

AAOS • 2003

Chronic Exertional Compartment Syndrome: Diagnosis & Treatment

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Chronic Leg Pain: The Diagnostic Dilemma

- Exercise related leg pain is common among athletes
  - Most common in runners
- "Shin splints" are a wastebasket term that does not specify diagnosis or guide treatment and should be discouraged



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Anatomic Sources of Leg Pain

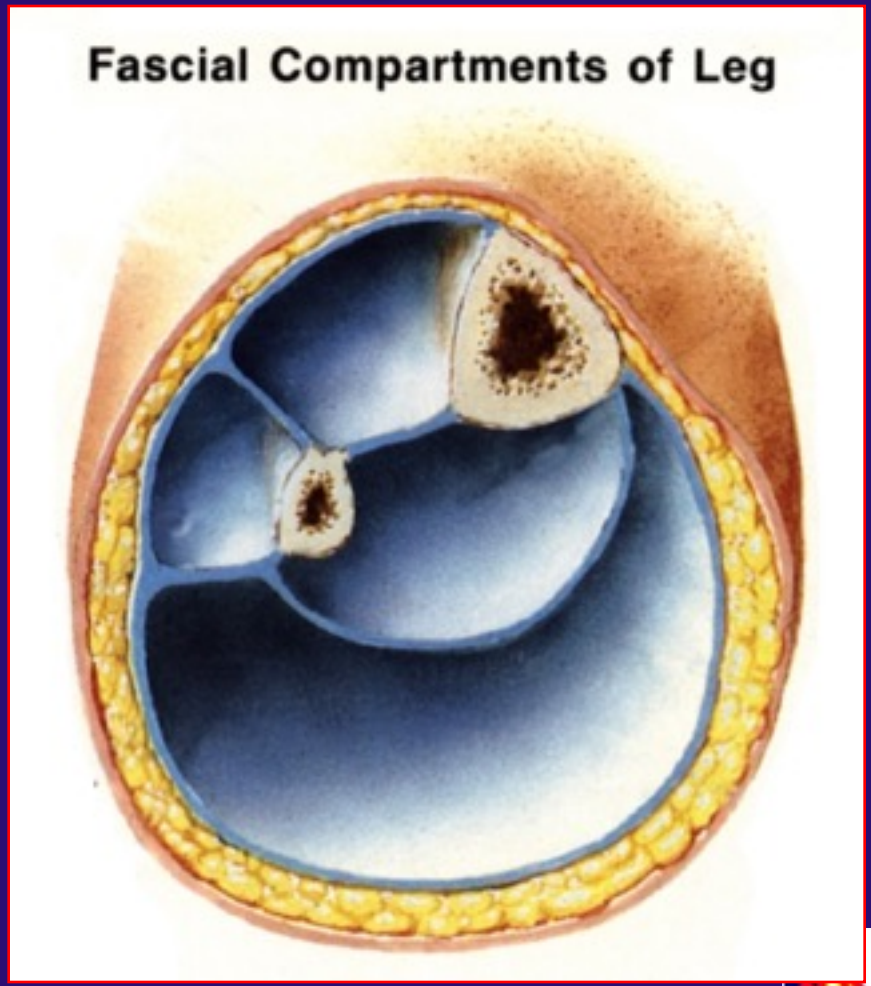
- Bone
  - A continuum of bone trauma exists from bone strain to stress reaction to stress fracture
- Periosteum
  - Inflammation occurs at muscular insertions particular of tibialis posterior and soleus.



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Anatomic Sources of Leg Pain

- Muscles and Compartments
  - 4-5 muscle compartments
  - Chronic strains and tendinopathy can occur
- Nerves
  - Proximal nerve entrapment can cause radicular pain
  - Systemic diseases can lead to neuropathy

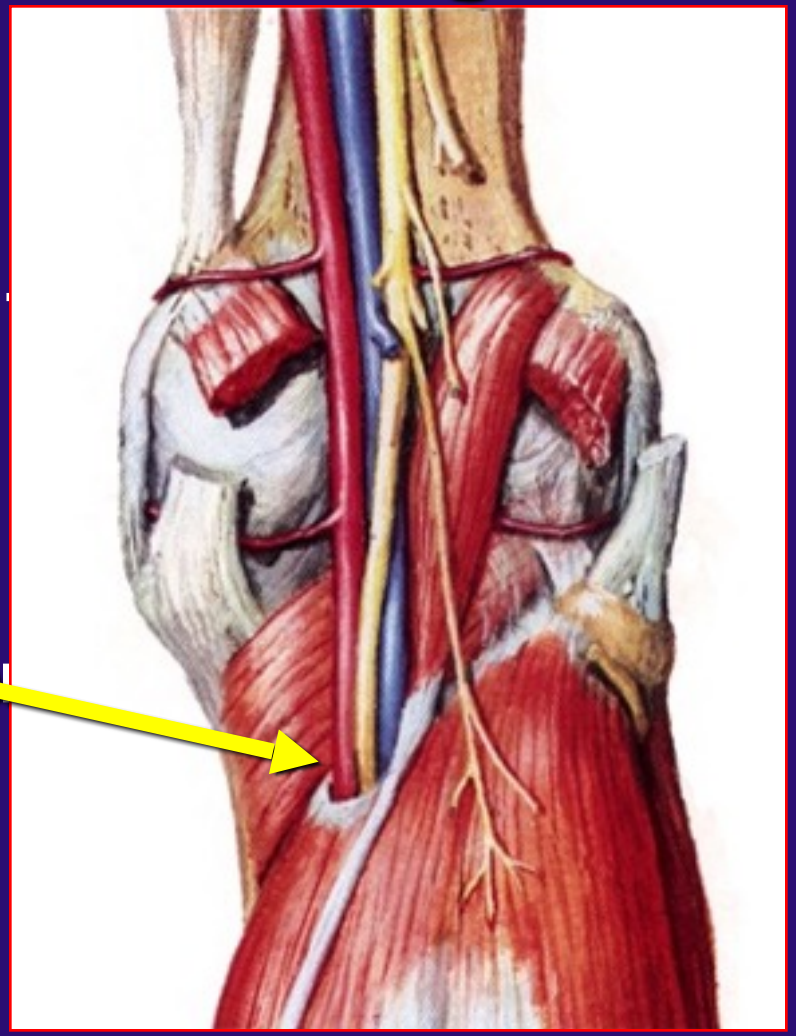


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Anatomic Sources of Leg Pain

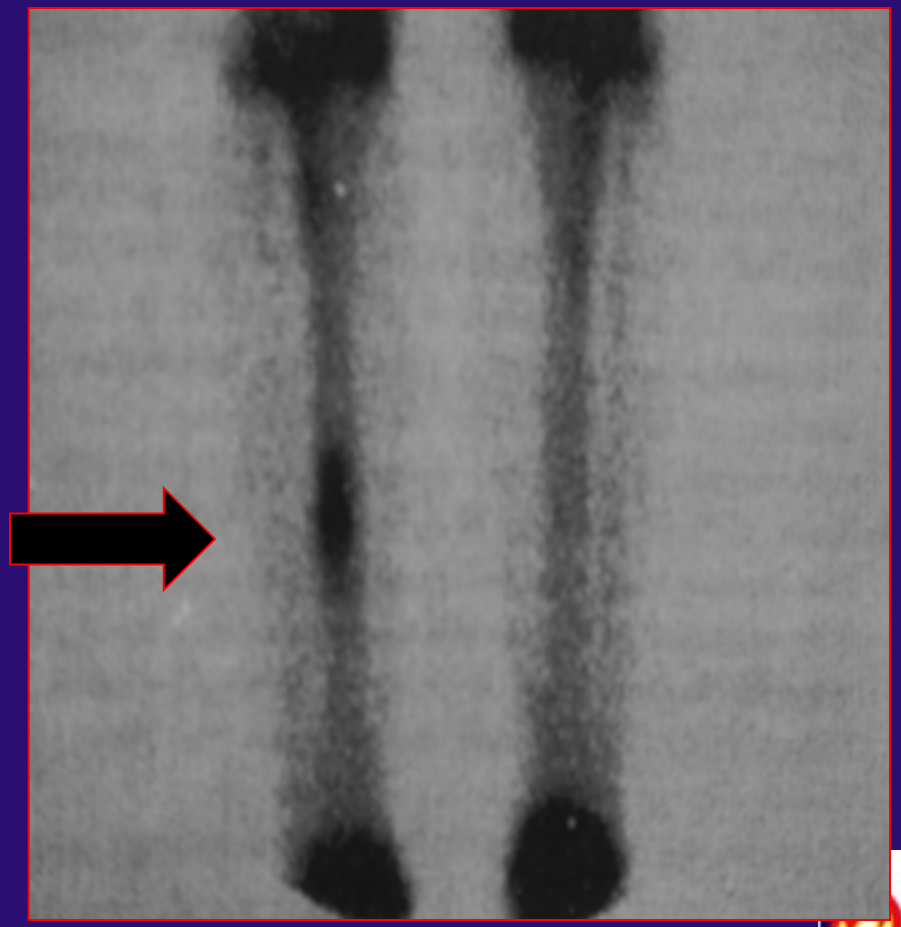
- Arteries and Veins
  - Atherosclerosis can lead to claudication
  - Venous phlebitis or thrombosis can occur
  - Popliteal artery entrapment and arterial endofibrosis has been described in younger population.



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Differential Dx of Chronic Leg Pain in Athletes

- CECS
- Muscle herniation
- Stress fractures
- Medial tibial periostitis (shin splints)
- Chronic muscle strain
- Popliteal artery entrapment
- Referred from spine



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Don’t forget the Zebras

- Osteosarcoma /Tumors
- Trauma /Abuse
- Infection including TB, syphilis, bacterial, fungal
- Metabolic
  - Rickets, Hyperparathyroidism, Sarcoid, Sickle cell, Pagets, etc



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Chronic Exertional Compartment Syndrome

"CECS is an effort induced pathologic elevation of tissue pressures within an osteofascial envelope that results in debilitating pain and neurologic symptoms."

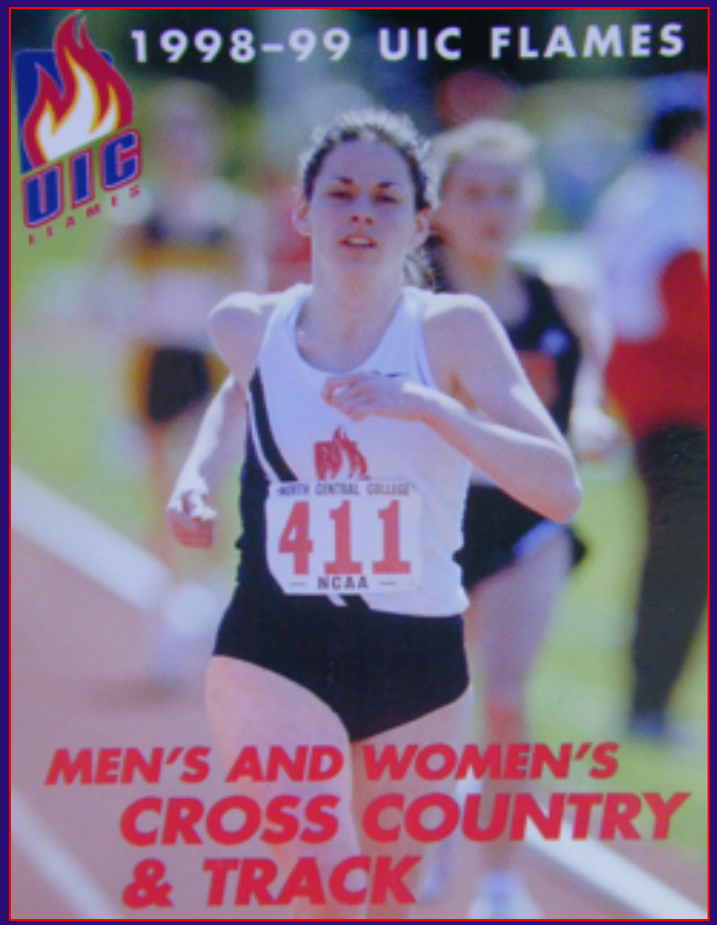


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Leversedge, *Am J Sports Med*, 2002

Chronic Exertional Compartment Syndrome

- Age 12 to 70 years old
- Most common in runners
- May occur in any endurance athlete
  - Soccer
  - Cycling
  - Gymnastics
  - Basketball
  - Roller blading
  - Dance



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Compartment Syndromes

- **Traumatic**
  - Secondary to fracture, crush, and reperfusion injuries
  - Surgical emergency
  - Skin and fascia may both contribute to compartmental restriction and increased pressure
  - Non-physiologic swelling secondary to trauma
- **Exertional**
  - Consistently exercise-induced
  - Generally endurance athletes
  - No pain at rest, pain consistently relieved with cessation of sport
  - Attributed to restriction of muscle swelling secondary to tight fascial compartments
  - Diagnosed with pre and post exercise pressure measurements



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History and Physical: Clinical Pearls in Athletic Leg Pain



- Pain with initial impact
  - Stress fracture
  - Periostitis
  - Muscle strains and tendinitis
- Focal bone pain
  - Stress fracture
- Diffuse medial bone pain
  - Medial tibial periostitis
- Focal muscle pain
  - Strain or Hernia

History and Physical: Clinical Pearls in Athletic Leg Pain

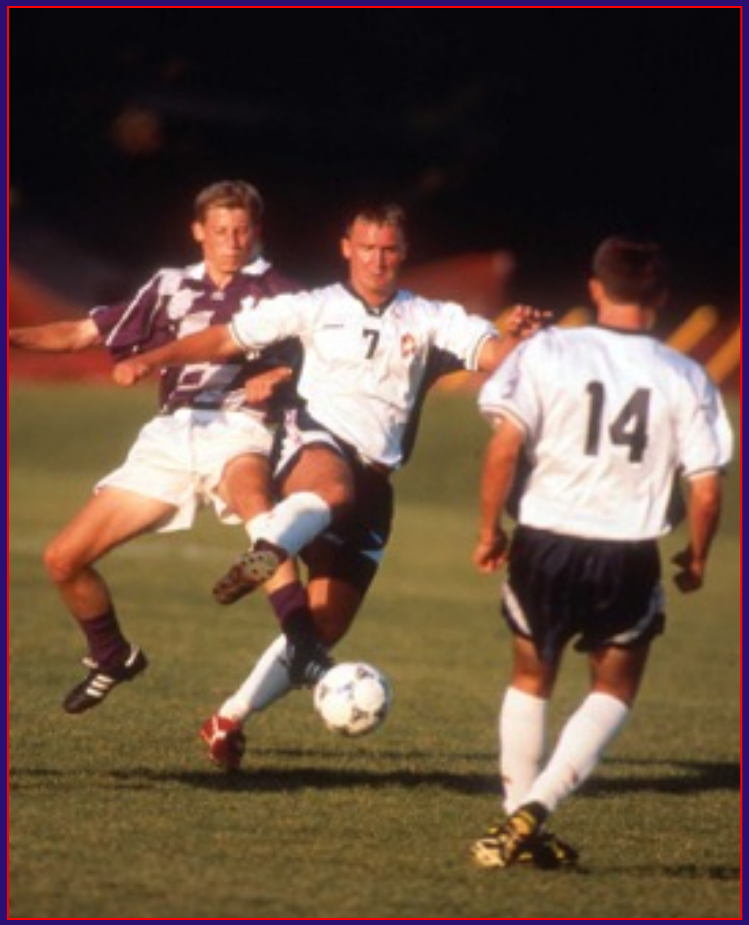
- Pain with resisted motion
  - Muscle strains and periostitis
- Pain with vibration
  - Stress fractures
- Pain at night
  - Tumors
- Pain with exertion
  - CECS, Popliteal artery entrapment
- Paresthesias at rest
  - Nerve entrapment
- Paresthesias with exertion
  - CECS
- Electrical shooting pain
  - Radicular pain from back



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History and Physical: Clinical Pearls in Athletic Leg Pain

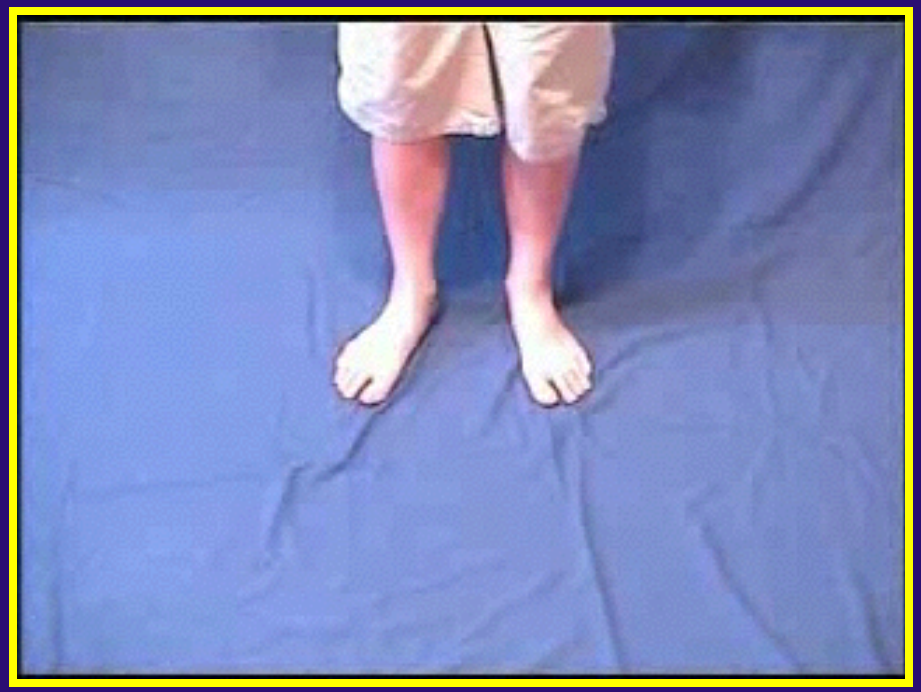
- Diffuse swelling
  - DVT
  - CECS
  - Muscle ruptures
- Focal swelling
  - Muscle herniation
  - Ganglion
  - Tumor



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Physical Examination

- Inspection
- Anatomical palpation
- Muscle resistance
- Neurovascular
- Weight-bearing
- Ambulation
- Jumping
- Stair climbing



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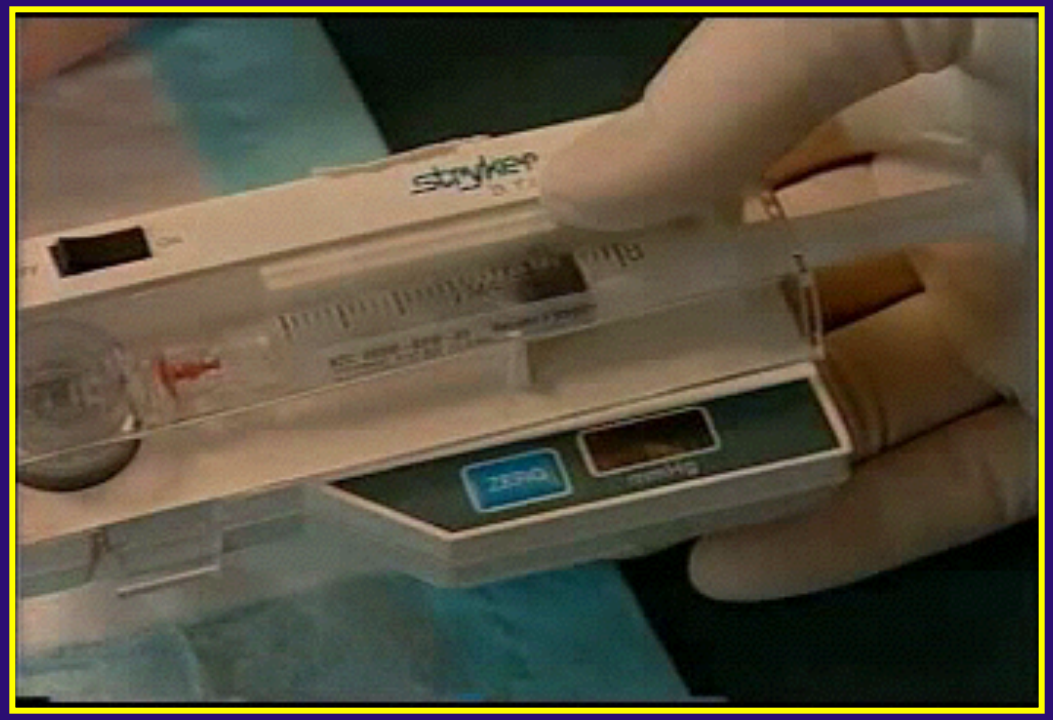
TESTING: Diagnostic Criteria of CECS

Intra-compartmental pressure measurements are key to diagnosis.

- Normal 0-10 mmHg

Abnormal

- Resting
  > 15 mmHg
- Post exertion
  > 30 mmHg
- Delayed
  > 20 mm Hg

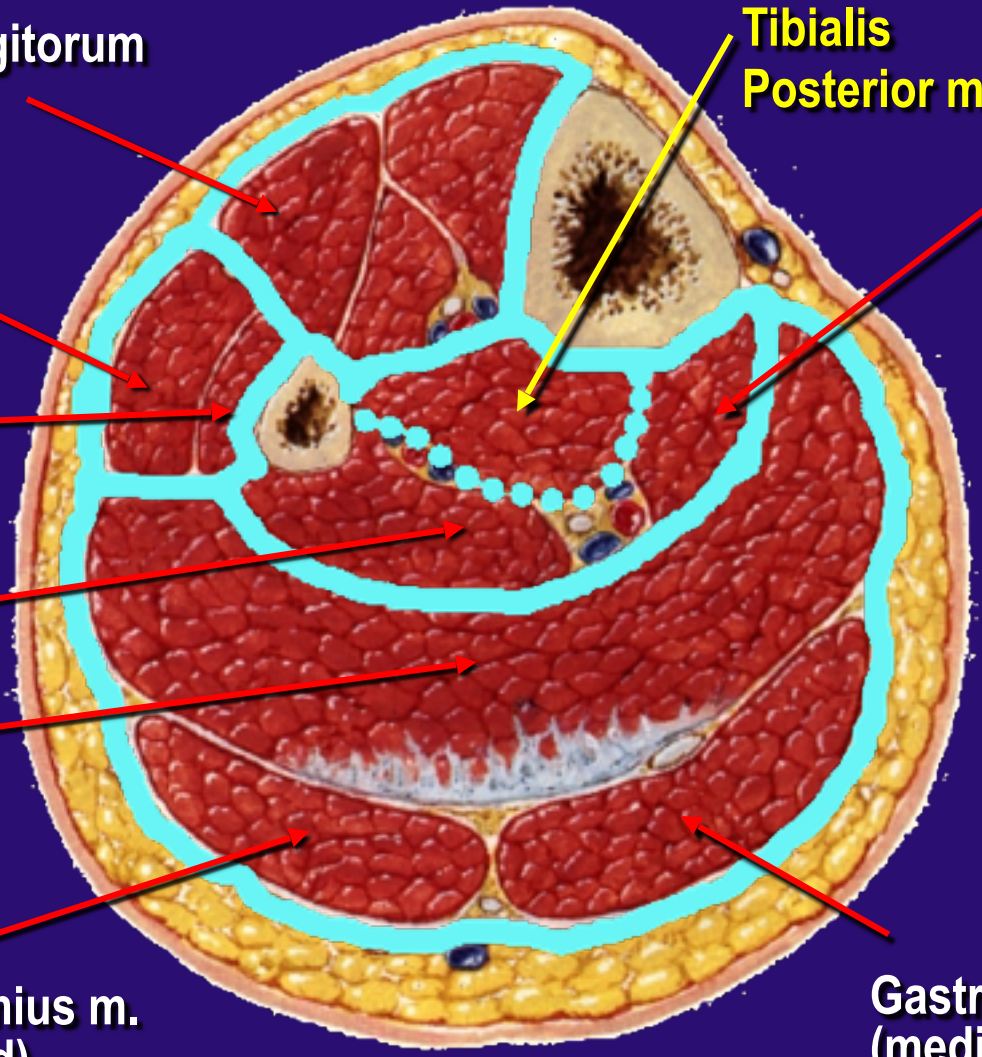


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Pedowitz, *Am J Sports Med*, 1990

80% of CECS involve the anterior or lateral compartments

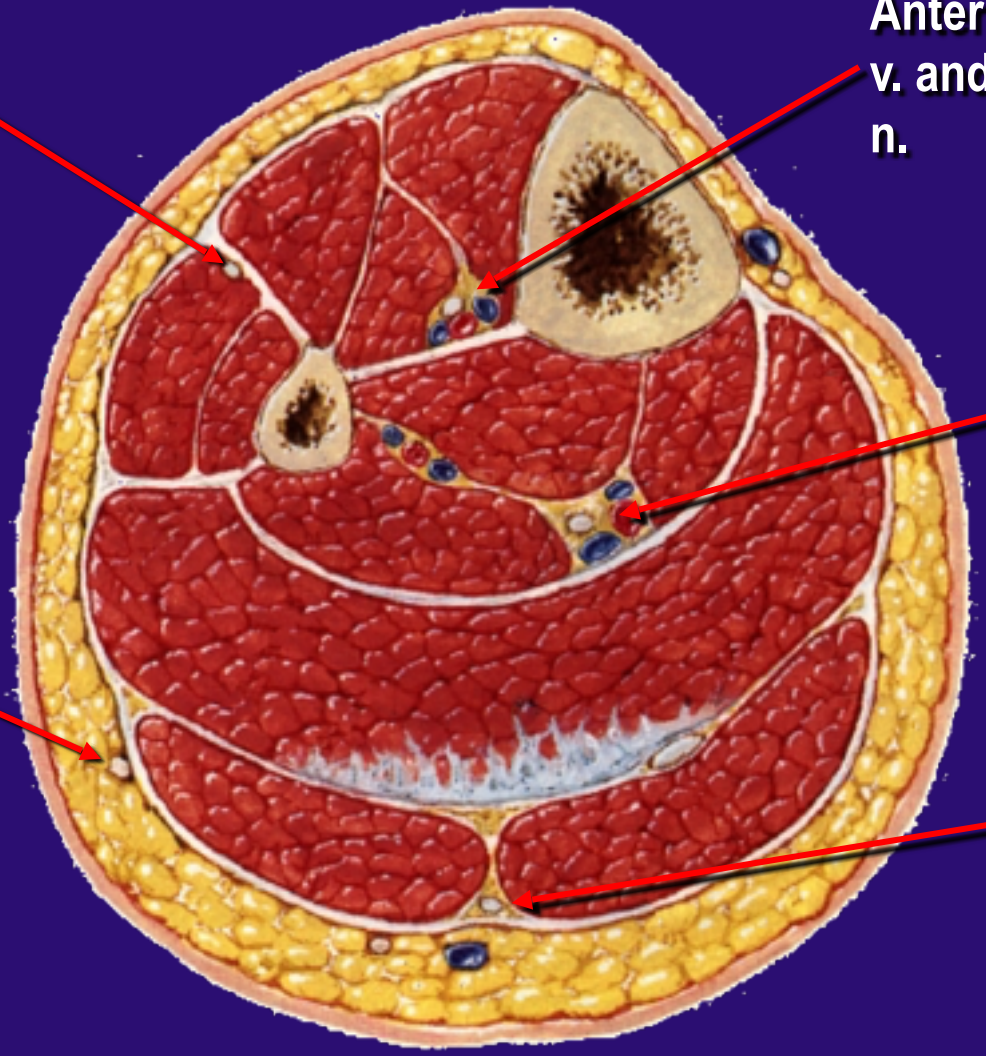
(Cross-section just above middle of leg)



Davey J, Rorabeck C, and Fowler P. **The tibialis posterior muscle compartment.** *Am J Sports Med* 12(5): 391-397, 1984.

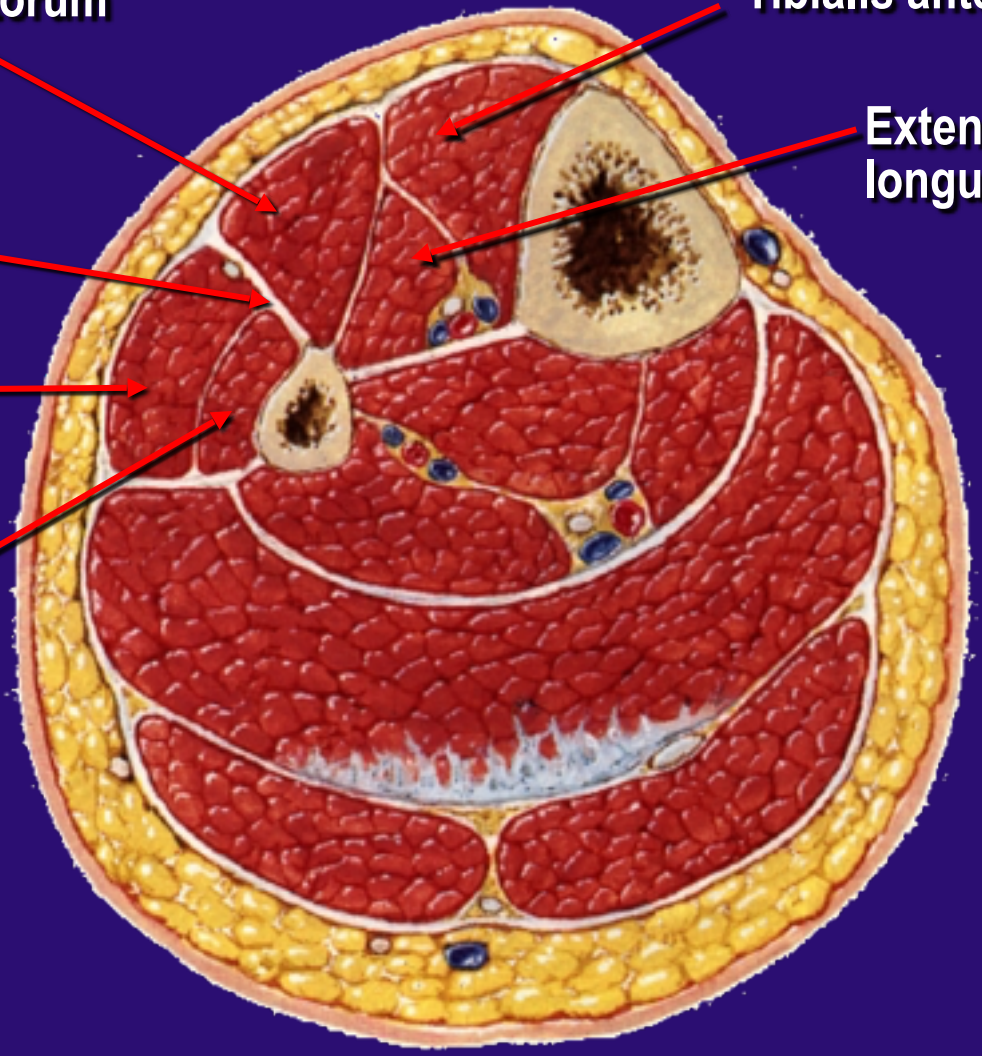
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Nerves (Cross-section just above middle of leg)



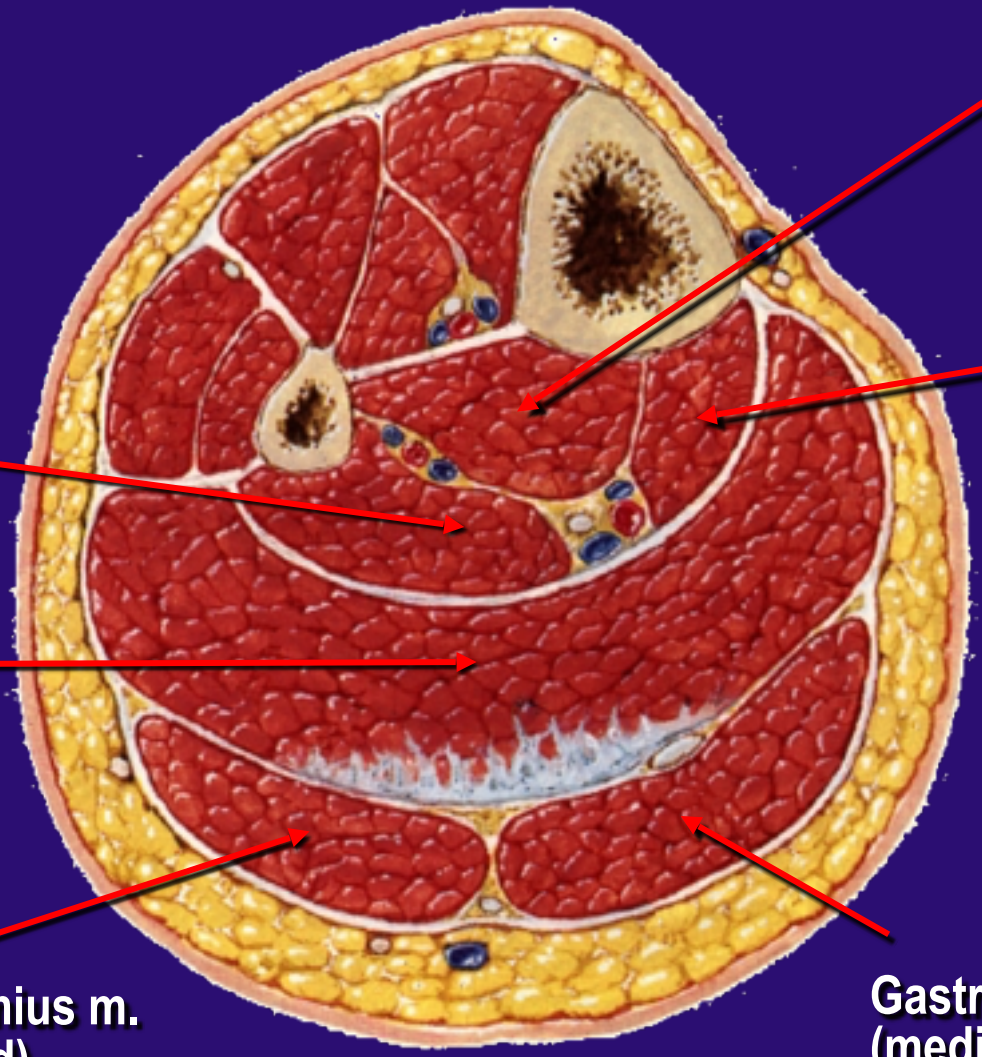
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Anterior and Lateral Compartments



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Posterior Compartments: Deep and Superficial



Tibialis Posterior m.

Flexor digitorum longus m.

Flexor hallucis longus m.

Soleus m.

Gastrocnemius m. (lateral head)

Gastrocnemius m. (medial head)

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Pre-Exercise Testing



Exercise and Post-Exercise Testing



TESTING: Diagnostic Criteria of CECS

Intracompartmental pressure measurements are key to diagnosis.

Normal	0-10 mmHg
ABNORMAL	
Resting	> 15 mmHg
Post exertion	> 30mmHg
Delayed	> 20 mm Hg

Pedowitz, *Am J Sports Med*, 1990

Treatment Options for CECS

- NSAIDS (-)
- Massage (-)
- Rest (±)
- Stretching and strengthening (-)
- Modalities (-)
- Shoe and surface modification (±)
- Fascial release (+)

You must rule out associated factors or diagnoses.



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Options of Surgical Technique

- Formal fascial release
- Fasciectomy
- Percutaneous
- Dual incision mini approach
- Single incision mini approach
- Endoscopically assisted



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Development of Endoscopic-Assisted Fascial Releases for CECS

- First described as technique for leg releases as case report in 1999
  - Oto et al., *Arthroscopy*, 1999
- First described as forearm release in vitro study in 1999
  - Havig & Leversedge, *J Hand Surg*, 1999
- First description of 2-incision endoscopic technique in cadaveric study in 2002
  - Leversedge et al, *Am J Sports Med*, 2002



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Development of Endoscopic-Assisted Fascial Releases for CECS at UIC

- In 1996, we performed our first endoscopically-assisted fascial release on a young athlete in an aesthetically demanding sport.
  - Briner, Hutchinson et al, ACSM Annual Meeting, 1998
- Subsequent embalmed and fresh cadaveric studies identified the risk and efficacy of the procedure.
  - Hutchinson MR, Bederka B. AOSSM Annual Meeting, 2000



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Results of Anatomic Studies

10 cadaveric legs –
endoscopic technique

6 cadaveric legs –
percutaneous via minimal single incision

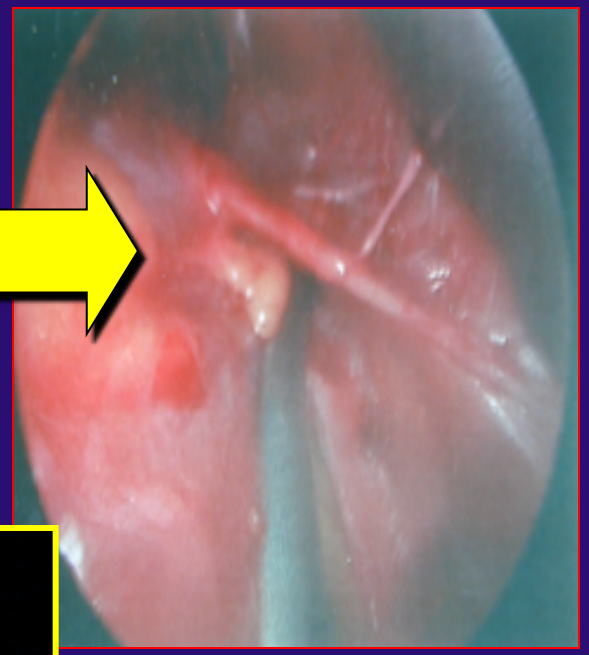
- Length of release
  - Anterior: 210 ± 28 mm
  - Lateral: 171 ± 27 mm
  - Sup posterior 189 ± 23 mm
  - Deep posterior 154 ± 28 mm



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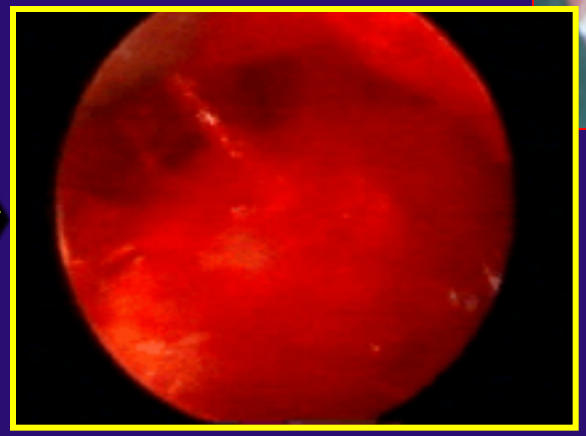
Superficial Peroneal Nerve Injury

- Endoscopically assisted: 0/10 legs
- Percutaneous: 4/6 legs
- P = 0.0082 (Fisher's Exact Test)



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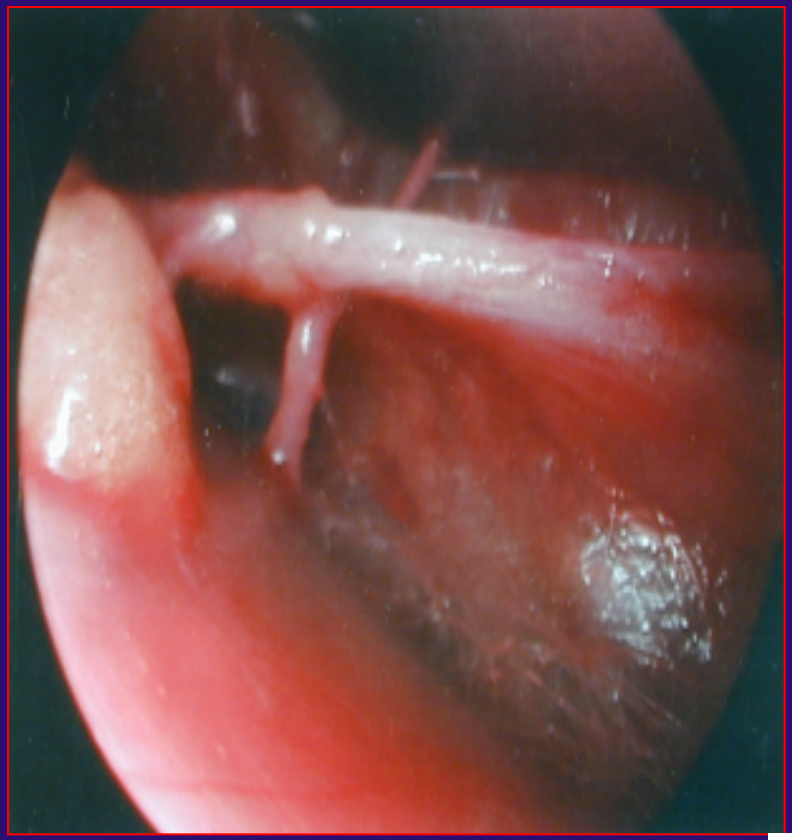
Endo is Safer



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Saphenous Vein Injury

- Endoscopically assisted: 1/10 complete transection, 3/10 branches only
- Percutaneous: 4/6 with complete transection or longitudinal laceration
- P = 0.036 by Fisher's Exact Test



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Most common injured structure.

Essential Equipment for Endoscopic Technique

- Long thin retractors
- 0 or 30 degree endoscope
- Arthroscopic electrocautery
- Extended Metzenbaum scissors or fasciotome



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Endoscopically Assisted One-Incision Fascial Release



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UIC Results for Single Incision Endoscopic Fascial Release for CECS

- Last 20 extremities
- 1 – 5 year follow-up
- No superficial peroneal nerve injuries
- Medial releases performed only when indicated
- No hematomas drained or post-operative cellulitis
- 12/13 return to sport

Literature Review

- Mavor, *JBJS*, 1956
  - First successful surgical release of CECS
- Detmer et al, *Am J Sports Med*, 1985
  - Largest consecutive series of fascial releases
  - 100 patients, 82 bilateral
  - 90% success as outpatient under local
  - Return to running in 21 days
- Fronek et al, *Clin Orthop*, 1987
  - 18 patients, 87% bilateral
  - 39% with fascial herniation
  - 92% success with releases

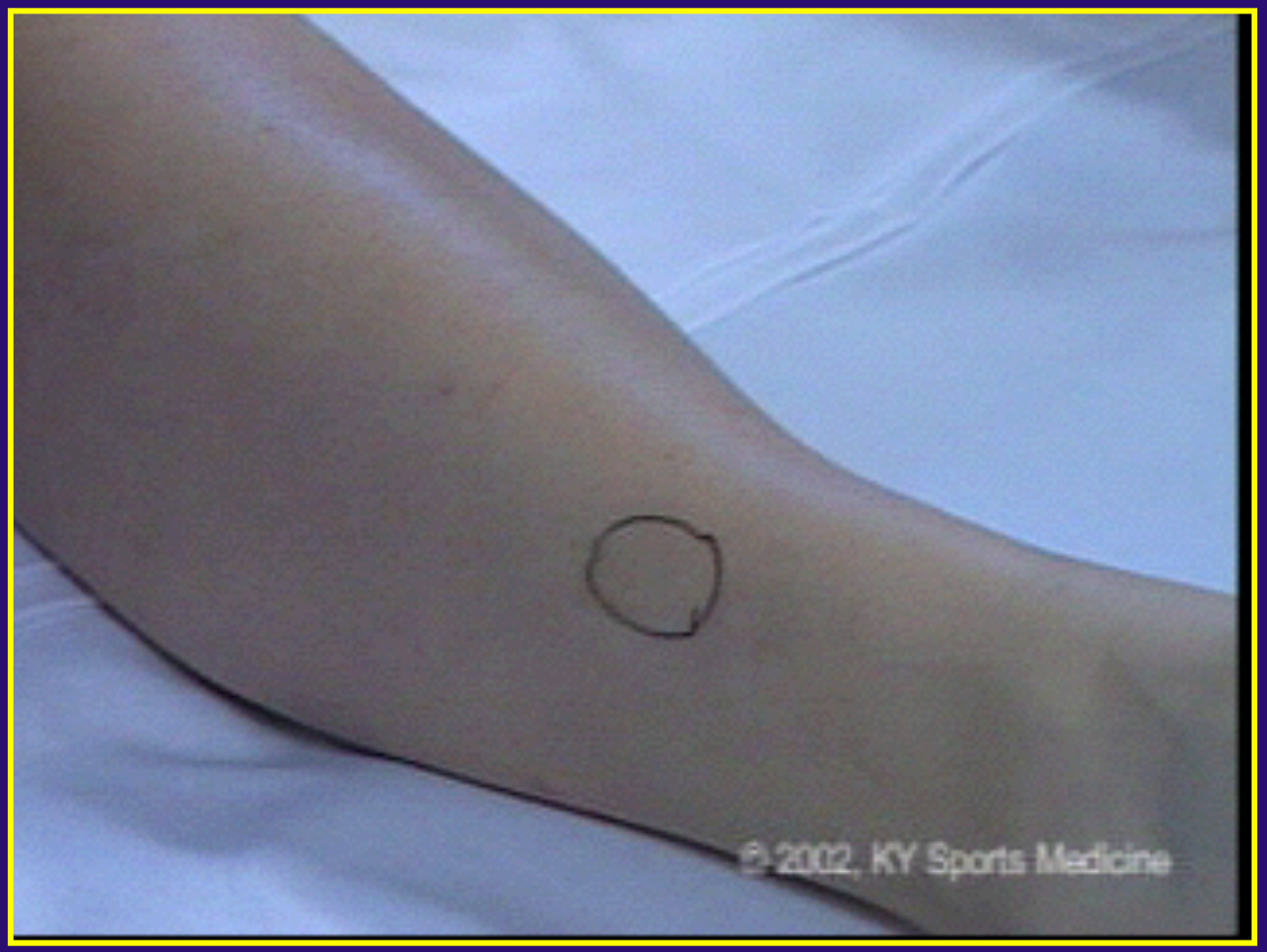


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Literature Review

- Micheli et al., *Am J Sports Med*, 1999
  - Reduced success of fascial releases in female athletes
- Garcia-Mata, et al. *J Pediatr Orthop*, 2001
  - Series of 23 adolescents (age 14-18)
  - 22 elected surgical release (percutaneous)
  - No reported complications
  - 100% success

Endoscopically-Assisted Two-Incision Fascial Release





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40% Have a Fascial Herniation

- If present, look for superficial peroneal nerve exiting there
- Begin release at that level
- Never close fascia

— Rorabeck C, Bourne R, Fowler P, Finlay J, and Nott, L. **The role of tissue pressure measurement in diagnosing chronic anterior compartment syndrome.** *Am J Sports Med* 16(2): 143-146, 1988.

Leg Pain: Rhythmic Gymnast:

- 12 yo pre-menarchal elite rhythmic gymnast
- Youngest documented case of CECS
- Bilateral leg pain
  - Absent at rest
  - Absent with 1st impact
  - Builds up with exertion



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Leg Pain: Rhythmic Gymnast

- Failed conservative tx
  - Massage
  - Nutrition
  - Hydration
  - NSAIDS
  - Therapy
- Imaging: negative
  - Radiographs
  - MRI
  - Bone scan



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Leg Pain: Rhythmic Gymnast

- Compartment measurements
  - Resting: All compartments < 15
  - Post exertion:
    - Anterior (R32/L35)
    - Lateral (R31/L30)
    - D post (R24/L22)
    - Sup (R12/L13)



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Leg Pain: Rhythmic Gymnast

- Treatment:
  - Let her grow out of it?
  - Endoscopically assisted fascial release elected secondary to competitive demands
- Results
  - Full, pain free competition at 3 months
  - Team Gold, Individual Bronze at 4-Continents at 6 months

18 YO Freshman collegiate basketball athlete

Complaints

- Pain L>R Calf
- Numbness, Tingling & Burning, Both Calves
- P.E. Calves soft
- Neurocirculatory Status Intact
- +FH: Brother with bilateral calf compartment





Differential Diagnosis

- Exertional compartment syndrome, left leg
- Stress fracture, left tibia

Clinical Course

- Passive stretching and reduction of running activities
- 2 months later, patient returned with continued symptoms; exam unchanged; compartments were soft.
- Patient underwent Stryker testing of bilateral compartments, pre- and post-exercise.

Stryker Compartment Testing

	Anterior		Posterior	
	Resting	Post Exercise	Resting	Post-Exercise
R	8	62	Not measured	
L	20	42	8	16


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Post Op Course

- Crutches, PWB 2 wks.
- Walked Normally, 4 wks.
- Running, 2 months.

6 Months Post Op

- Bilateral Anterior and Lateral Releases
- No Complaints
- Playing Basketball
- Compartments Soft, without Bulge





13 YO Female Soccer Athlete

- Bilateral Calf Pain, R>L
- Past 6 Months
- C/O Knots and Burning Sensation, Lateral Calf, After 15 Minutes of Running

P.E.

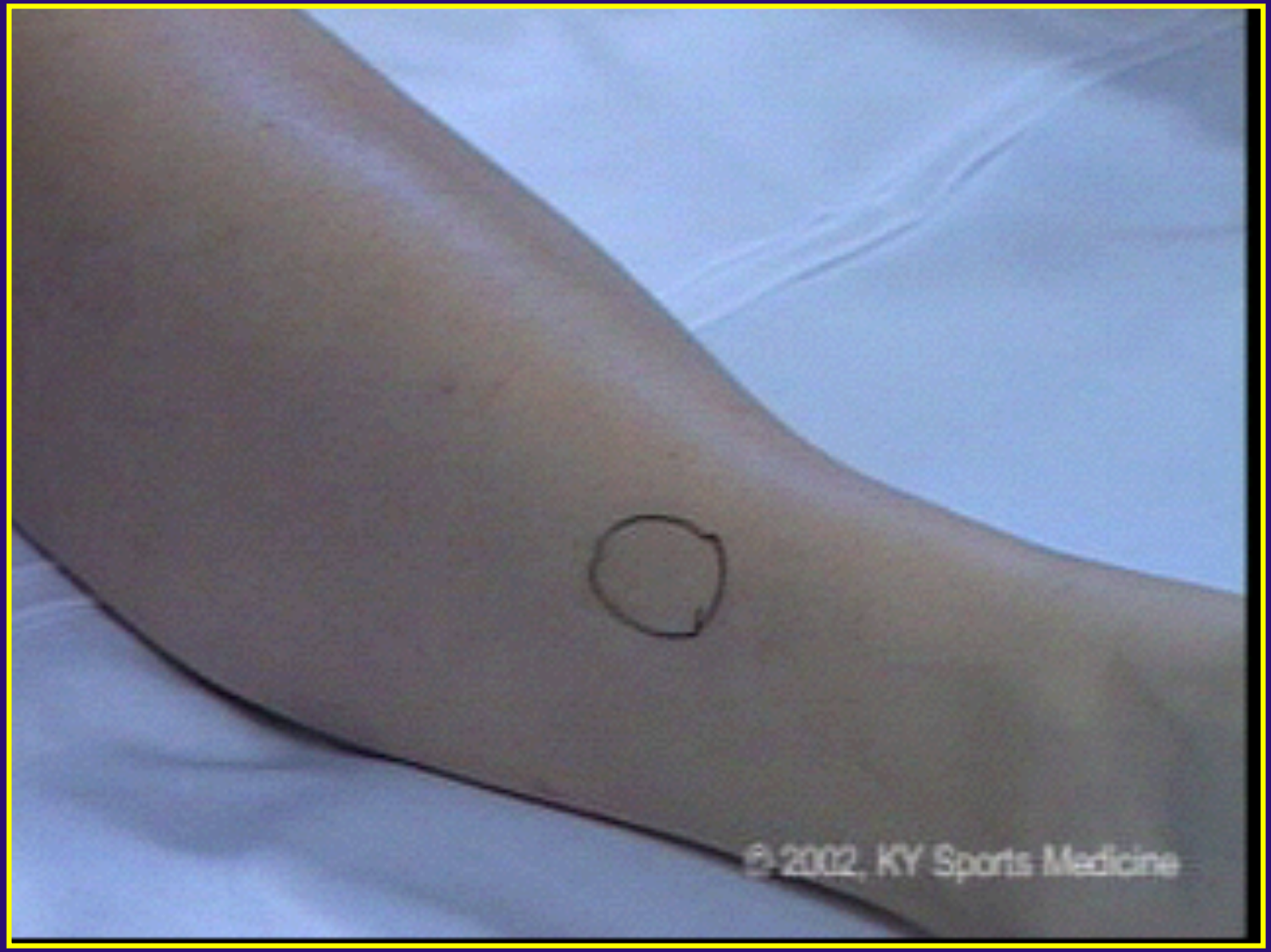
- No Pain or Firmness on Calf Palpation
- Fascial Defect Lateral Distal Third
- Neurocirculatory Status Intact
- Bilateral Cavus Feet

Stryker Compartment Testing

	Anterior		Lateral		Posterior	
	Resting	Post Exercise	Resting	Post-Exer.	Resting	Post-Exer.
R	33/26	42	8	29	7	9
L	10/13	22	30	22	7	13

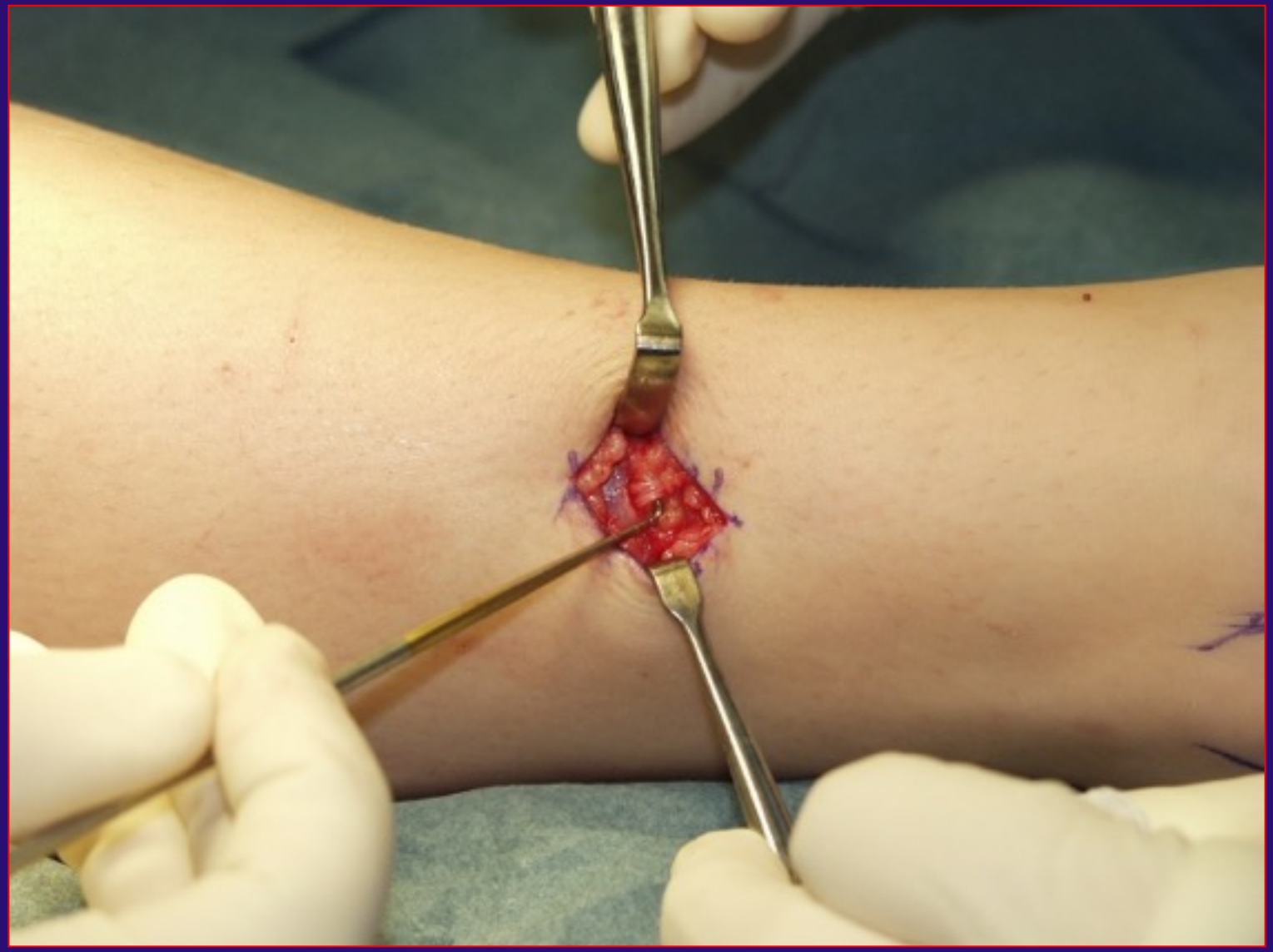


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Two-Incision

- Releases Anterior and Lateral Compartment
- Doing Well Post Op
- Pain Improved



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19 YO Freshman Division I Collegiate Cross-Country and Distance Track Athlete

- C/O Pain in Both Calves After Running
- Began Cross-Country at Age 10
- No Previous Complaints
- Running More Miles, and on Concrete

P.E.

- No Firmness to Compartments or Tibia to Palpation
- Normal Pulses & Neurologic Exam

Previous Workup

- Normal Tib-Fib X-rays
- Normal Bone Scan
- Lumbar Spine X-rays and MRI Normal
- Resting Pressures
    - Lateral 12mm
    - Posterior 10mm
- With Indwelling Needle, Unable to Reproduce Symptoms Due to Pain



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Compartment Testing Re-Done

- Resting
- After Symptoms Occurs 45 min. of Running on Treadmill

Stryker Compartment Testing

	Anterior		Lateral		Posterior	
	Resting	Post Exercise	Resting	Post-Exer.	Resting	Post-Exer.
R	15	6	13	18	2	5
L	26	6	20	18	11	15



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P. T. Evaluation & Treatment

- Rear Foot Striker
- Core Weakness
- R>L Hip Abductors and External Rotators
- Borderline High Resting Pressure Which ↓es with Exercise

Treatment

- Modification of Running Program
- Hip, Back & Abdomen Strengthening
- Significant muscular inflexibility in all lower extremity muscle groups


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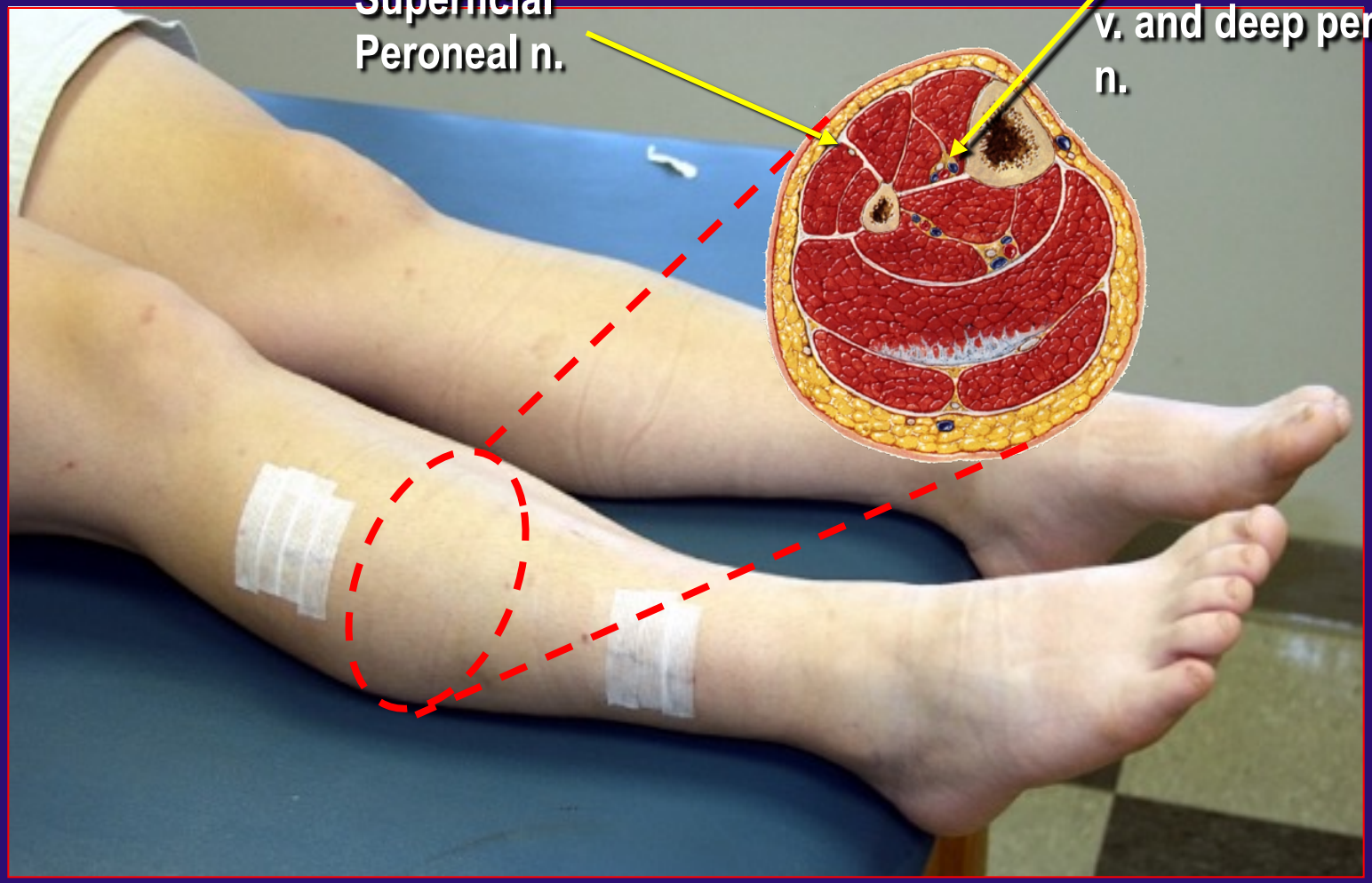

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Conclusions

- Diagnosis of compartment syndrome must be confirmed by compartmental testing before and after exercise
- Consider broad range of diagnoses for athletes with leg pain.
- Make sure of the diagnosis prior to surgical release



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Know the anatomy before performing compartment testing or surgical releases.

Aesthetics

- Patients judge you by your wound.
- Minimal incisions are visually appealing.
- All females with CECS expressed particular interest in minimal incision



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Combination of the arthroscope and long retractors and long scissors optimizes visualization, reduces risk of superficial peroneal nerve injury and bleeding



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Clinical Pearls

- Always visualize the superficial peroneal nerve
- Confirm dx with compartment measurements
- Avoid medial release unless indicated
- Diligent intra-operative bleeding control without tourniquet
- Post-operative cryotherapy



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Future Directions

- Increasing awareness of problem in all providers
- Does minimal incision surgery allow adequate fascial release?
- What is adequate release?
- Non-invasive testing to confirm the diagnosis (Near infrared spectroscopy)



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The End . . . Thank You!