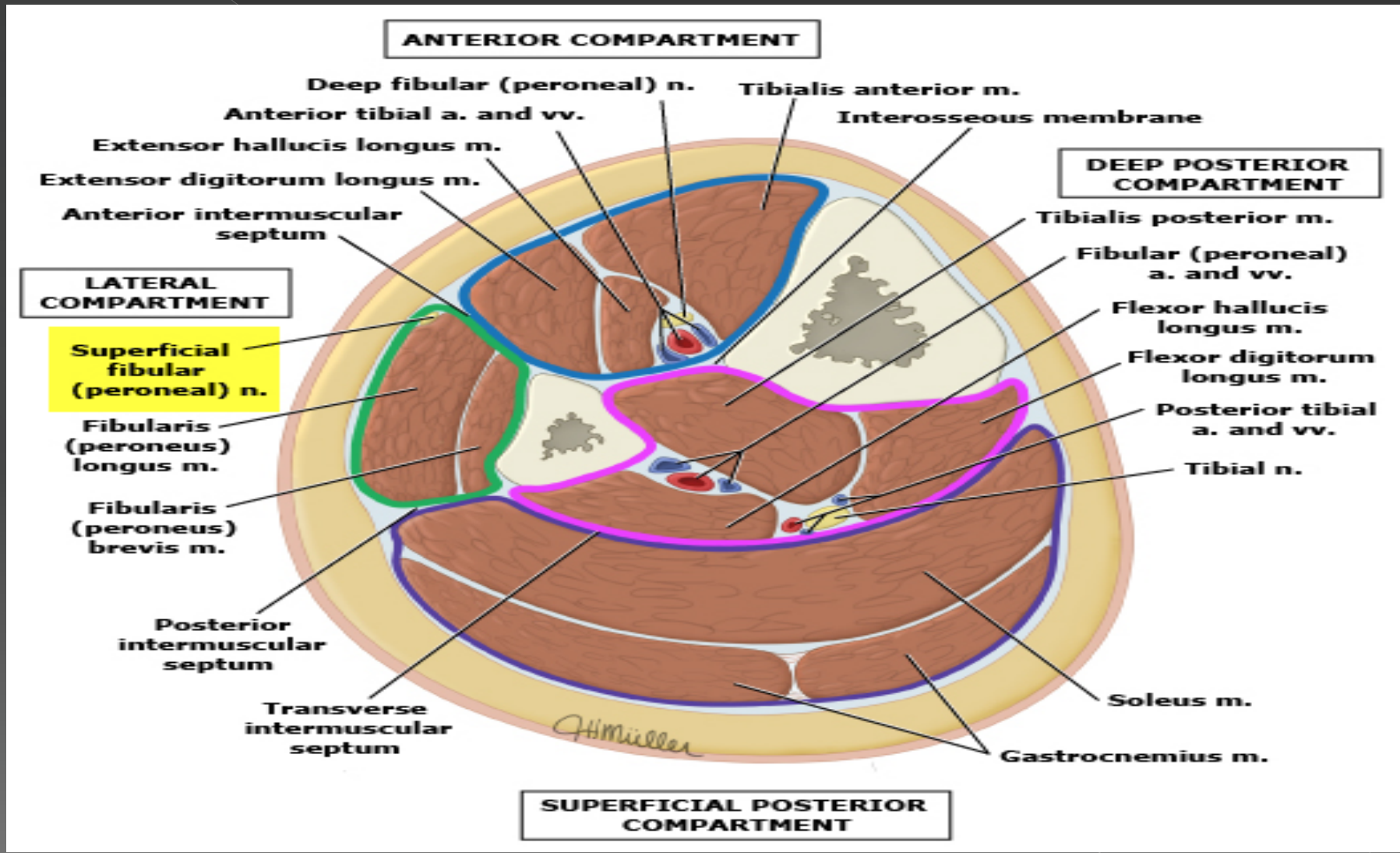
Contraindications

- Extremity non-viable due to multiple injuries or severe tissue ischemia
- Missed compartment syndrome (>10-12 hrs)
- Greater risks from delayed fasciotomy
 - Life-threatening reperfusion injury
 - Higher infection rate



Anatomy

• Muscle compartments of the leg

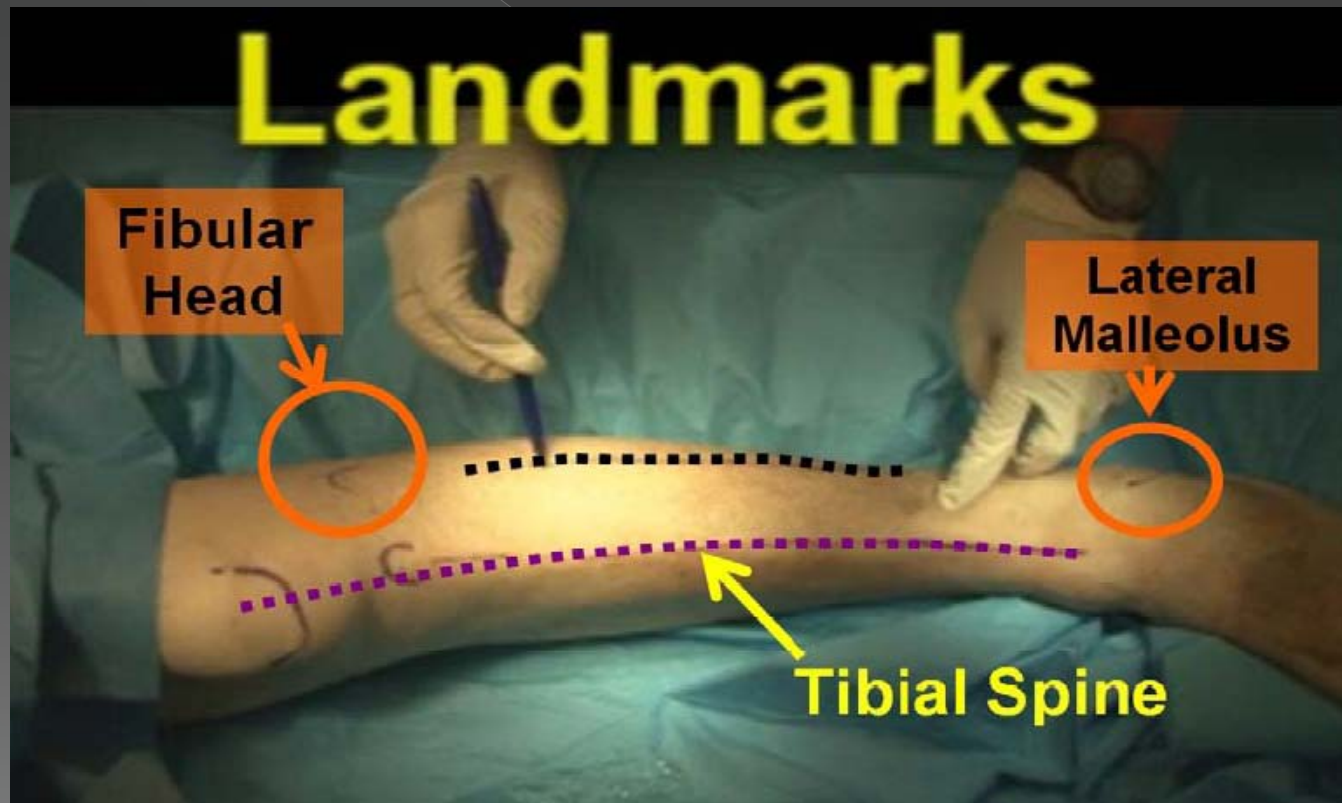


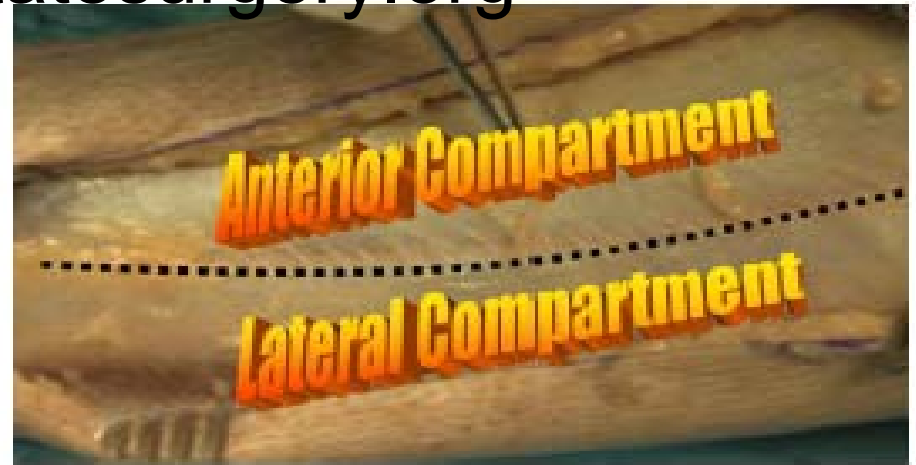
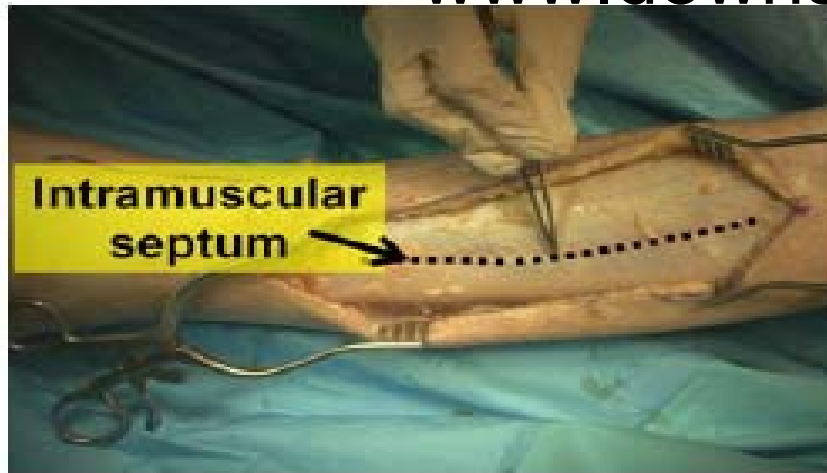
Techniques

Double incision 4 compartment fasciotomy

Anterolateral fasciotomy:

Lateral skin incision – 1 finger breadth anterior to edge of fibula





The lateral incision on this left lower extremity nicely demonstrates the intramuscular septum which separates the anterior and lateral compartments of the lower leg.



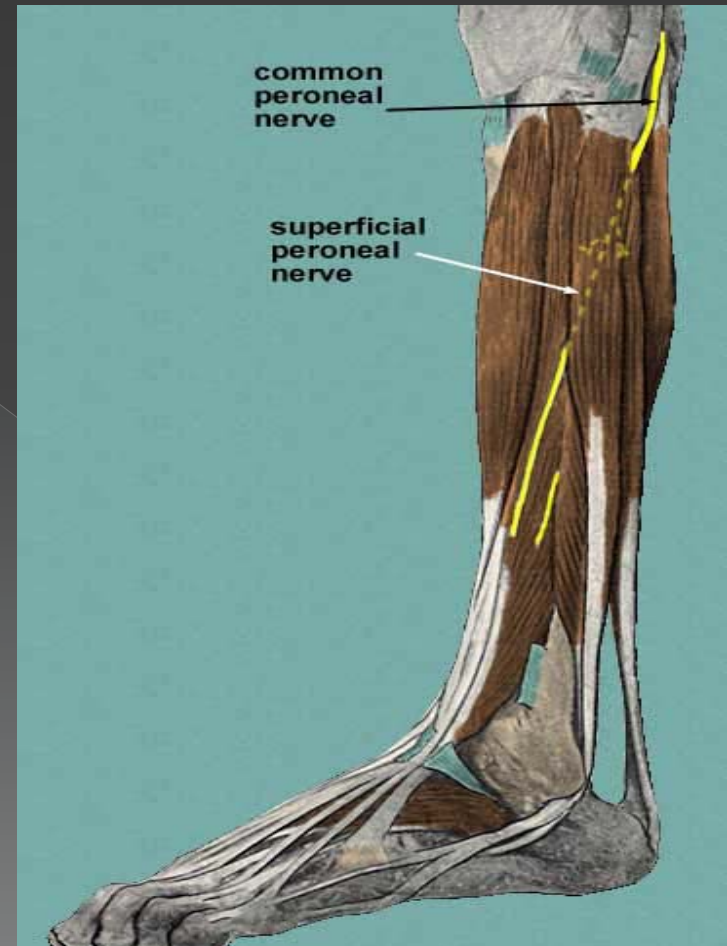
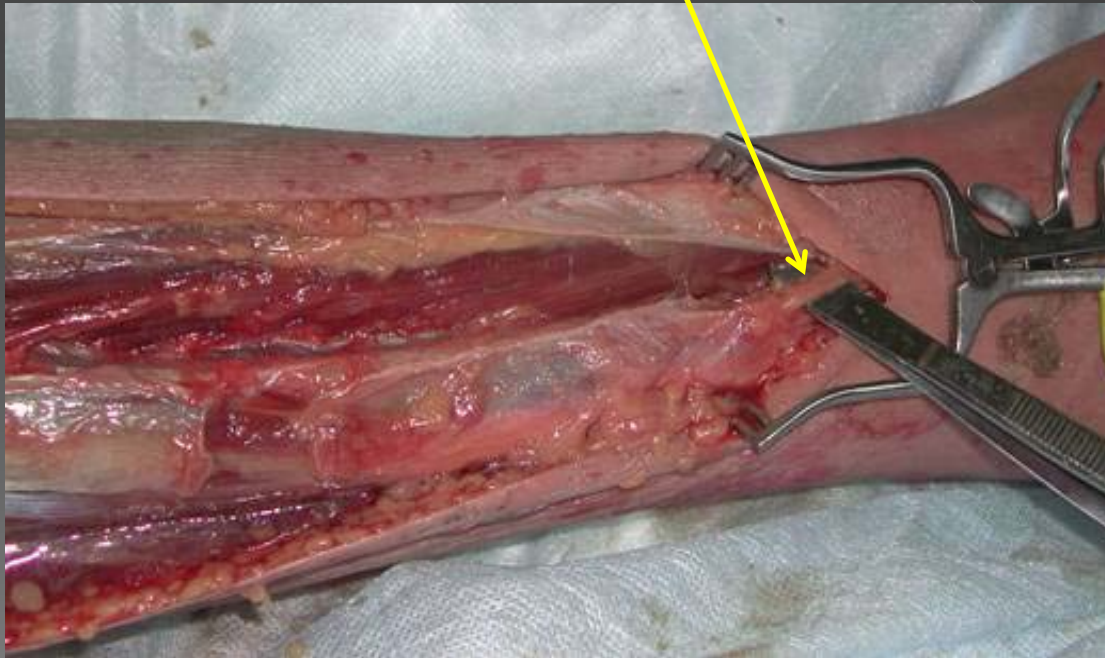
The fascia of the lateral lower leg is classically opened in a "H" shaped fashion for the length of the compartments



Once the fascia have been opened identification of the septum and deep peroneal nerve confirms entry into both compartments

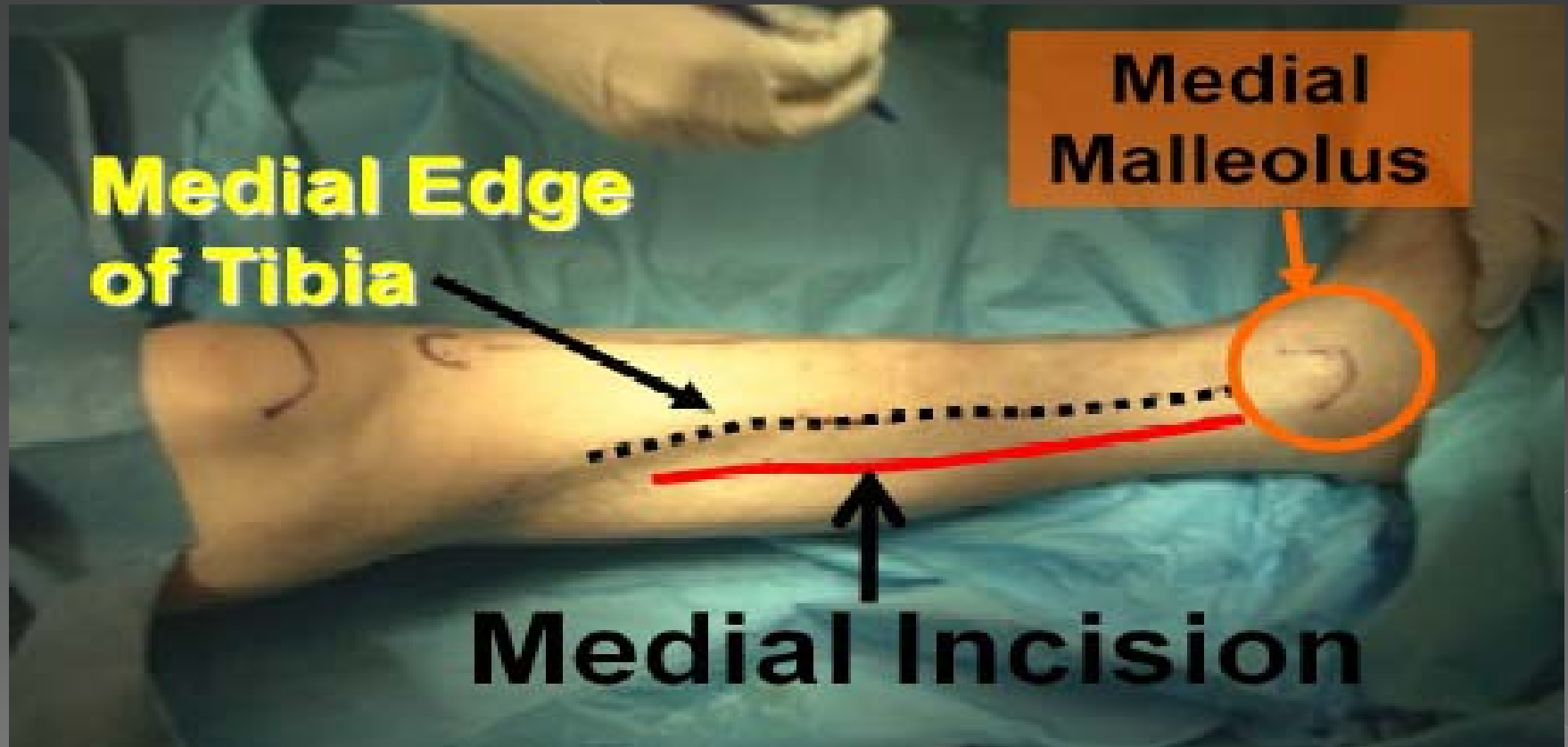
- Identify and preserve superficial peroneal nerve
- Exits from lateral compartment 10 cm above lateral malleolus and courses into anterior compartment

Superficial peroneal nerve



Posterior compartment fasciotomy

- Posteromedial skin incision – 1 finger breadth posterior to medial edge of tibia
- Identify and preserve saphenous nerve and vein





The medial incision is made below the edge of the tibia and the saphenous vein seen just below the retractor is preserved.



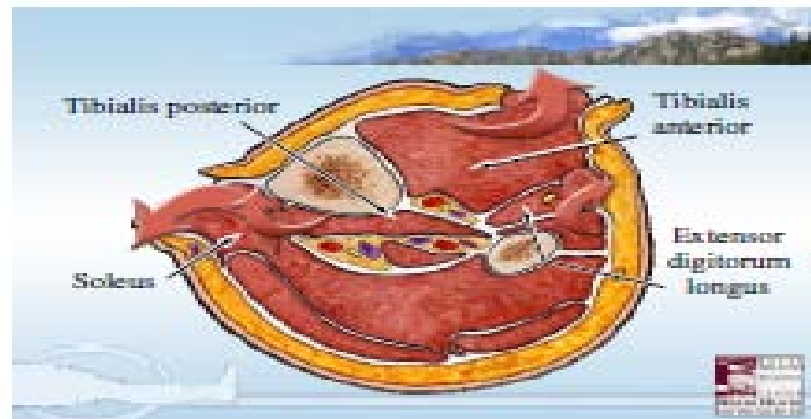
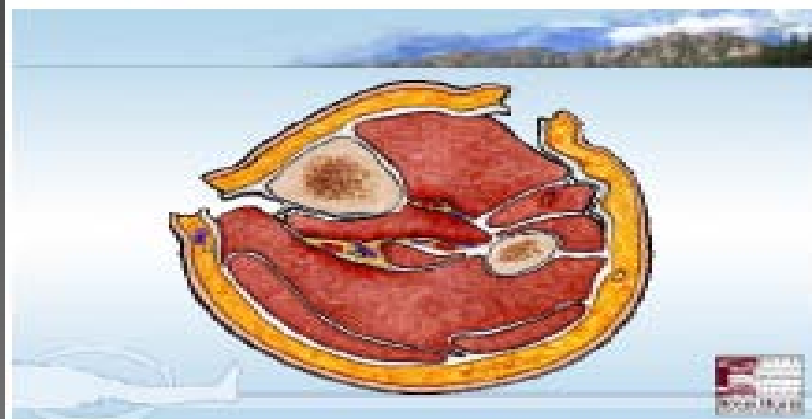
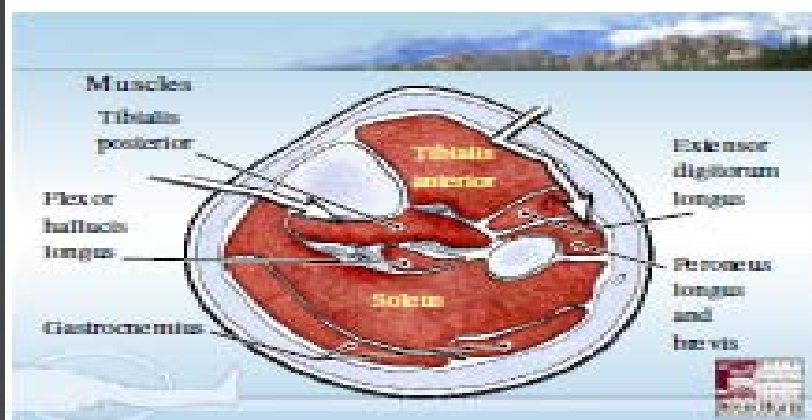
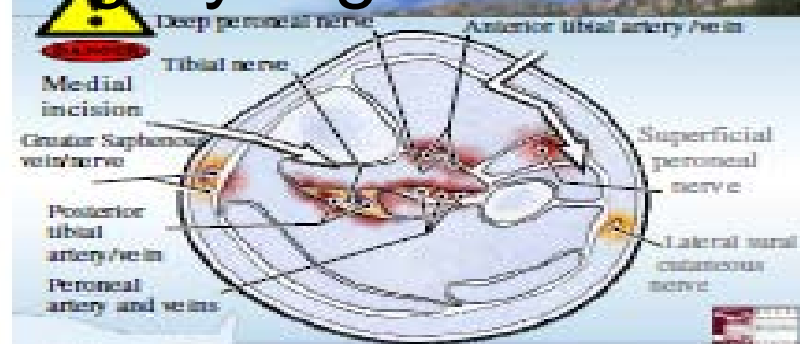
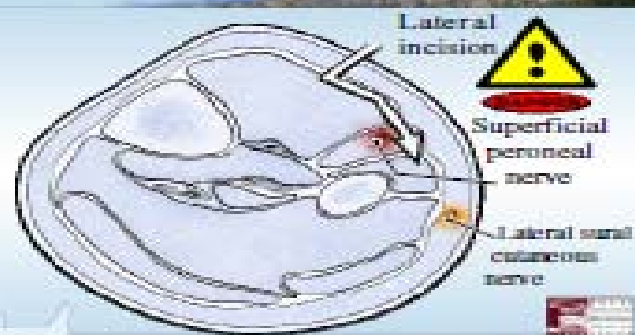
The fascia below the incision is opened decompressing the superficial posterior compartment.



dissecting the soleus muscle fibers off the undersurface of the tibia allows entry into the deep posterior compartment.



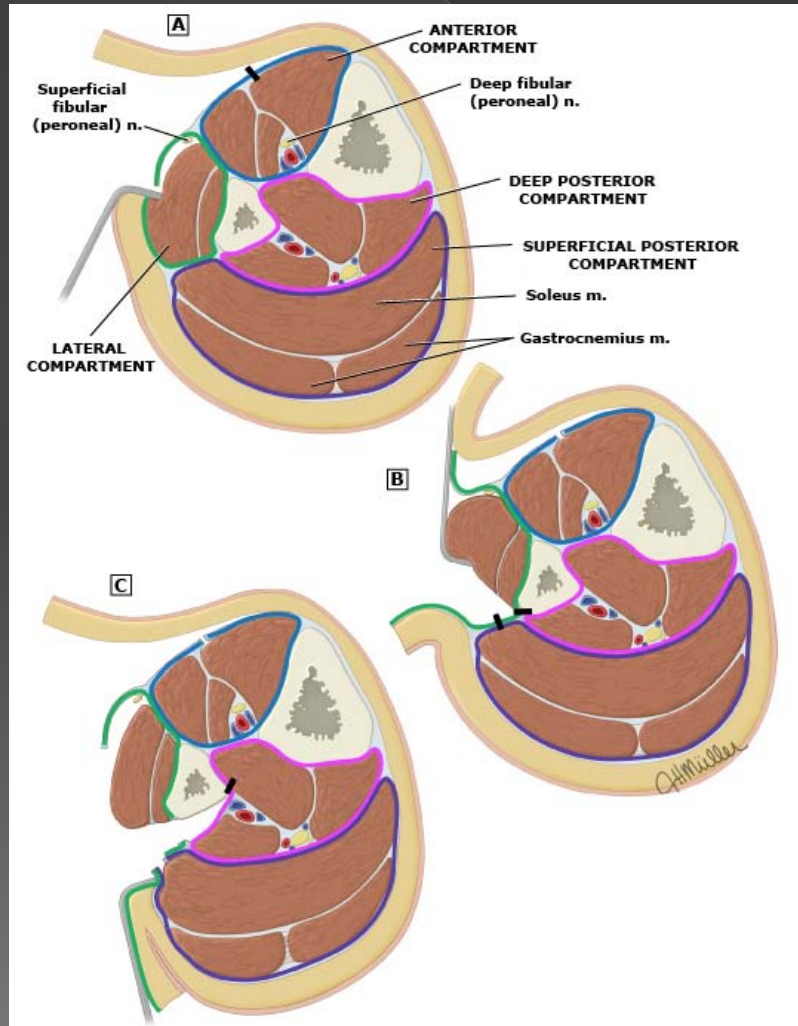
Identification of the neurovascular bundle further confirms that the deep posterior compartment has been entered.



Techniques (cont.)

Single incision fasciotomy

Lateral skin incision similar to double incision technique



- Anterolateral fasciotomy
- Undermine lateral flap to expose superficial posterior compartment
- Incise fascia over gastrocnemius longitudinally
- Develop a plane between lateral and superficial posterior compartments, detach soleus to expose deep posterior compartment
- Perifibular dissection – incise fascial attachment of tibialis posterior to fibula. Protect peroneal vessels with posterior retraction.
- +/- fibulectomy – no longer advocated

Complications of Fasciotomy

● Metabolic

Ischemia reperfusion injury

- Increased perfusion after fascial release
- Extremity swelling leading to wound complications
- Metabolic acidosis from lactate release → myocardial depression and hypotension
- Hyperkalemia from potassium release from necrotic muscle
- Rhabdomyolysis and myoglobinuria

Management – aggressive fluid resuscitation and treatment of metabolic derangements

Complications (cont.)

- Wound complications
 - Infection
 - Altered skin sensation
 - Pruritis
 - Recurrent ulceration
 - Muscle herniation
 - Wound pain
 - Tethered scars and tendons

Complications (cont.)

◉ Technical complications

- Incomplete fasciotomy
 - Inadequate skin and fascial openings → recurrent compartment syndrome
 - Selective compartment fasciotomy → delayed development of compartment syndrome
 - Up to 13% fasciotomies needing revision due to inadequate release in some studies
 - Recommended incision 16-20 cms

Jensen SL, et al., Eur J Vasc Endovasc Surg. 1997

Cohen MS, et al., J Bone Joint Surg Br. 1991

Complications (cont.)

- Neurovascular injury

Superficial peroneal nerve injury

- Foot drop and loss of sensation to dorsum of foot
- Due to inadequate knowledge of anatomy
- Up to 6% occurrence in trauma literature
- Proximal fascial incision of anterolateral compartment – 4-5 cm distal to fibular head

Peroneal artery injury

- Risk with single incision technique, particularly with fibulectomy

Complications (cont.)

● Venous insufficiency

- Lower extremity fasciotomy may predispose to chronic venous disease
- Calf pump dysfunction noted in injured extremities

● Limb loss

- 5-20% of limbs needing fasciotomy will require major amputation
- Highest rates in those with occluded vascular repairs

Wound Management

- Wound not closed at initial surgery
- Immediate post-op period - sterile saline gauze dressing to allow assessment
- Assess for need for second look/debridement
- Goal – definitive coverage within 7-10 days

Wound Management (cont.)

◉ Interim coverage techniques

- Simple absorbent dressing
- Vacuum assisted closure
 - Studies show significantly higher rate of skin closure and decreased time to skin closure compared to gauze dressing
- Vessel loop “bootlace”



Wound Management (cont.)

Skin closure

- Confirm muscle viability
 - Ensure regression of swelling
-
- ◉ Delayed primary skin closure (8-14 days)
 - ◉ Skin grafting
 - ◉ Myocutaneous flap – exposed neurovascular structures/vascular grafts

Summary

- High index of suspicion for diagnosis of ACS
- 4 compartment fasciotomy is definitive treatment
- Considerations for prophylactic fasciotomy
- Knowledge of lower extremity anatomy decreases risk of incomplete fasciotomy and neurovascular injury
- Management of metabolic complications – aggressive rehydration, management of hyperkalemia, management of acidosis

Summary (cont.)

● Fasciotomy principles

- Early diagnosis
- Aggressive fasciotomy technique with generous skin and fascial incisions (12-20 cms)
- Worse outcomes with recurrent compartment syndrome
- Release all fascial compartments
- Wound management – aim for delayed primary closure in 7-8 days

Re-debridement as indicated

Bridging with “bootlace” technique, VAC

Thank you

Question 1

A 23-year-old man sustains a closed right midshaft tibia-fibula fracture in a motorcycle crash. He is alert, awake, and hemodynamically normal, and has severe pain, pain with passive stretch, and numbness in his right lower extremity. Dorsalis pedis and posterior tibial pulses are dopplerable but not palpable. The most appropriate management now would be:

- A. compartment pressure measurements
- B. measurement of arterial pressure indices
- C. angiography
- D. leg elevation, splint, and reassessment in 4 hours
- E. fasciotomy

Question 2

When performing a four-compartment fasciotomy for leg compartment syndrome, the...

- A. femoral nerve can be easily injured.
- B. soleus muscle is taken down off the tibia to decompress the deep compartment.
- C. anterior tibial artery can easily be injured.
- D. procedure should not be performed until the pedal pulses are absent.
- E. skin should be closed.

Question 3

True statement regarding anterior tibial compartment syndrome include which of the following?

- A. It may be caused by severe exertion.
- B. Pain is the dominant symptom and is elicited on palpation of the calf.
- C. The dorsalis pedis pulse is always absent.
- D. Unlike the treatment of other compartment syndromes, fasciotomy is rarely needed.
- E. The presence of pulses does not negate the diagnosis.