


INNOVATIVE. EXCELLENT. CARE.



The Orthopaedic Specialists of South Texas

Compartment Syndromes of the Leg Related to Athletic Activity

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Introduction

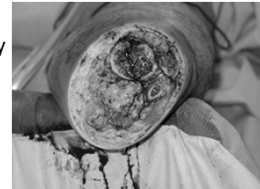
- Consequences of a misdiagnosis
 - persistence of a performance limitation
 - loss of function/compartments
 - loss of limb
- Goal:
 - anatomically and physiologically based understanding of the condition

Disclosure

- None relevant to this topic

Anatomy

- Four distinct, inelastic compartments divided by
 - Tibia
 - Fibula
 - Crural fascia
 - Intermuscular septums



Introduction

- Misunderstood
- Misdiagnosed
- Increased pressure within one or more of the leg compartments produces symptoms that are bewildering and confusing



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Anatomy

- Four distinct, inelastic compartments divided by
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 - Intermuscular septums



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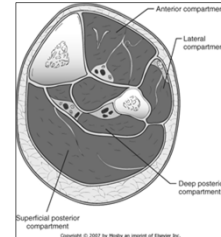
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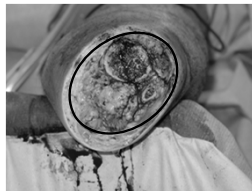
Anterior Compartment

- Boundaries
 - lateral border of the tibia
 - crural fascia
 - anterior crural septum
 - fibula
 - interosseous membrane
- Contents
 - anterior tibial m.
 - extensor hallucis longus m.
 - extensor digitorum longus m.
 - Ant. tibial neurovascular bundle



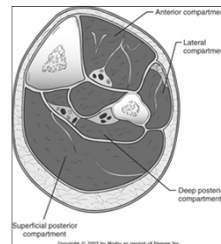
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Lateral Compartment

- Boundaries
 - anterior crural septum
 - crural fascia
 - posterior crural septum
 - lateral border of the fibula
- Contents
 - P. brevis and longus muscles
 - superficial peroneal nerve



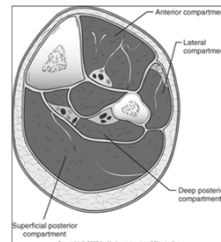
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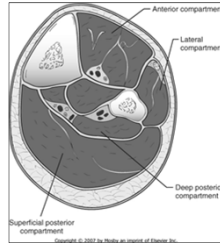
Deep Posterior Compartment

- Boundaries
 - posterior tibia
 - interosseous membrane
 - fibula
 - posterior crural septum
 - intermuscular septum
- Contents
 - posterior tibial, flexor hallucis longus, and flexor digitorum muscles
 - posterior tibial and peroneal vessels
 - tibial nerve



Superficial Posterior Compartment

- **Boundaries**
 - intermuscular septum
 - crural fascia
- **Contents**
 - soleus and the gastrocnemius muscles
 - no named vessels or nerves



Acute Compartment Syndrome

- **Persistent** pressure elevation
- **Trigger**
 - athletic activity
 - trauma (tibia fracture, muscle tear)
 - prolonged compression (bandage or cast)
- **Pathology**
 - necrosis of muscle and nerve
 - irreversible loss of function
 - below or above the knee amputation

Classification

- Acute compartment syndrome (ACS)
- Chronic exertional compartment syndrome (CECS)

Chronic Exertional Compartment Syndrome

- Short term, reversible and recurrent pressure elevation
- **Trigger**
 - athletic activity
 - short walk
- **Symptoms**
 - muscle pain
 - swelling
 - loss of sensory and motor function

Acute Compartment Syndrome

- Elevated pressure within the inelastic compartment
- Reduces blood perfusion to the nerves and muscles
- Vicious cycle of increasing swelling and pressure
- **Symptoms**
 - muscle pain
 - swelling
 - loss of sensory and motor function

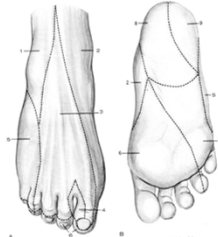


Chronic Exertional Compartment Syndrome

- Symptoms force a cessation of activity
 - Compartment pressures fall
 - Symptoms remit as the
- **Can lead to an ACS with all of its associated morbidity**

History

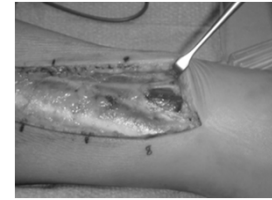
- Pain
 - localized to the specific compartment
 - rest
 - activity
 - passive lengthening of the muscle
 - distal referred pain related to the course of a nerve within the compartment.
- Nerve dysfunction
 - numbness
 - tingling
 - weakness
 - paralysis
- Swelling
 - firmness
 - muscle herniation



Sarrafiian SH. *Anatomy of the Foot and Ankle, 1983.*

Physical Exam

- Inspection
 - swollen
 - with or without muscle herniations
- Palpation
 - firmness and tenderness at the affected compartment
 - muscle herniations

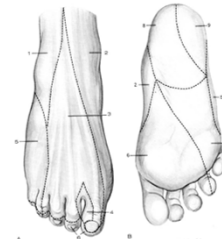


History ACS

- Acute and progressive symptoms
- Resolution of pain without the recovery of nerve or muscle function may signal the loss of muscle viability

Physical Exam

- Percussion
 - superficial peroneal nerve at its hiatus
 - paresthesias in the distribution of the nerve
- Loss of sensation
 - first web space - anterior compartment and deep peroneal nerve involvement
 - dorsal foot, exclusive of the first web space- lateral compartment and the superficial peroneal nerve
 - plantar foot- deep posterior compartment and the tibial nerve



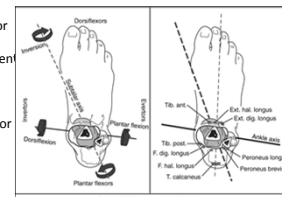
Sarrafiian SH. *Anatomy of the Foot and Ankle, 1983.*

History CECS

- Pain or loss of function after activity
- Recovery following rest
- Predictable and recurrent
- CECS can convert to a fulminate ACS without warning
 - Treatment must be directed by the acute condition

Physical Exam

- Weakness or paralysis
 - ankle and toe extensors- anterior compartment involvement
 - foot evertors- lateral compartment involvement
 - toe flexors- deep posterior compartment involvement
 - ankle flexors- superficial posterior compartment involvement
- Pain with passive muscle stretch
 - very sensitive indicator of compartment syndrome



Physical Exam

- Post-exertion exam
 - mandatory to rule out CECS
 - type
 - duration
 - intensity
 - time to onset
 - ability to continue activity
 - time to recovery



Diagnostic Testing

- Invasive compartment pressure measurement
- Anesthetized
- Arterial line
 - >30mm Hg
- ACS
 - emergent
- CECS
 - elective (post-exertion)
- Correlate with the clinical presentation



Physical Exam

- Focal bone tenderness
 - stress fracture
- Linear tenderness
 - posterior medial tibial stress syndrome



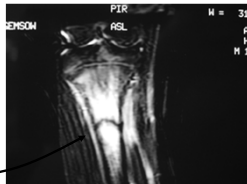
Non-Surgical Treatment CECS

- Not ever indicated for ACS
- Limitation of physical activity
- Cross-training
- Stretching
- Warm-up
- Conditioning
- Infrequently successful
- CECS may convert to ACS



Diagnostic Testing

- Routine radiographs
- CT
- Bone scan
- MR
 - Post-exertion MR may demonstrate muscle edema
 - fracture
 - stress fracture
 - tumor
 - infection

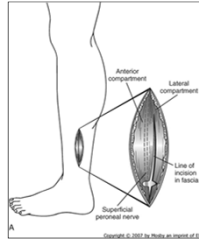


Surgical Treatment

- Compartment release
 - all effected compartments
 - extensile approaches
- Indications
 - ACS
 - CECS with failed non-surgical treatment

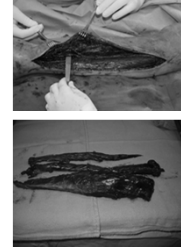
Anterior and Lateral Fasciotomy

- 13 cm incision in-line with the fibula
- Hiatus for the superficial peroneal nerve is isolated
- SPN protected during lateral compartment release
- Anterior compartment released under direct vision



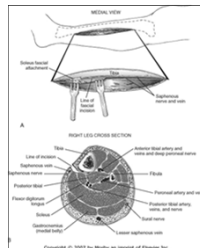
Surgical Treatment

- Necrotic muscle must be removed
- Fascia is never closed



Superficial and Deep Posterior Fasciotomy

- 10 cm medial incision in-line with the posterior tibia
- Saphenous vein and nerve protected
- Fascial attachments of the soleus and flexor digitorum longus are released directly off of the posterior medial border of the tibia to decompress the deep posterior compartment
- Soleus fascia is released for superficial posterior compartment decompression



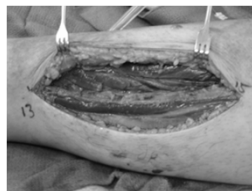
Surgical Treatment

- Skin is closed only if tension-free closure is possible
 - VAC
 - repeat debridement
 - delayed closure
 - split-thickness skin graft



Muscle Viability/The 4 C's

- Red color
- Ability to contract
- No loss of consistency
- Intact capacity to bleed



Motor Deficit

- Orthosis
 - wedged shoe heel
 - AFO



Motor Deficit

- Reconstruction
 - calcaneal osteotomy
 - tendon transfer
 - subtalar arthrodesis
 - ankle arthrodesis

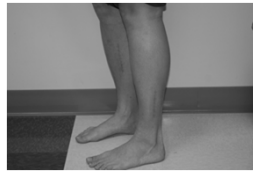


Case 1

- 17 year old
- HS football player
- Initial evaluation by sports specialist
 - Early season exertional leg pain
 - Lateral and anterior
- Subsequent evaluation
 - Foot drop
 - Dorsal foot numbness
- Office compartment measurements at rest
 - Ant and lat 30 mm
 - Sup and Deep post 12 mm

Rehabilitation

- 2 Weeks
 - Non-weightbearing
 - Suture removal
- 3 weeks
 - Return to activity
 - cross-training with pain-free activities
 - appropriate stretching, warm-up, and conditioning
 - Training log
 - type
 - duration
 - intensity
 - frequency of activity
 - performance and symptom observations
- Compression stockings

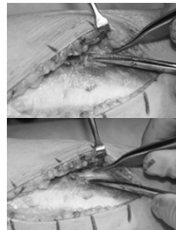


Case 1

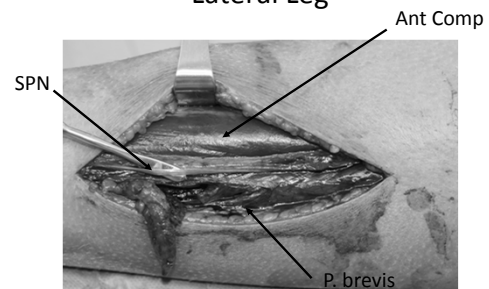
- Day 9
 - Orthopaedic Consult
 - DF and eversion weak
 - Numb at DPN
- Compartment measurement
 - Ant and lat 32 mm
 - Sup and deep post 14 mm

Complications

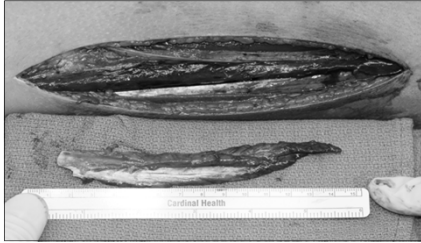
- Persistence
- Recurrence (CECS)
 - Revision fasciectomy as opposed to fasciotomy
- Nerve injury
 - saphenous
 - superficial peroneal
- Vascular injury
 - saphenous vein
- Infection
- Hematoma
- Delayed wound healing



Lateral Leg



Necrotic P. Brevis Muscle



Case 2

- Day 5
 - Persistent, severe, unrelenting pain after brief but intense competitive performance
 - Anterior leg swelling, herniation, dorsal foot numbness at first web space, weak DF

Case 1

- Post op
 - Weak DF
 - Weak Eversion
 - AFO
- 6 months
 - Full recovery
 - Full athletic activity



Case 2

- Day 5
 - Assessed by trainer
 - Compartment syndrome suspected
 - Patient sent to ER
 - ER physician discharged patient

Case 2

- 17 year old cheerleader
- New onset exertional anterior leg pain

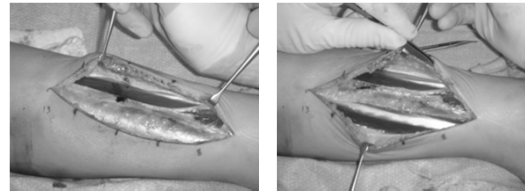
Case 2

- Day 6
 - Orthopaedic Consult
 - <24 hours after conversion from CECS to ACS
 - Numb DPN
 - Weak (1/5) DF

Case 2



Case 2



Case 2

- Compartment Pressure
 - Anterior- 41
 - Lateral- 44
 - Sup. Post- 23
 - Deep Post- 23



Case 2

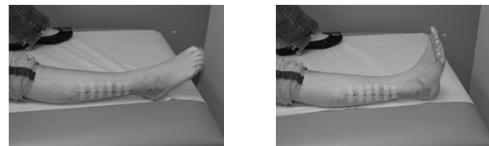


Case 2



Case 2

- 3 weeks post-op
 - Full DF power
 - Normal DPN sensation

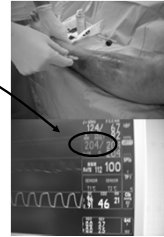


Case 3

- 48 year old male
- No hx exertional leg pain
- Drinking and wrestling until 11pm
- Awoke at 2 am w severe anterior and lateral leg pain and swelling
- Presented to ER at 3 am and discharged

Case 3

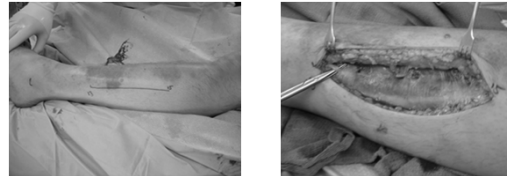
- Day 5
- Compartment Pressure
 - Anterior >100
 - Lateral 35
 - Sup. Post 9
 - Deep Post 9



Case 3

- Day 2
 - Returned to work with persistent pain
- Day 3
 - Resolution of pain
 - Foot drop
- Day 4
 - Redness over leg
 - Admitted w cellulitis

Case 3

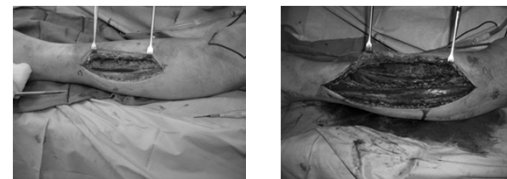


Case 3

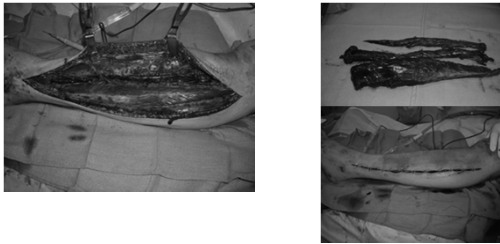
- Day 5
 - Orthopaedic consult
 - Tight, firm anterior compartment
 - Soft lateral compartment
 - Normal sensation and pulses
 - Pain with active PF
 - No DF power at ankle, toes



Case 3



Case 3

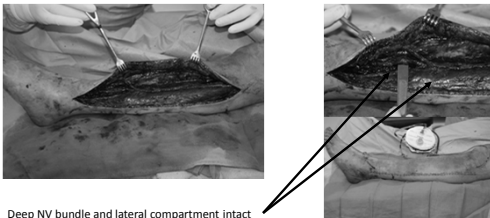


Case 4

- Post-exertion measurements
- Compartment Pressure (R/L)
 - Anterior- 18/19
 - Lateral- 21/18
 - Sup. Post- 12/10
 - Deep Post- 13/9



Case 3 Repeat debridement and Closure



Deep NV bundle and lateral compartment intact

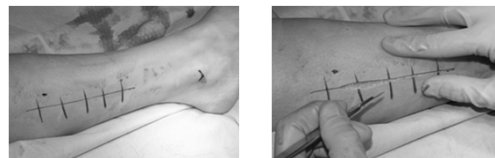
Case 4



Case 4

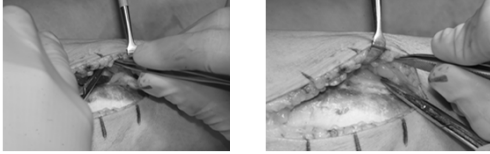
- 19 year old college student
- 18 month history of exertional anterior and lateral leg pain
- Initially occurring after running
- Now occurring after walking

Case 4



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Case 4



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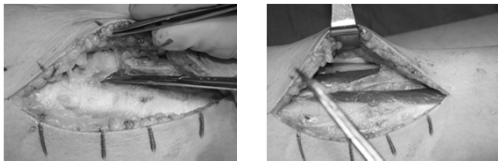


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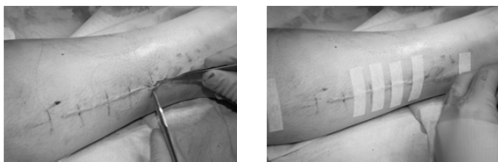
Mark M. Casillas, M.D. – Orthopaedic Surgery, Foot & Ankle
Jeremy L. Dickerson, M.D. – Family Practice, Sports Medicine
Stacé S. Rust, M.D. – Orthopaedic Surgery, Hand, Wrist, Elbow & Shoulder
Ryane M. Galindo – MPAS, PA-C

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Case 4



Case 4



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