

Treatment of Tendon Injuries

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November 19, 2014





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Keep People Active!



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Don't bury the lead!

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Who is this guy?



- PhD Anatomical Sciences
 - Sports Biomechanics- Overhand Throwing Performance in Females
 - Stony Brook University
- Physical Medicine & Rehabilitation
 - Residency, UMDNJ-NJMS/ Kessler Institute of Rehabilitation
 - Sports & Spine Fellowship, Rehabilitation Institute of Chicago/ Northwestern University
- Academic Medicine
 - University of Arkansas
 - Director, Spine Clinic
 - University of Pittsburgh
 - Director, Musculoskeletal Sports & Spine Fellowship
- Inventor/ Leadership
 - ActivAided Orthotics
 - Chair, AAPM&R Musculoskeletal Council
 - Journal Editor, PM&R, ACSM Health & Fitness

Academic Stuff

- Patient Satisfaction
- Athletic Low Back Pain
- ACL Tears
- Teaching Spine Injections
- Complications of Spine Injections
- Cervical Manipulation for Neck Pain
- RFA for low back pain
- EDX Testing to Predict Outcome for Epidurals
- Barefoot Running
- Endocrine changes in MSK
- Ultrasound guidance for Carpal Tunnel Injections
- Pelvic floor pain
- Core Strengthening
- Platelet-Rich Plasma for Knee OA
- Sickle Cell Testing for Athletes
- Performance enhancing drugs
- Hypogonadism in aging male athletes
- Rehabilitation of basketball injuries
- Gender differences in pain

How about the good-looking one?



Academic

- *MD/MPH
- *PM&R at UW
- *Chief Resident
- *Fellowship in Sports Medicine
- *UW Clinical Associate Professor
- *Journal Reviewer

Selected Writing

- *Patellar tendinosis "Jumper's Knee"
- *Knee osteoarthritis
- *Cervical spine
- *Lumbar epidural steroid injections

National Lectures

- *Diagnostic musculoskeletal ultrasound -- multiple -- knee, shoulder, ankle/foot
- *Ultrasound guided peripheral joint and tendon injections

Leadership

- *Course Director, Introduction to Diagnostic Musculoskeletal Ultrasound, ACSM
- *AAPM&R Ultrasound Workgroup (political advocacy)
- *AAPM&R Volunteer, CME question developer

Disclosures



My Real Disclosure

- I take money from the Center for Medicare and Medicaid Services (CMS)
 - For now
- A far, far higher % of my income comes from CMS than any industry influence
- Changes the way I practice medicine
 - And **not** for the good

Why Tendon?

What do we see?



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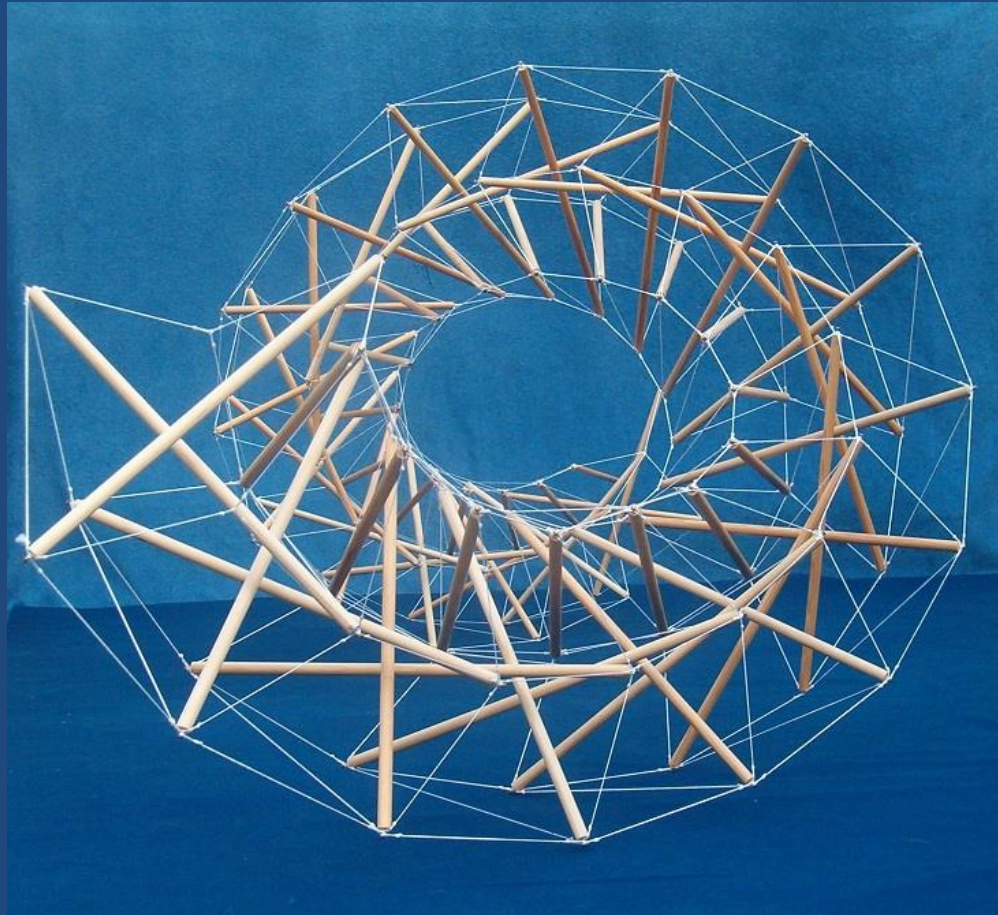
What about Tendon?



The Bone and Joint Decade
Promoting musculoskeletal health

Keep people moving

Tensegrity



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Thought Experiment



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Tension-Based



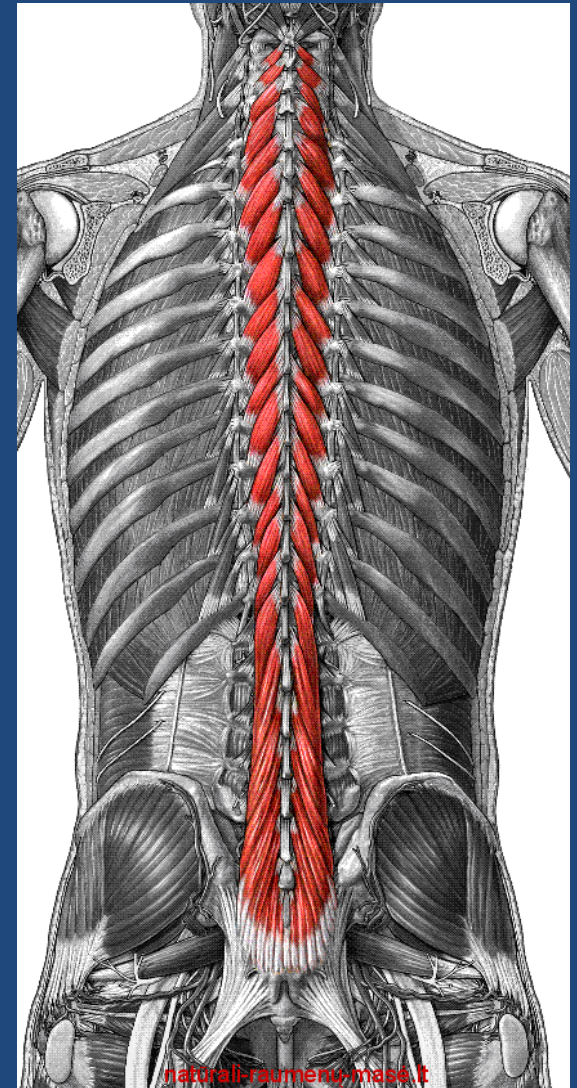
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Tension-Based



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Tension-Based



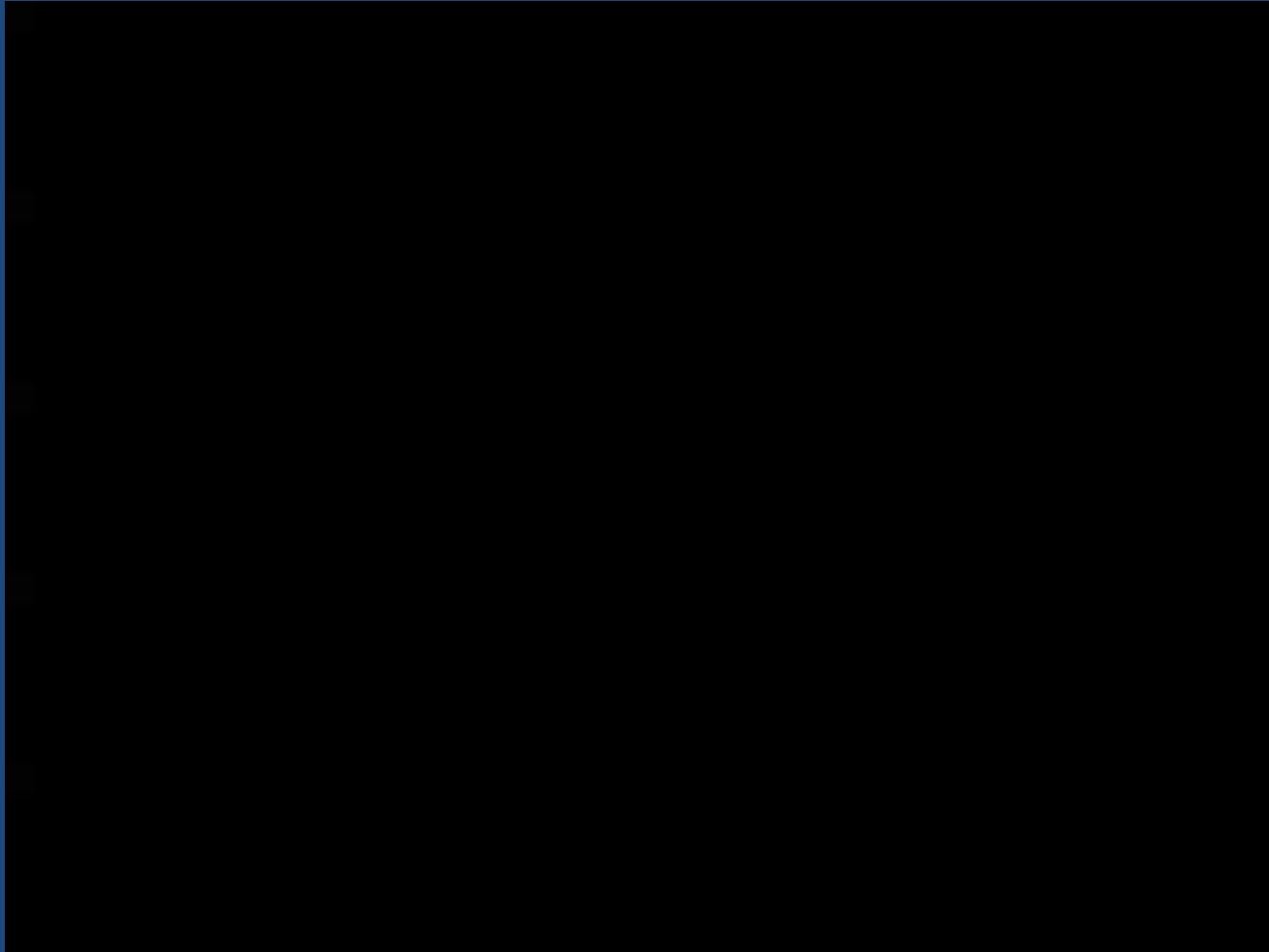
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Tension-Based



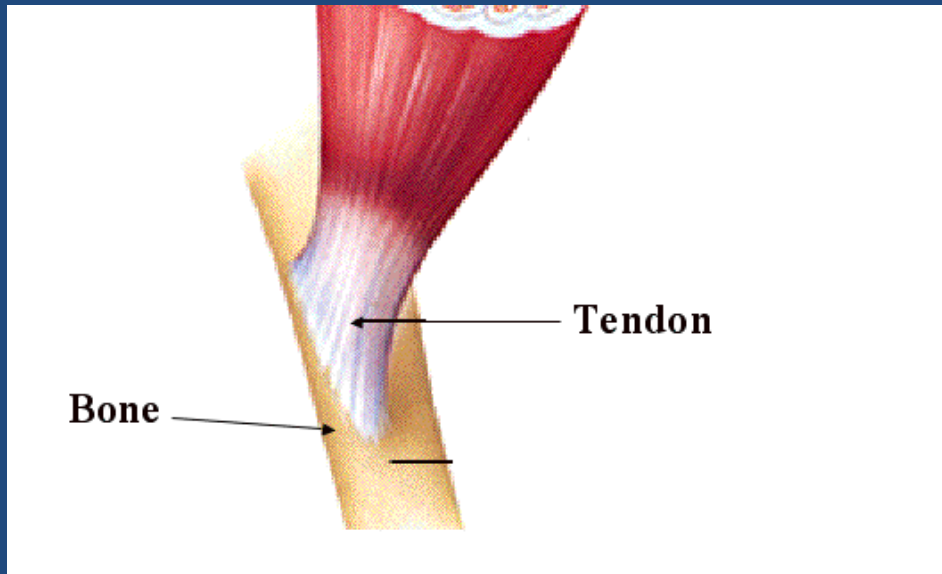
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Tension-Based



What is a Tendon?

Tendon



- Tendon
 - Connects muscle -
→ bone
- Ligament
 - Connects bone →
bone
- Fascia
 - Connects muscle
→ muscle

Ok- I'm convinced
tendon is important

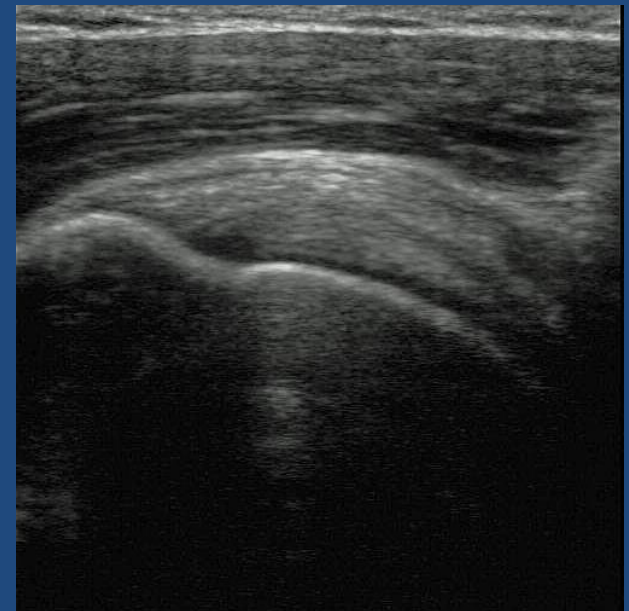
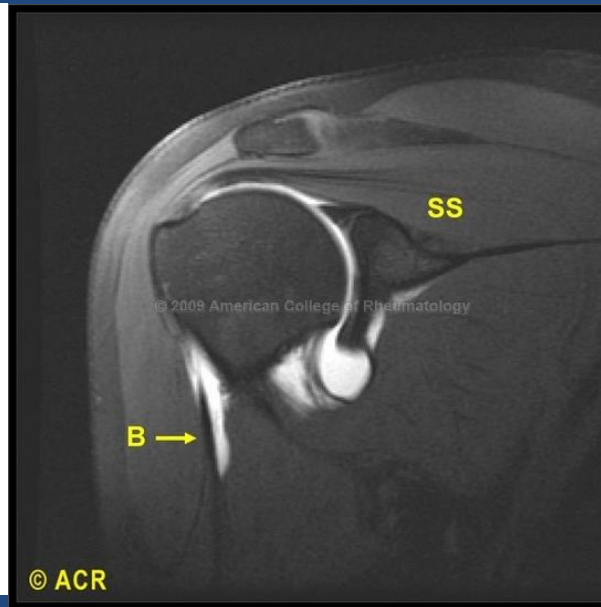
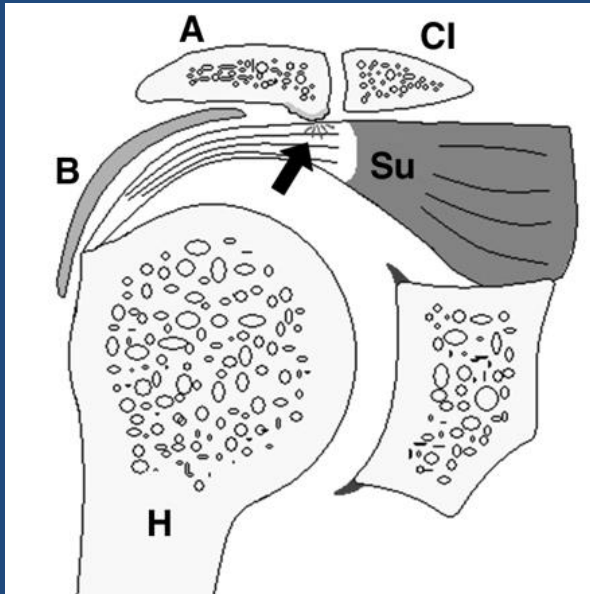
.... but how can I *see* it?

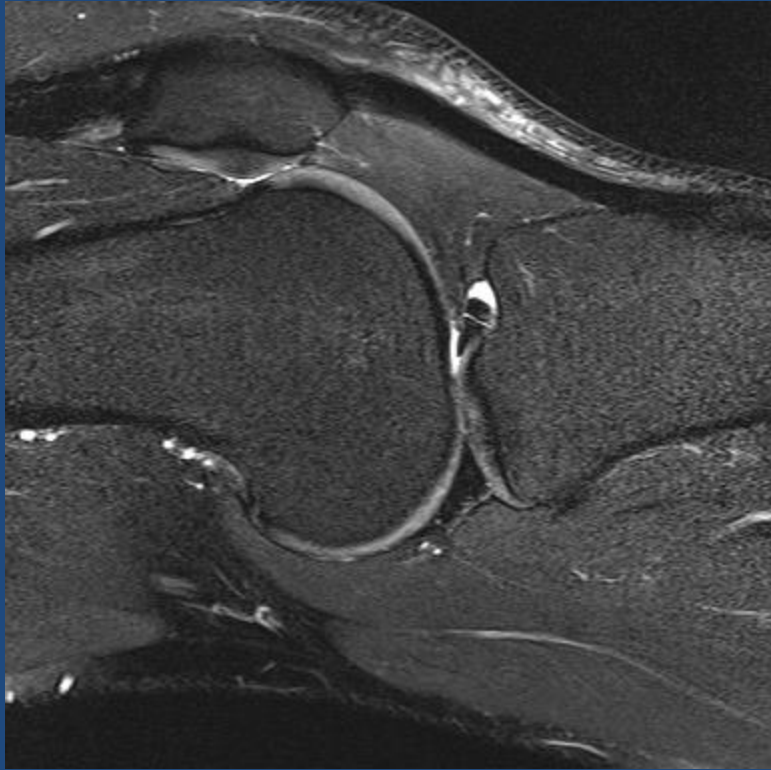
ULTRASOUND

Indications for Tendon

- High resolution diagnostic imaging
- Dynamic imaging
- Can provide detail of tendon fibrillar architecture
- Point of service imaging
- Guided injections

Supraspinatus





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UPMC PMR

03/21/11 3:37:21 PM

ADM

30675615

MI 0.6

TIs 0.3

12L-RS

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UPPER

GE
Le

Right knee long axis view

patellar ligament

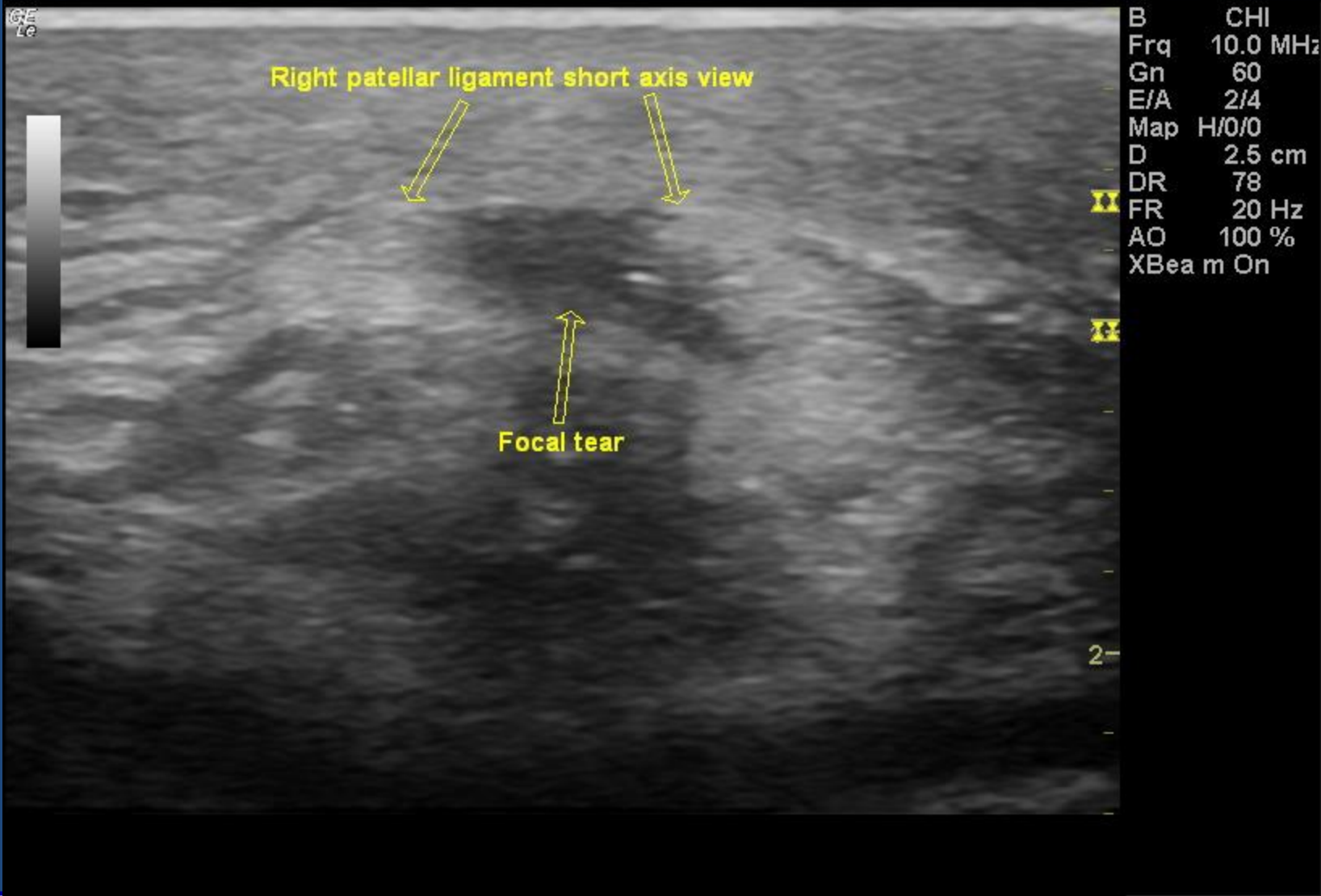
Patella

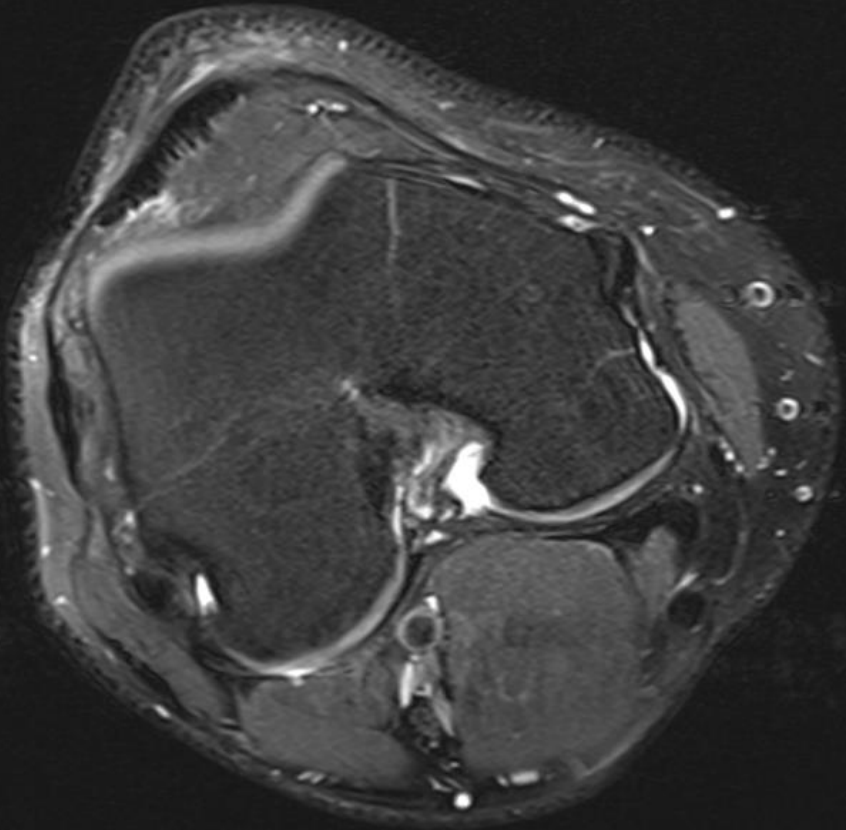
Focal tear

B CHI
Frq 10.0 MHz
Gn 60
E/A 2/4
Map H/0/0
D 2.5 cm
DR 78
FR 20 Hz
AO 100 %
XBea m On



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Advantages

Interventional



- Tendon sheath
- Perineural
- Bursal
- Joint
- Dry-needling
- Prolotherapy
- Platelet-Rich Plasma
- Aspirations

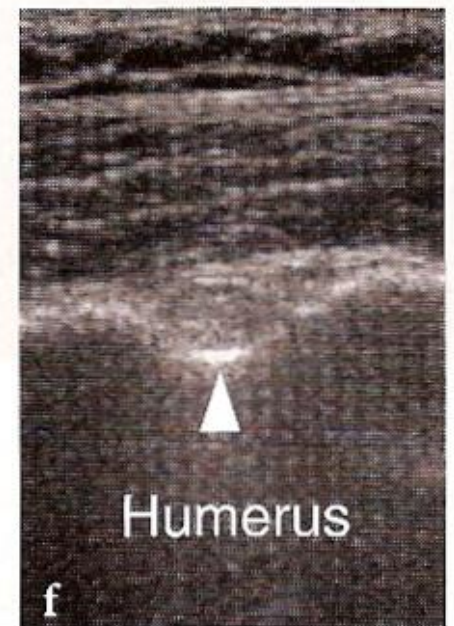
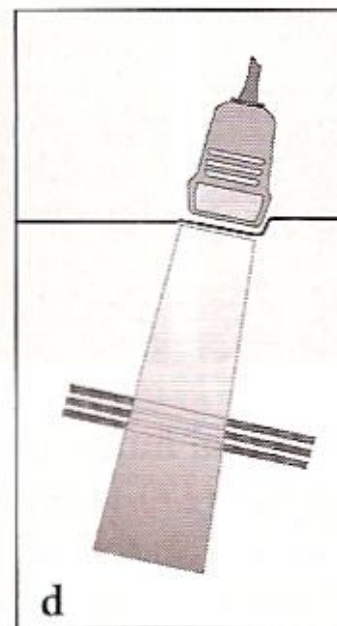
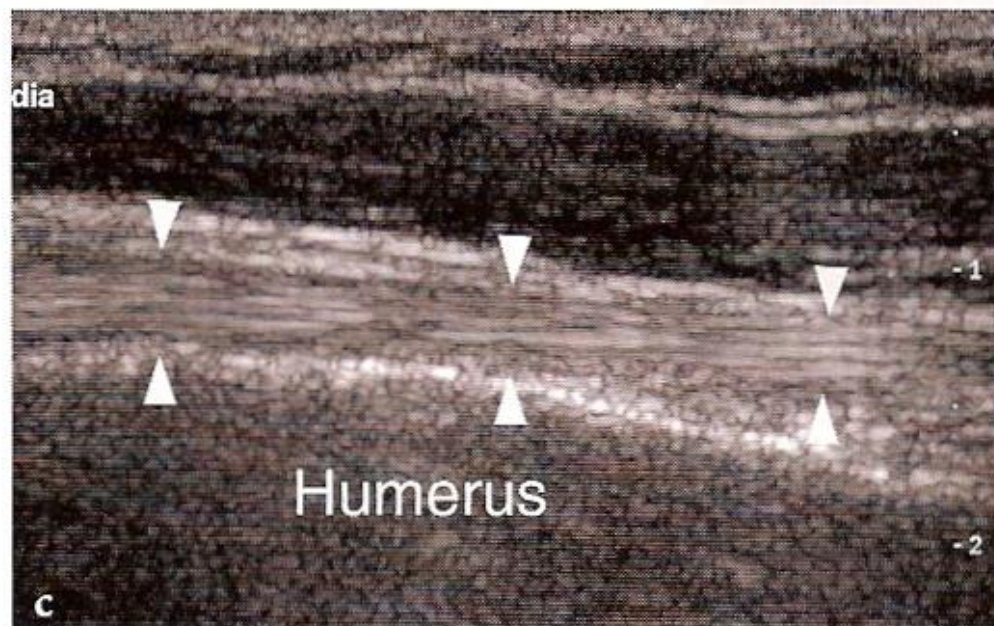
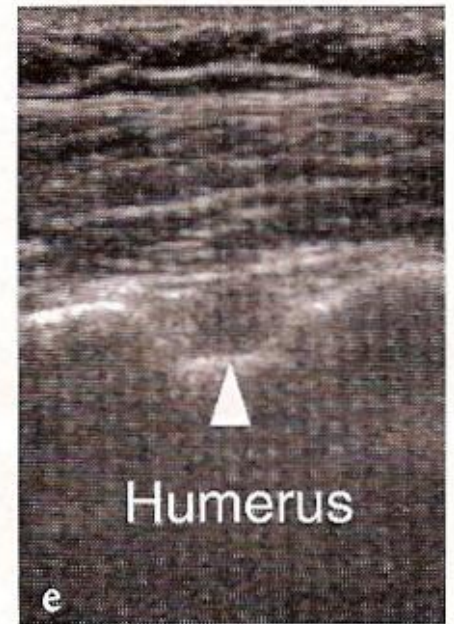
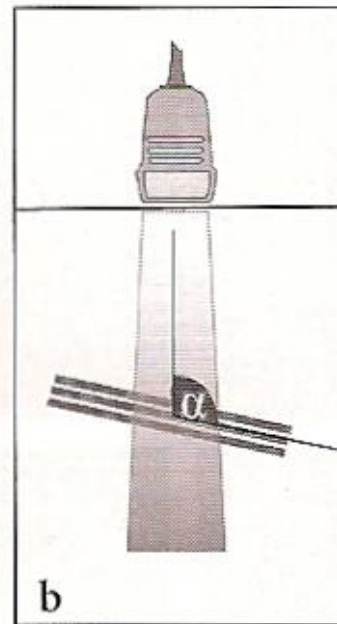
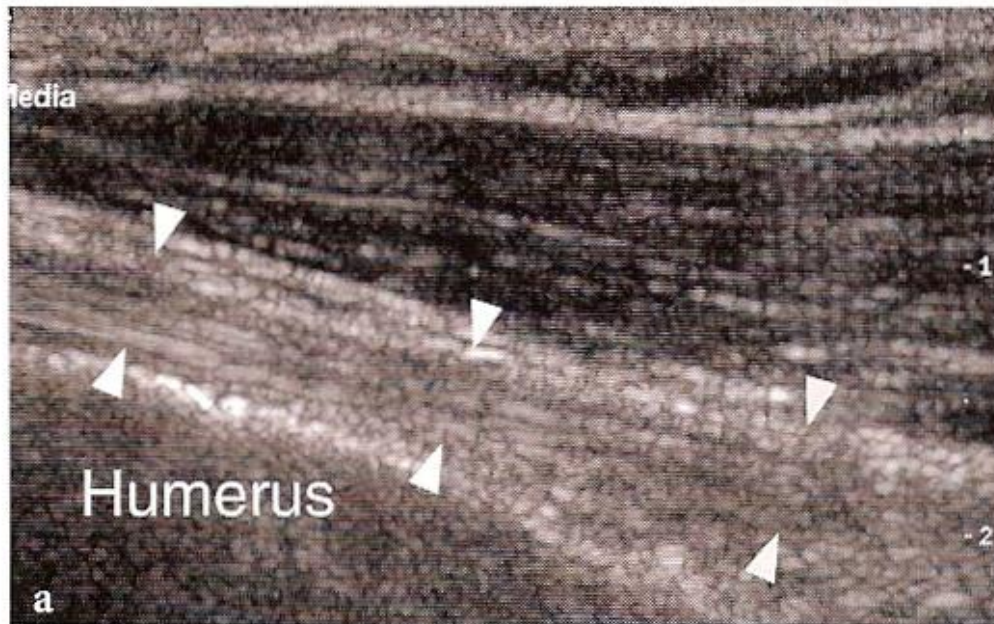
Does Guidance Matter?

| Joint | Landmark Guidance | Ultrasound Guidance |
|------------------------------|-------------------|---------------------|
| Shoulder (Glenohumeral) | 10-100% | 93-100% |
| Shoulder (Acromioclavicular) | 39-72% | 90-100% |
| Elbow | 38-100% | 91-100% |
| Wrist | 25-97% | 79-94% |
| Knee | 51-80% | 97-100% |
| Ankle (Subtalar) | 68-100% | 90-100% |

Hall (2013) *Curr Sports Med Rep.* Sep-Oct;12(5):296-303

TECHNIQUE CONCERNS

Why Experience Matters

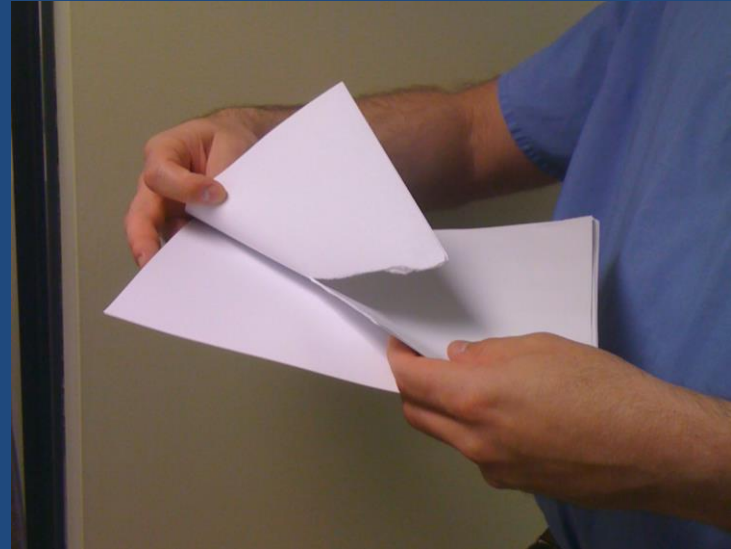


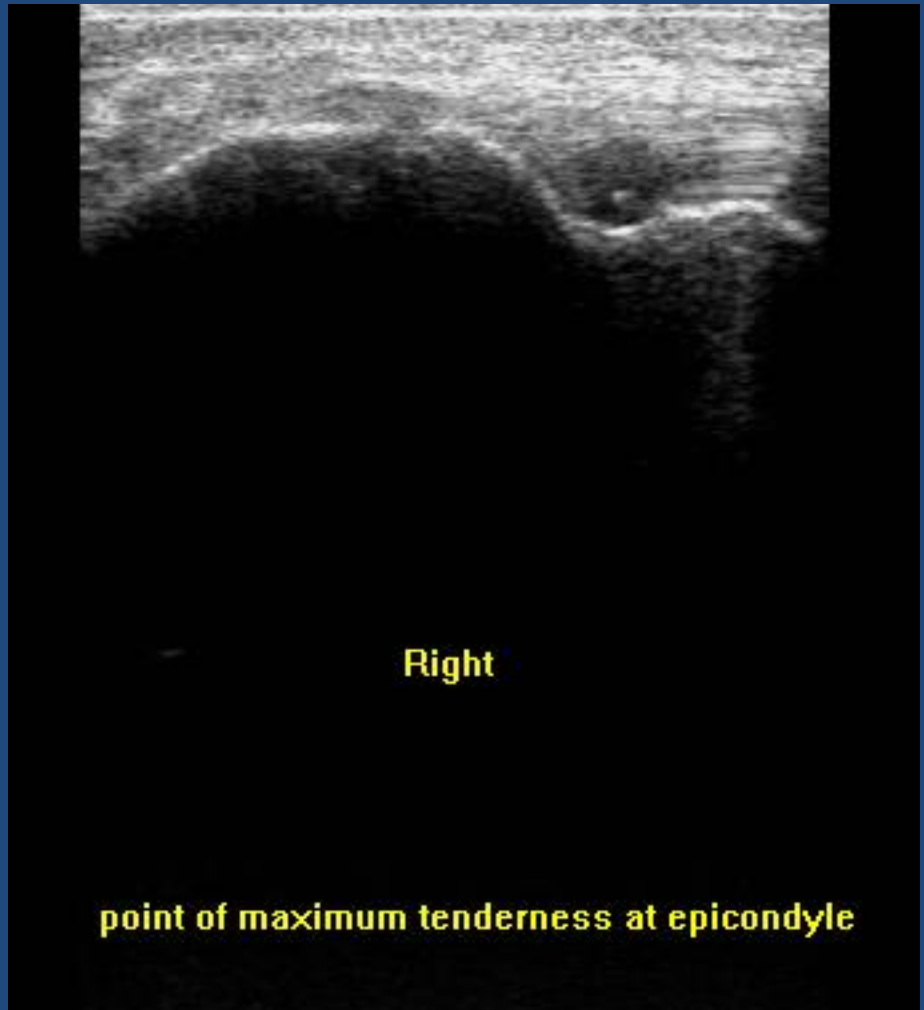
Da Planes



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Scanning All Planes





Supraspinatus

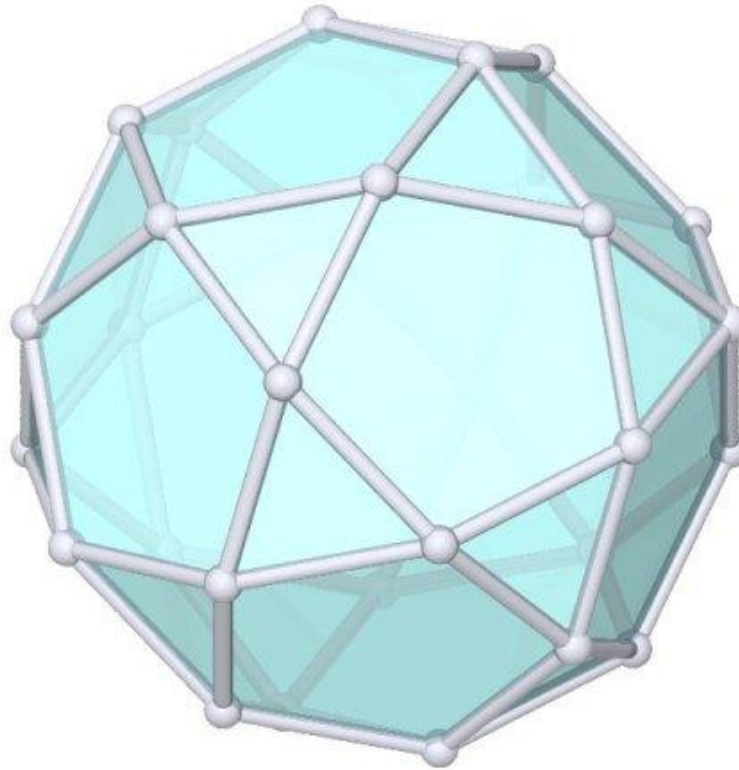


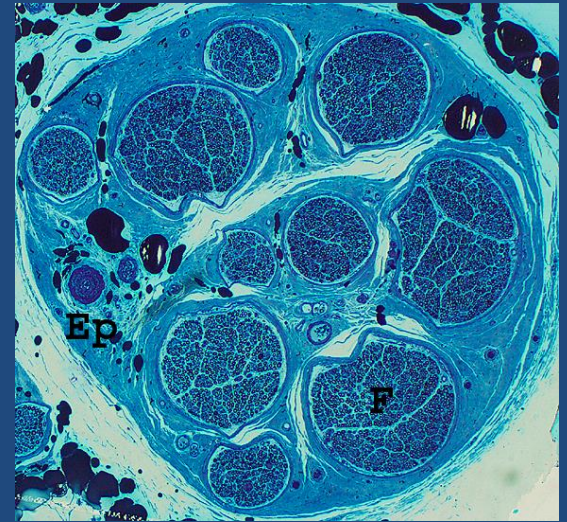
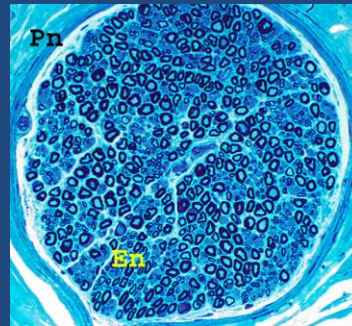
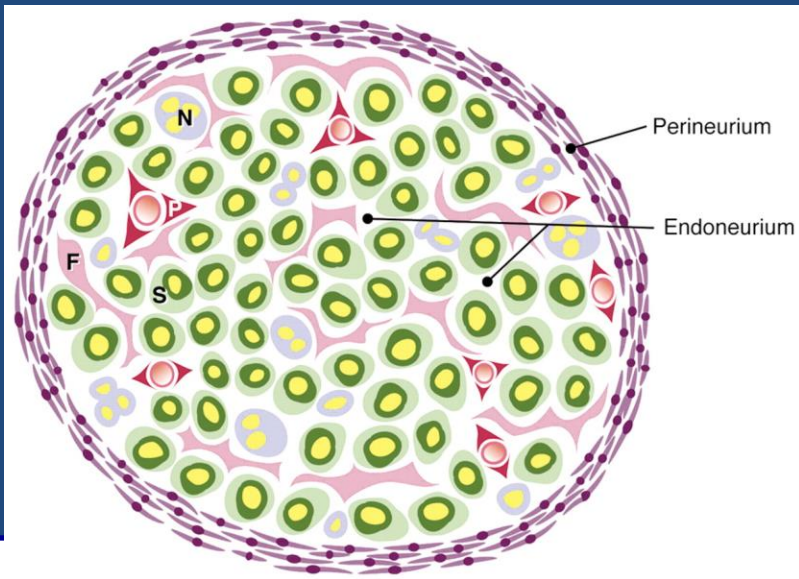
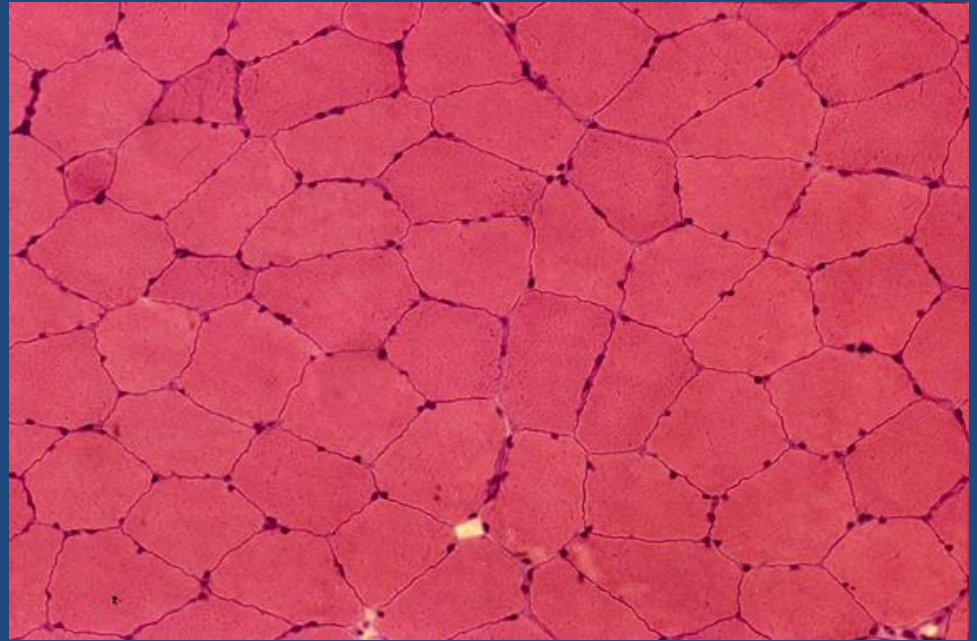
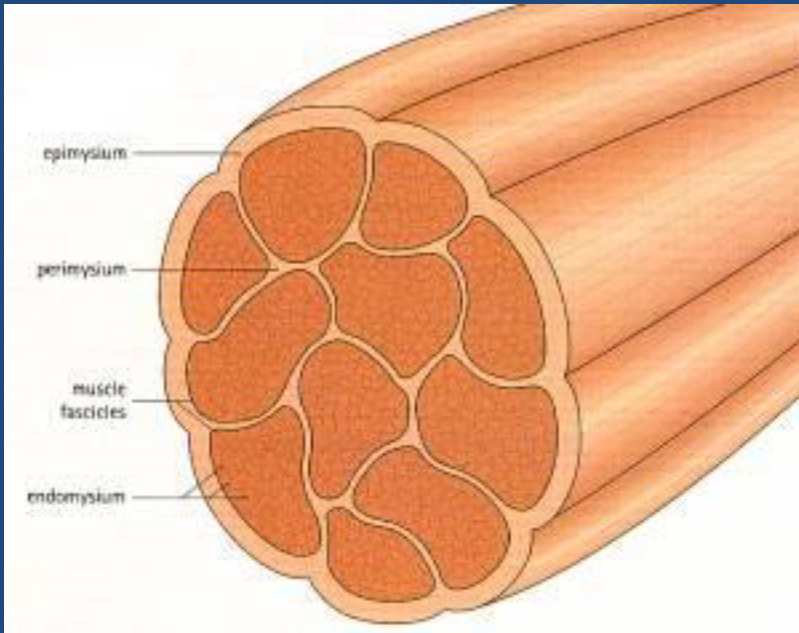
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Partial Thickness Tear



Isotropy





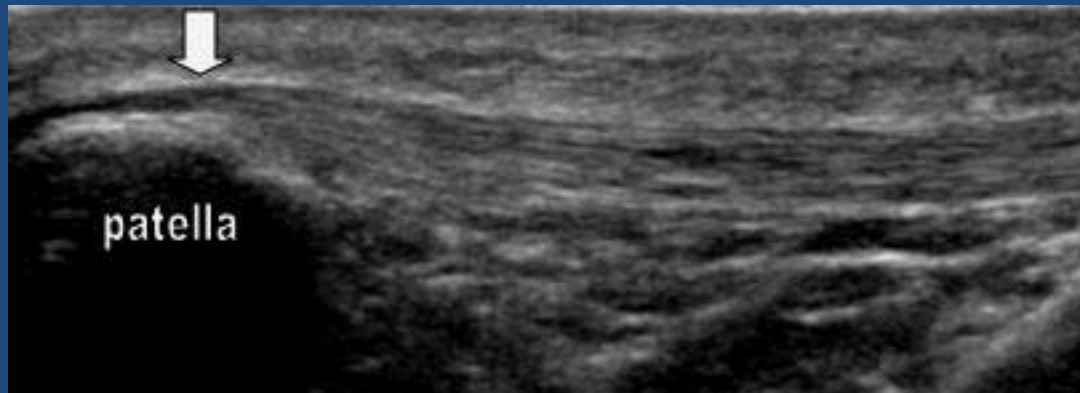
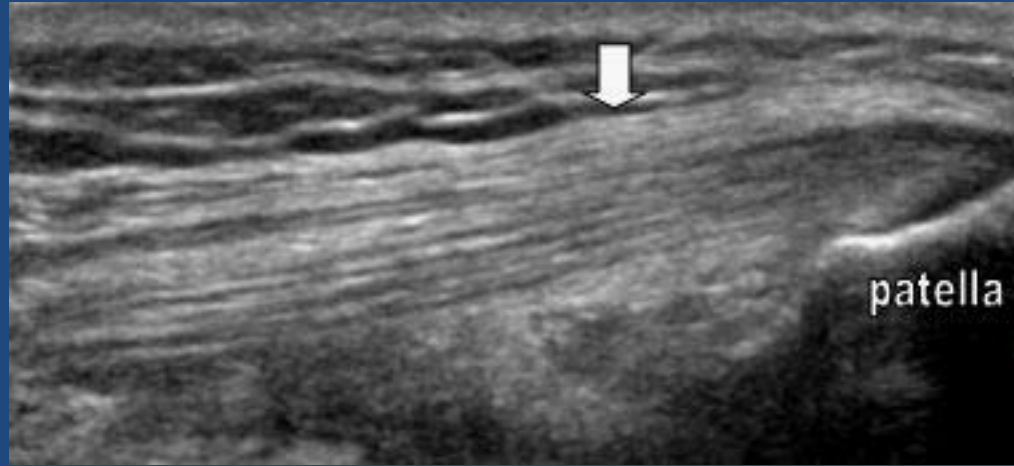
Tendon/Ligament



- Longitudinal
 - Fibrillar
- Transverse
 - Broom-end
- Anisotropic



Tendon- Longitudinal



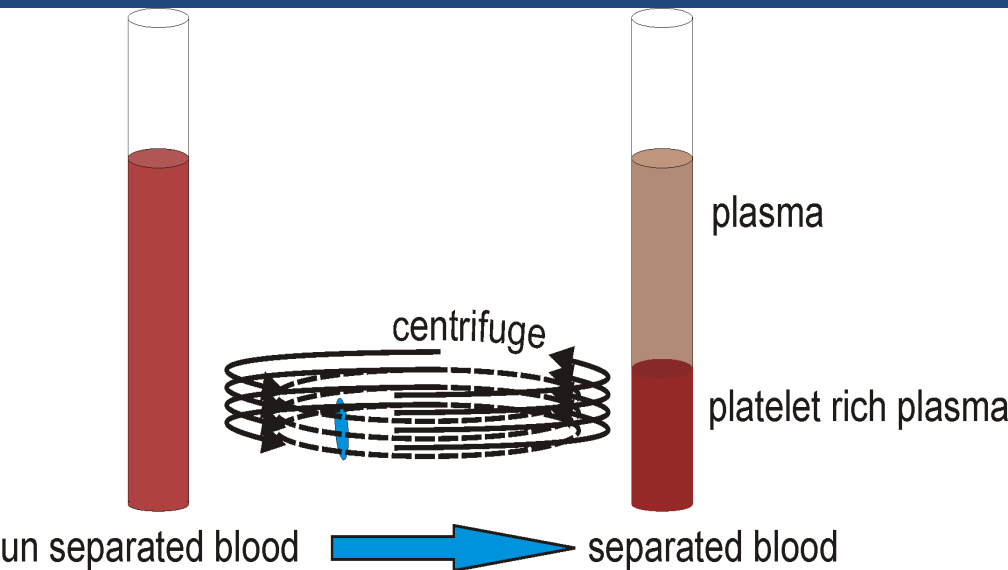
Quad Tendon



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Injections

Do we have to use corticosteroid?



- Proliferative Therapy
 - Prolotherapy
 - Platelet Rich Plasma
 - Achilles ventral scraping

PM R. 2011 Apr;3(4):377-86.

Treatment options in knee osteoarthritis: total knee arthroplasty versus platelet-rich plasma.

Klatt BA, Lopez HL, Segal NA, Chimes GP.

Prolotherapy

Brad Fullerton, MD



- ProloAustin.com
- Friend
- Mentor in Prolotherapy
- Prolo study on Tennis Elbow together

- Many slides/ ideas borrowed from Brad

Healing Cascade

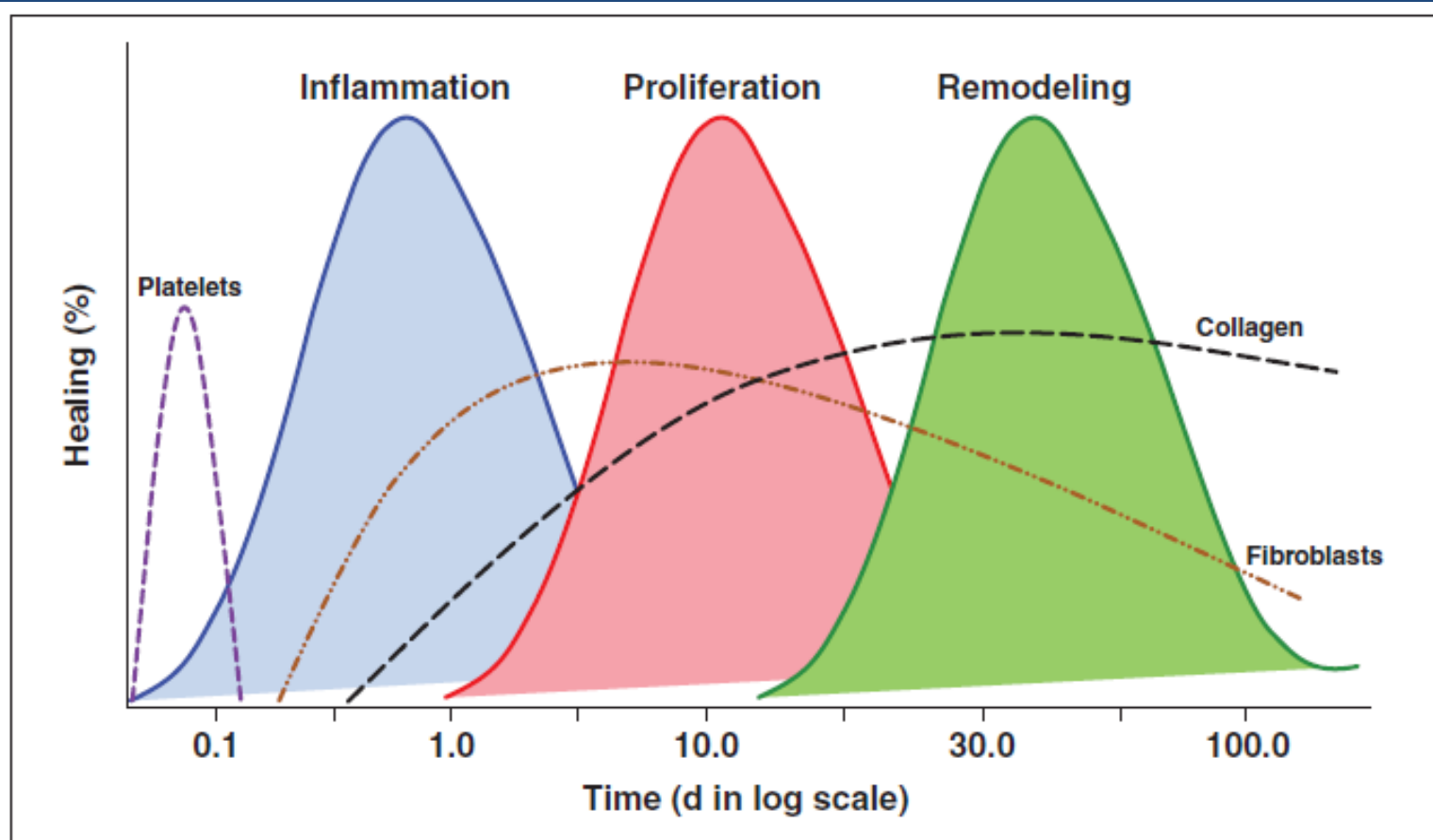


Fig. 1—Diagram shows wound healing cascade, outlining intricate process of three overlapping phases of healing: inflammation, proliferation, and remodeling.

Rene Leriche, MD 1936

Treatment of sprains by interligamentary injection of novocaine

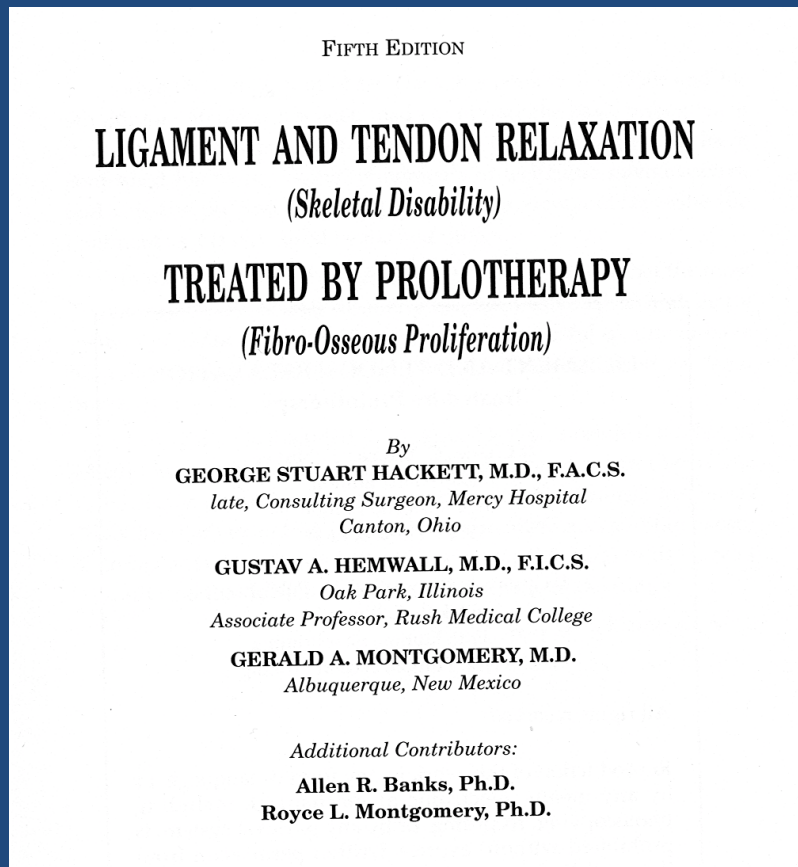
- “...we have found that the interligamentary injection of novocaine satisfactorily relieves symptoms and speeds the healing of sprains, where no associated fracture or ligamental tear can be demonstrated.”

The American Journal of Surgery
Vol 32, Issue 1, April 1936, Pages
45-47

Earl Gedney, DO 1937

- Extrapolated from use of sclerosants in treatment of abdominal hernias.
 - 1st experience, was treating his own thumb injury. *
 - Reported on the injection of “NeoPlasmoid” for treatment of knee and sacroiliac ligaments. #
- Alderman, D in Journal of Prolotherapy, vol 1, issue 4 November 2009

George Hackett, MD - 1956



- Introduced the term Prolotherapy to imply Proliferation
- Used Synasol

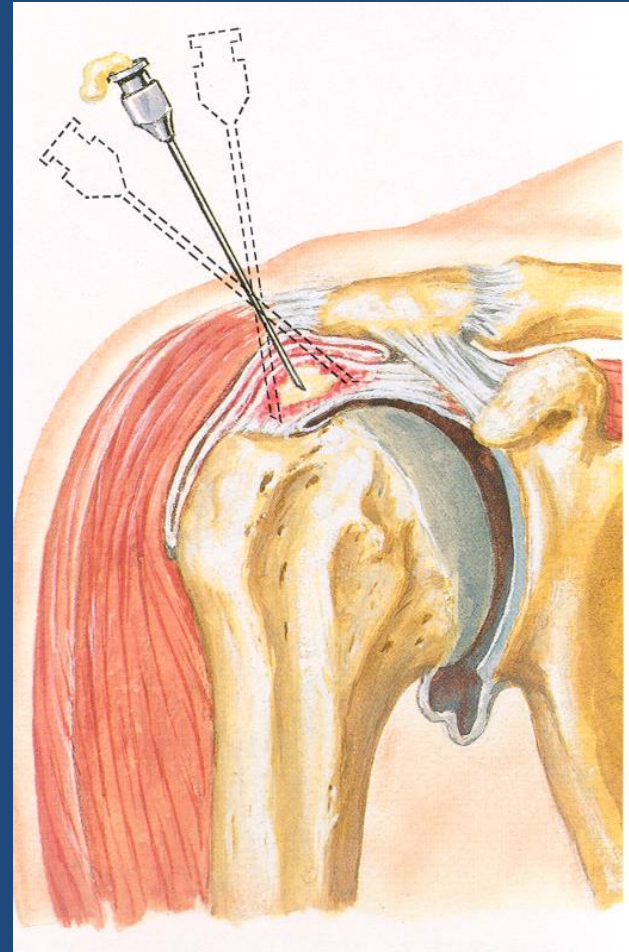
1st reported use of P2G (phenol-glycerin-glucose) in 1962



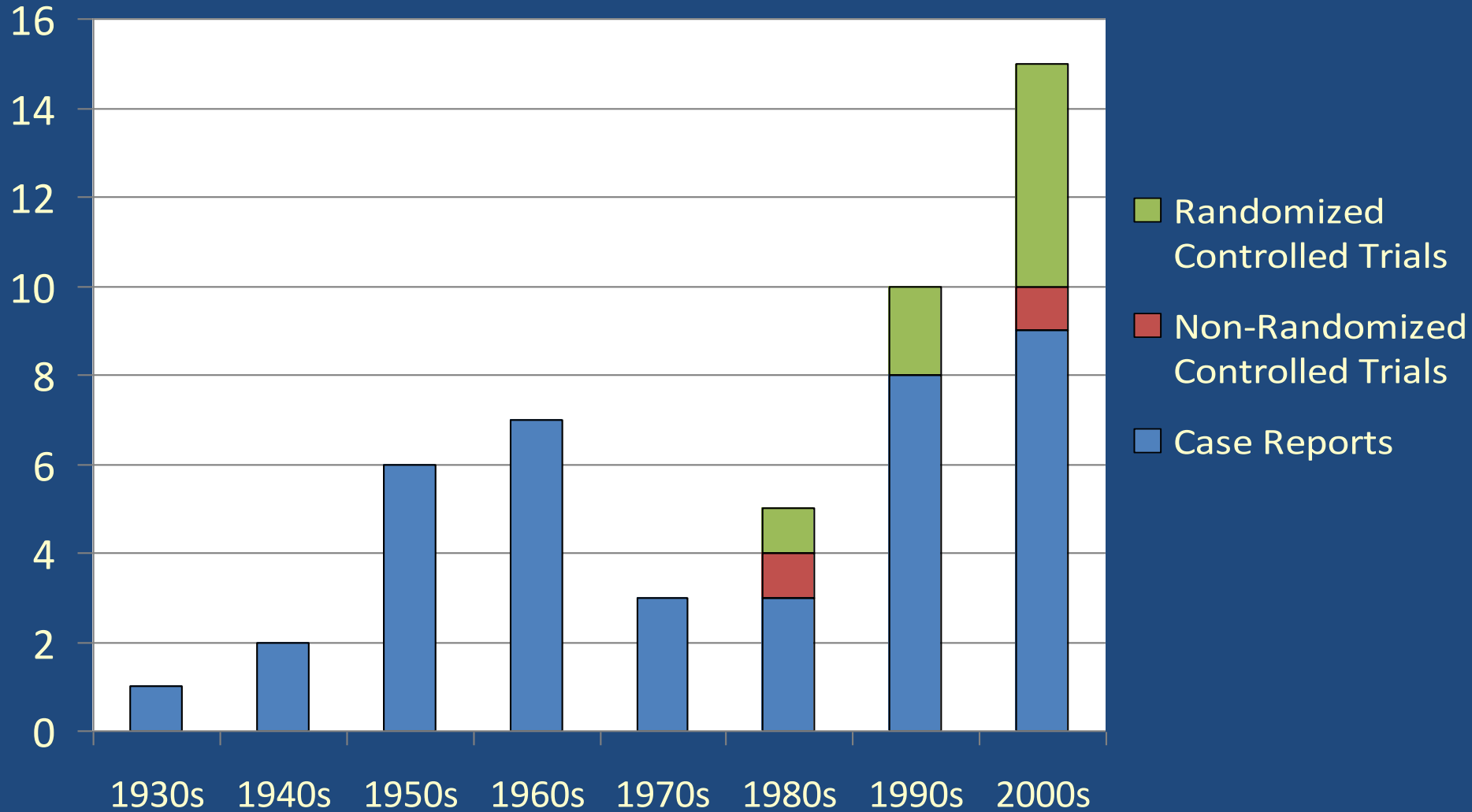
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Injection of “Proliferant” (not a “sclerosant”)

- ❖ Dextrose – most common
(3cc's 50% dextrose, 3cc's 1% lidocaine,
4cc's sterile water)
- ❖ Morrhuate Sodium – 0.25-
1ml added to above (from
cod liver oil)
- ❖ P2G (Phenol, Glycerin and
Glucose) – “Ongley’s solution”
- ❖ Synasol (historical-extract
from psyllium seed)



Prolotherapy Research Publications by Decade



U.S. Preventative Services Task Force Classification (Summarized*)

- A: Good evidence that benefits substantially outweigh risk
- B: Fair evidence that benefits outweigh risk
- C. Fair evidence of benefit but risk may be equal.
- D. Fair evidence that risks outweigh benefit
- I. Scientific evidence lacking, poor quality or conflicting.
- Key statement for A and B levels. “Clinicians should discuss the service with eligible patients.”

Prolotherapy: Levels of Evidence

- B: Achilles tendinosis
- B/C: ACL ligament laxity in Osteoarthritis
- B: Adductor/abdominal tendinosis (i.e. osteitis pubis)
- B/C: Coccygodynia
- A/B: Finger OA
- B: Knee OA
- A/B: Lateral epicondylosis
- B: Low Back Pain: Non-specific
- A: Osgood Schlatter Disease
- B/C: Plantar fasciosis
- A/B: SI pain anesthetic confirmed

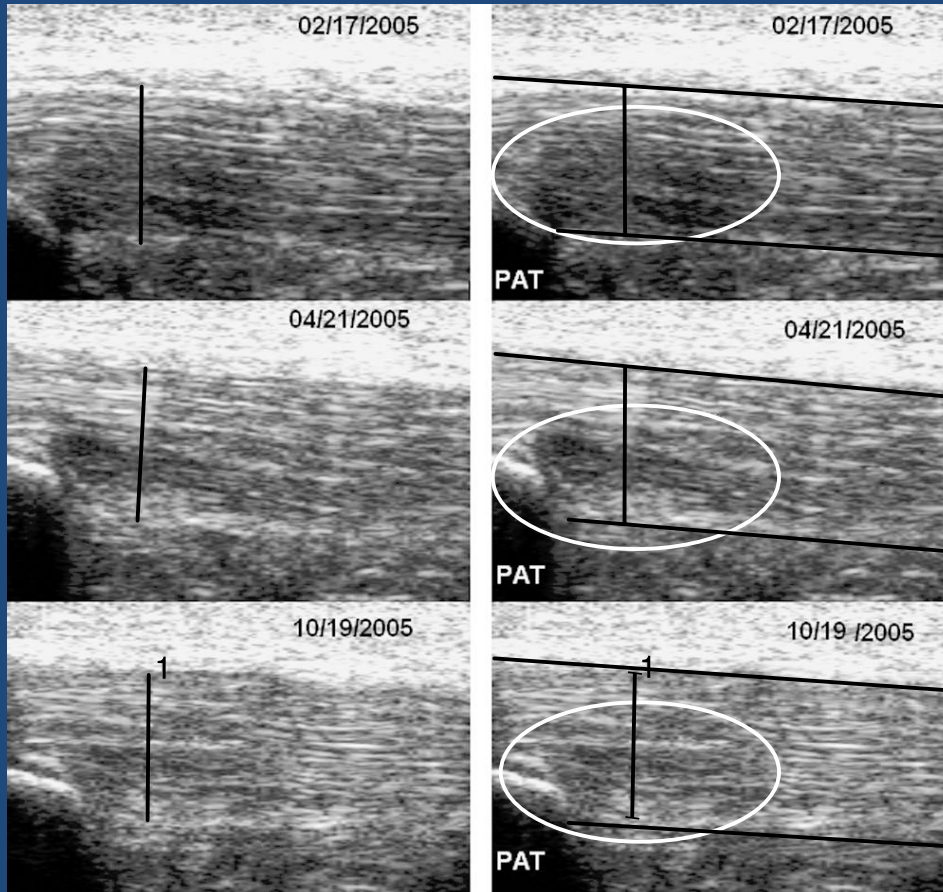
Rabago D, Slattengren A, Zgierska A. Prolotherapy in Primary Care Practice. Prim Care. 2010;37(1):65-80.

Reeves KD, Lyftogt J Prolotherapy: Regenerative injection therapy. In: Waldman SD (ed): Pain Management. Philadelphia; Saunders (Elsevier), 2nd ed; 2011:Pending.

Gary's Personal Experience

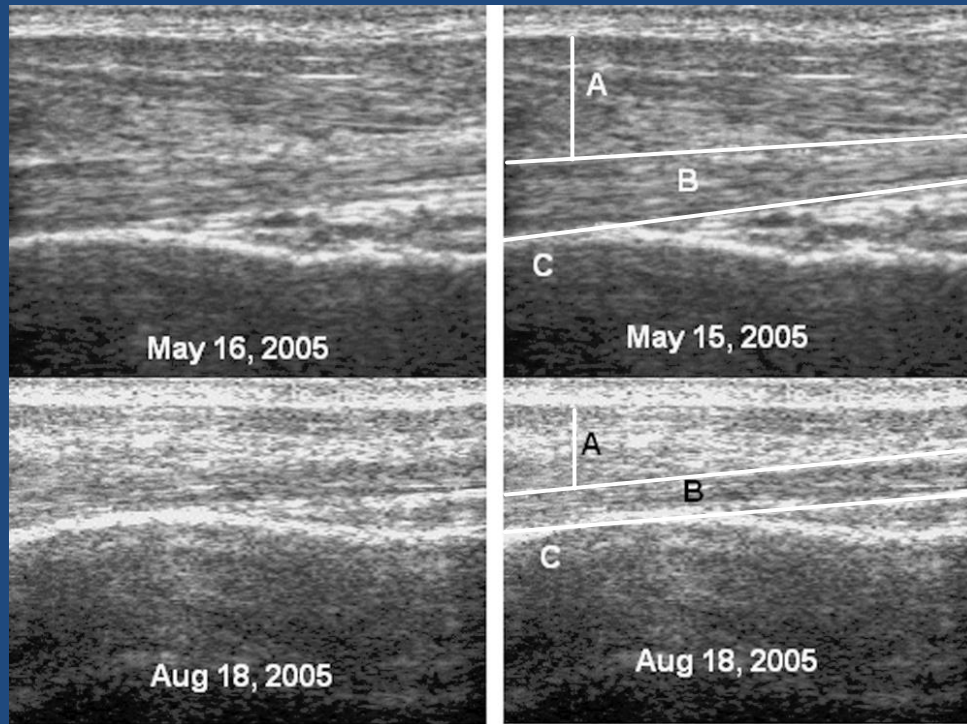
- Home Runs
 - Knee- Medial Collateral Ligament
 - Sacro-Iliac Joint
- Triples
 - Lateral epicondyle elbow
 - AC-Joint
 - ATFL in ankle

Prolo for Patellar Tendon



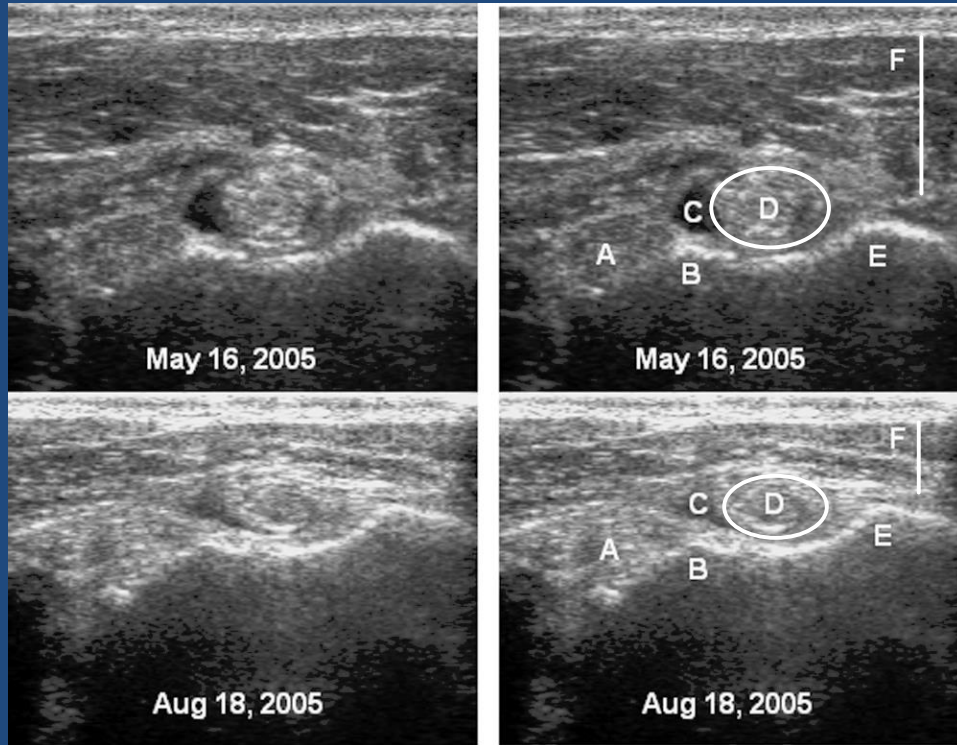
- 40 yo male competitive cyclist
- 2 Prolo procedures using a Dextrose solution
- Reeves, Fullerton & Topol, *Evidence-Based Regenerative Injection Therapy (Prolotherapy) in Sports Medicine*

Prolo for Biceps Tendon



- 85 yo male
- 3 Prolo procedures using a Dextrose solution
- Reeves, Fullerton & Topol, *Evidence-Based Regenerative Injection Therapy (Prolotherapy) in Sports Medicine*

Prolo for Biceps Tendon, part 2

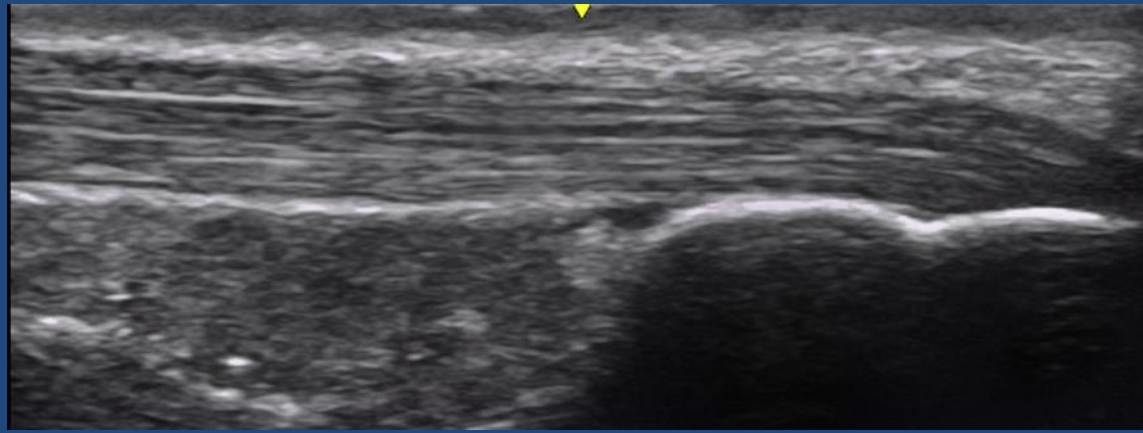
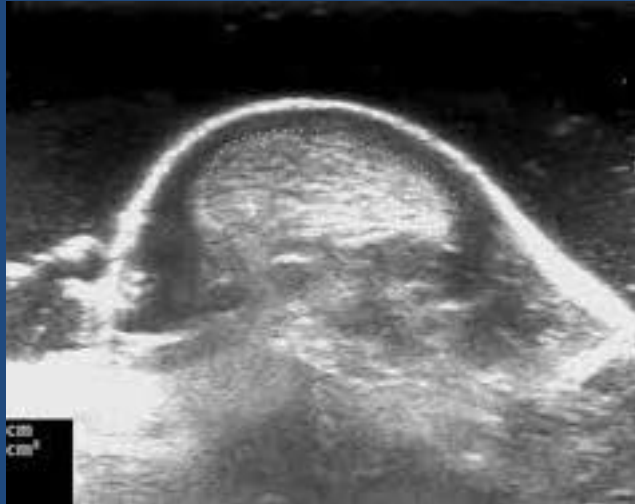
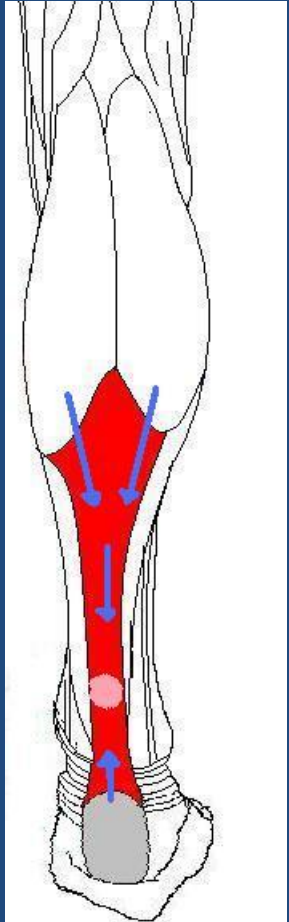


- 85 yo male
- 3 Prolo procedures using a Dextrose solution
- Reeves, Fullerton & Topol, *Evidence-Based Regenerative Injection Therapy (Prolotherapy) in Sports Medicine*

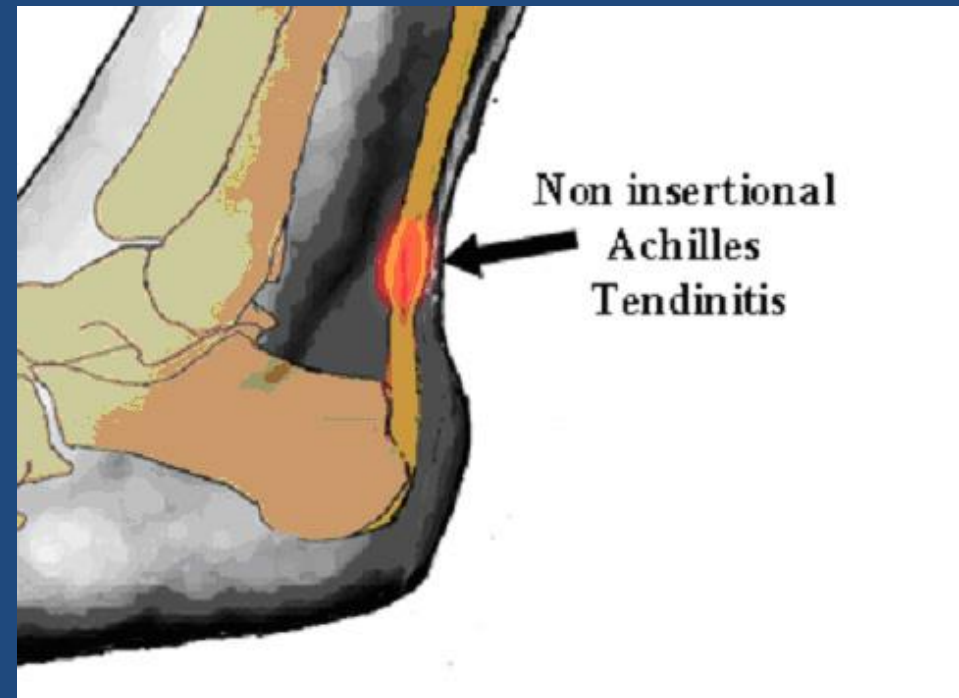
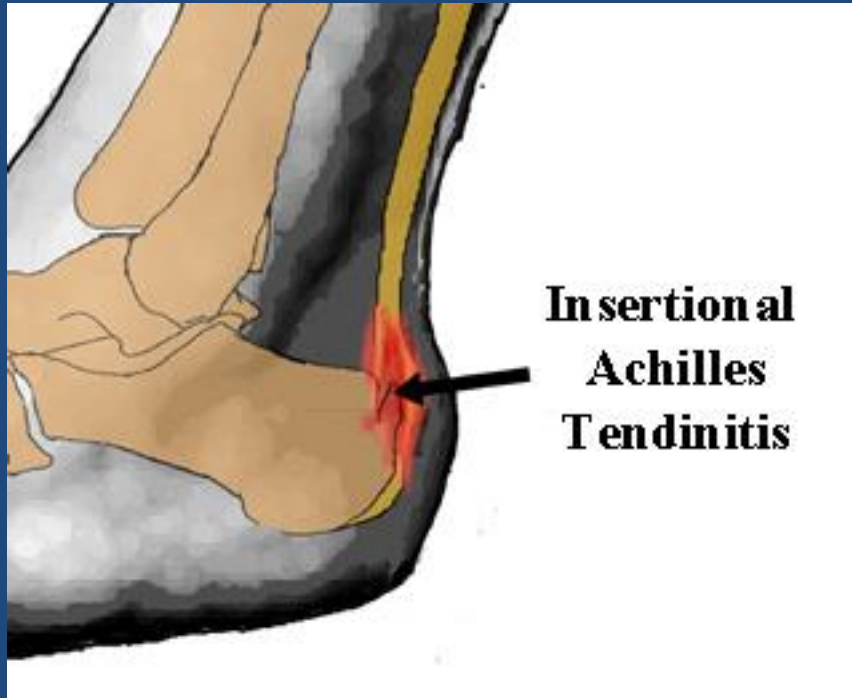
Case #1

Achilles Tendinopathy

Achilles Tendinopathy



SUB-TYPES



Tendinopathy



from
Conservative treatment of
chronic Achilles
tendinopathy, Scott et al
(2011)

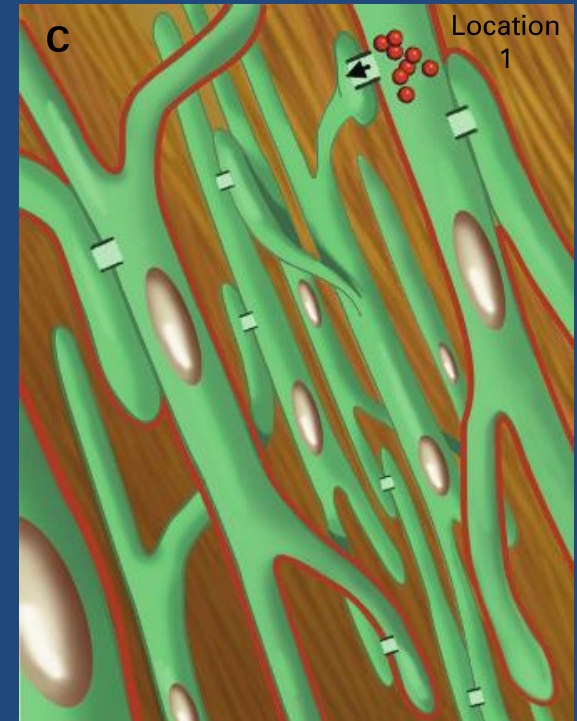
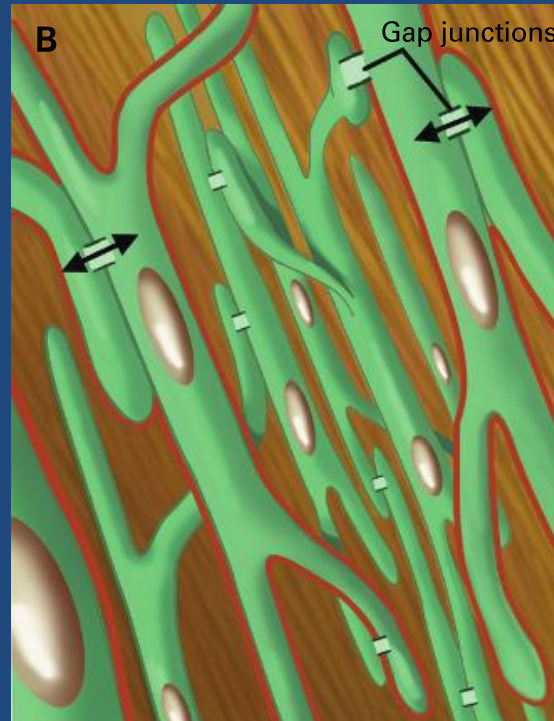
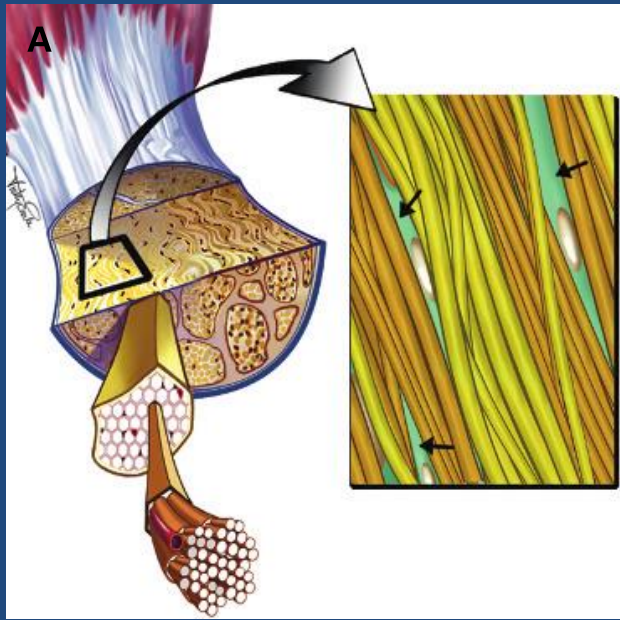


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Mechano-Receptors

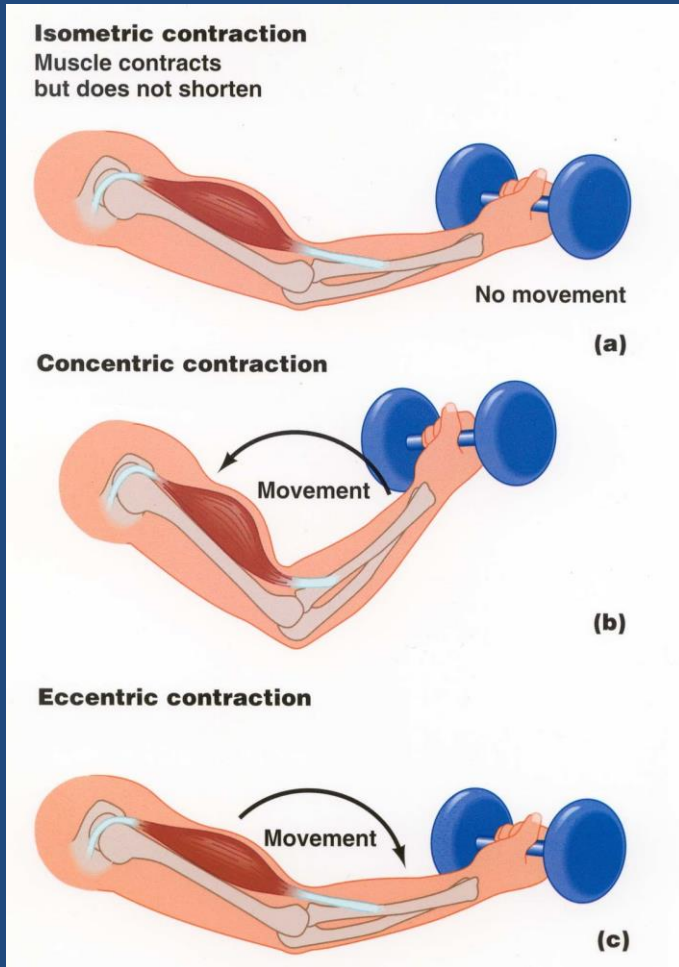
- Tendons have receptors that respond to motion
- Stimulate healthy growth
- Time-dependent
 - Rapid load does *not* stimulate growth
- Emerging research
 - Eccentric Loading
 - Long, slow resistance loading

Mechanoreceptors



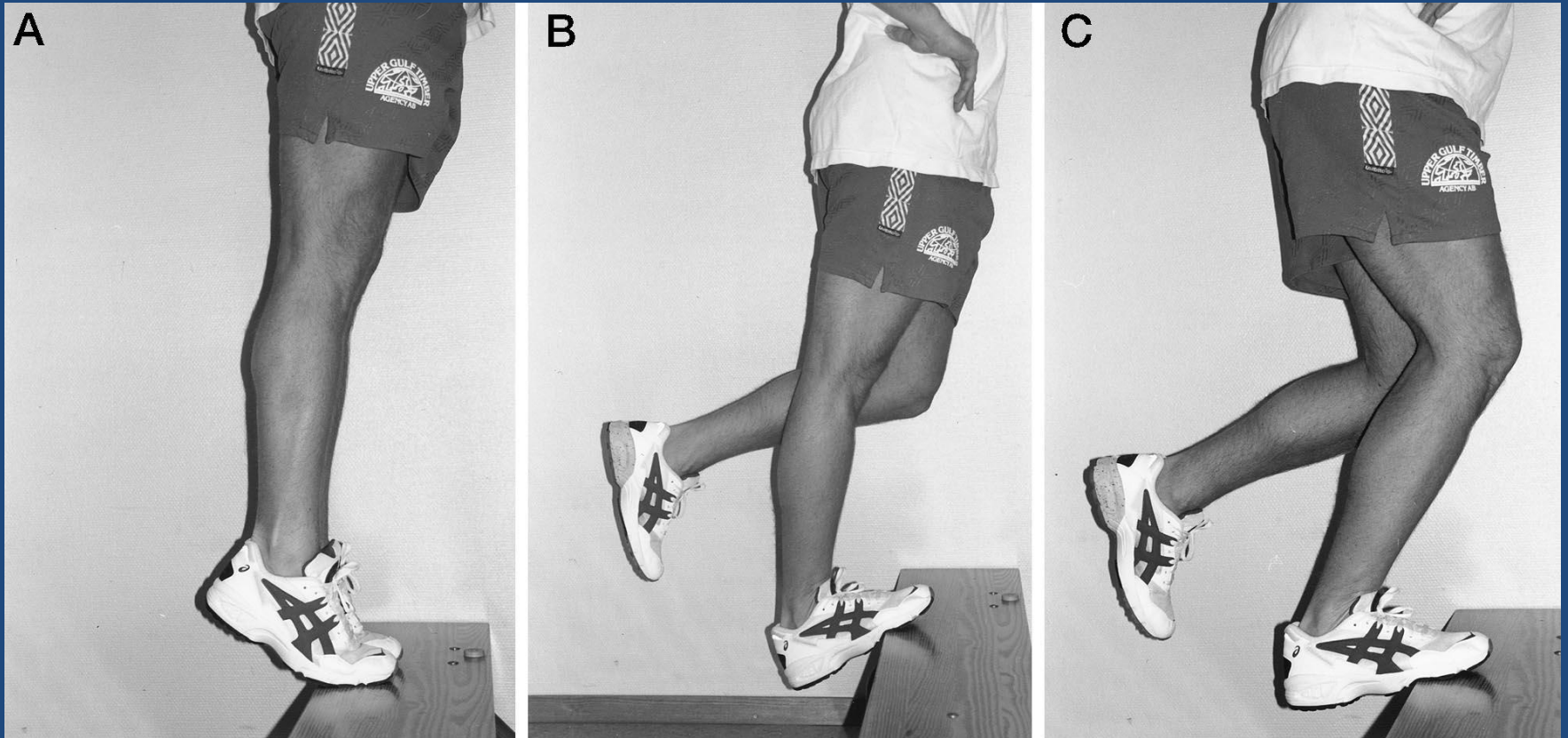
Khan & Scott (2009) Mechanotherapy: how physical therapists' prescription of exercise promotes tissue repair

Eccentric Loading



- Alfredson
 - Multiple Protocols
- 3 sets of 15
- Twice daily
- 7 days/ week
- 12 weeks

Alfredson (1998)



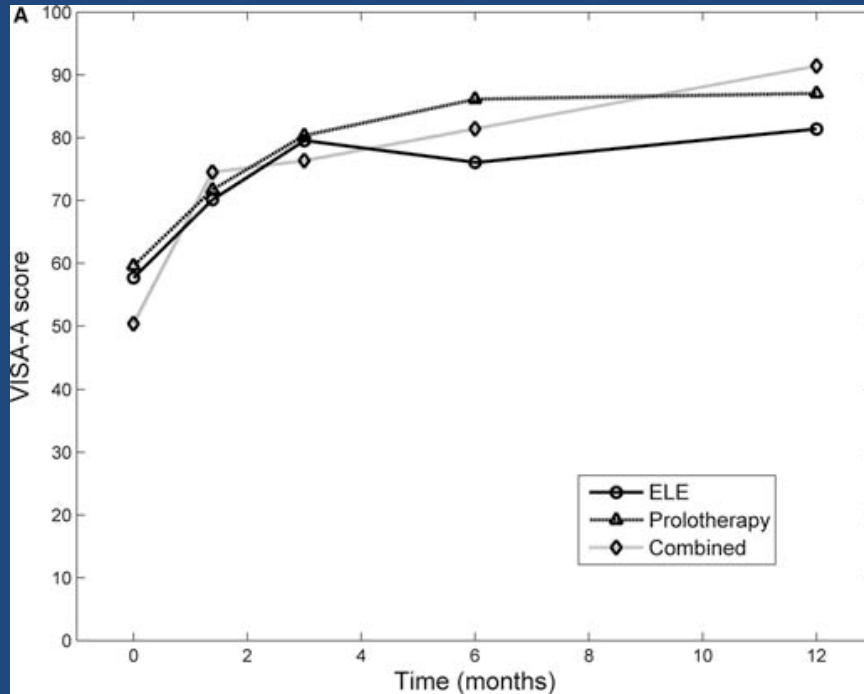
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Prolotherapy and Eccentric Loading

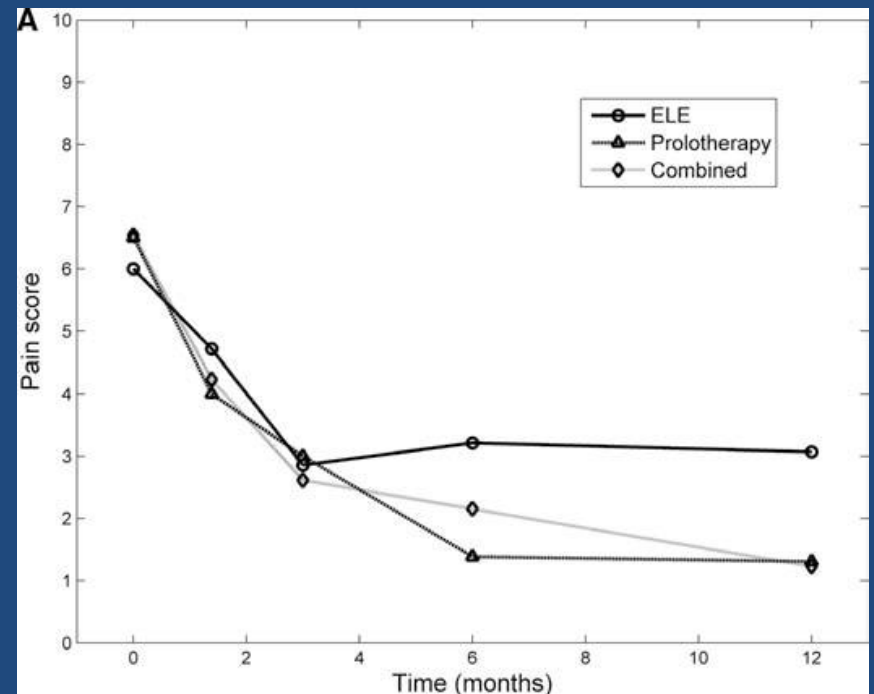
- 43 participants
 - Alfredson eccentric loading protocol
 - Dextrose prolotherapy
 - 4-12 sessions
 - No guidance
 - Combination group
- Combined group did marginally better
 - Smallest benefit was an aggregate score (VISA-A)

Yelland et al (2013), Prolotherapy injections and eccentric loading exercises for painful Achilles tendinosis: a randomised trial ,*Br J Sports Med* 2011;**45**:421–428

Yelland et al (2013)

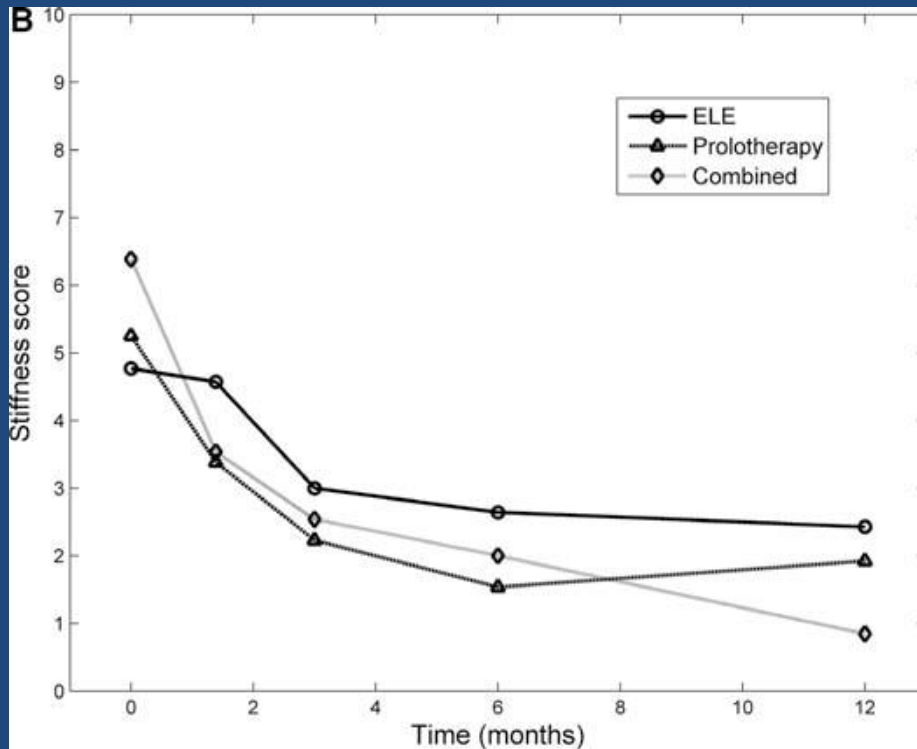


VISA-A

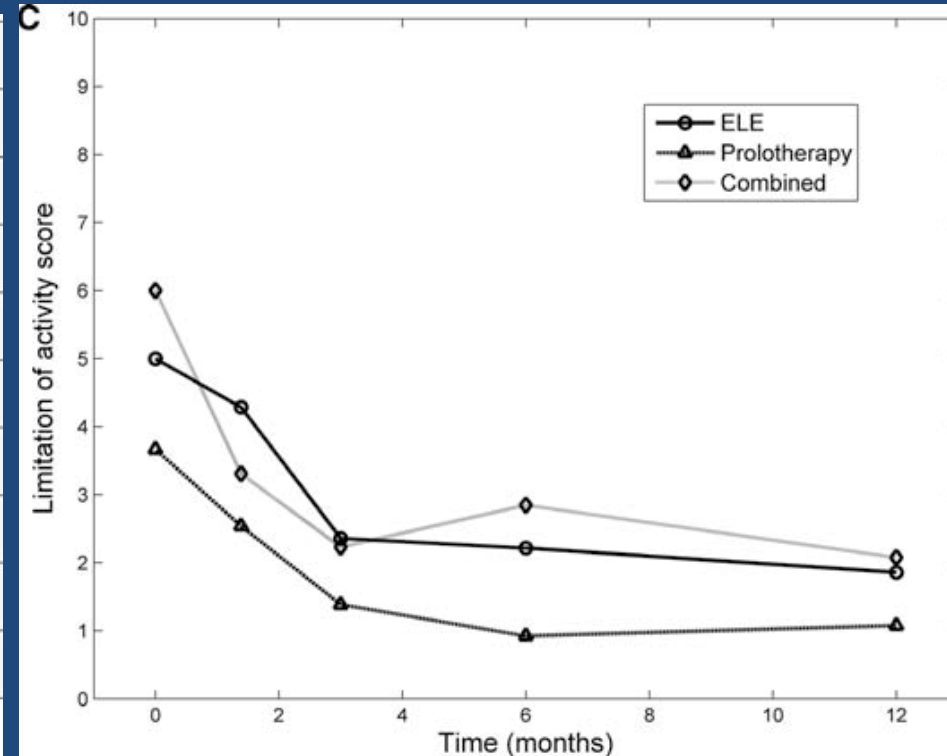


Pain

Yelland et al (2013)



Stiffness



Limitation of Activity

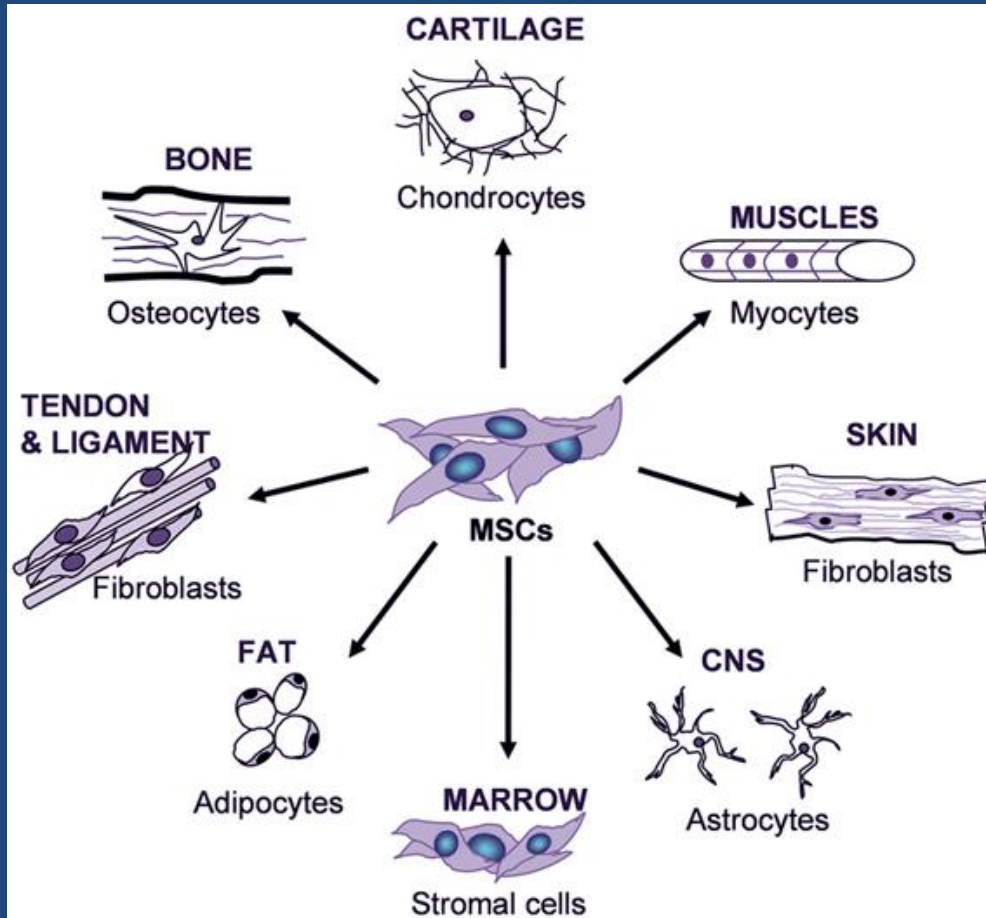
Do NSAIDs help?

No!

Fredriksson et al (2013)

- Diclofenac and triamcinolone acetonide impair tenocytic differentiation and promote adipocytic differentiation of mesenchymal stem cells
- Fredriksson et al. Journal of Orthopaedic Surgery and Research 2013, 8:30
- Looked at mouse mesenchymal stem cells
 - Can differentiate into healthy connective tissue
 - Including tendon
- Exposed to:
 - Diclofenac
 - An NSAID
 - Triamcinolone
 - A corticosteroid

Mesenchymal Stem Cell



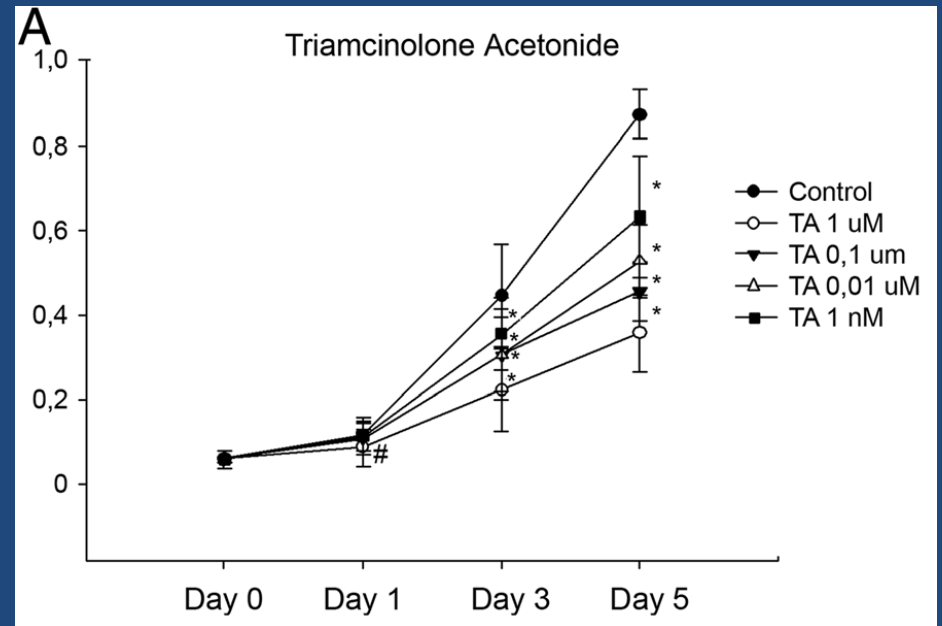
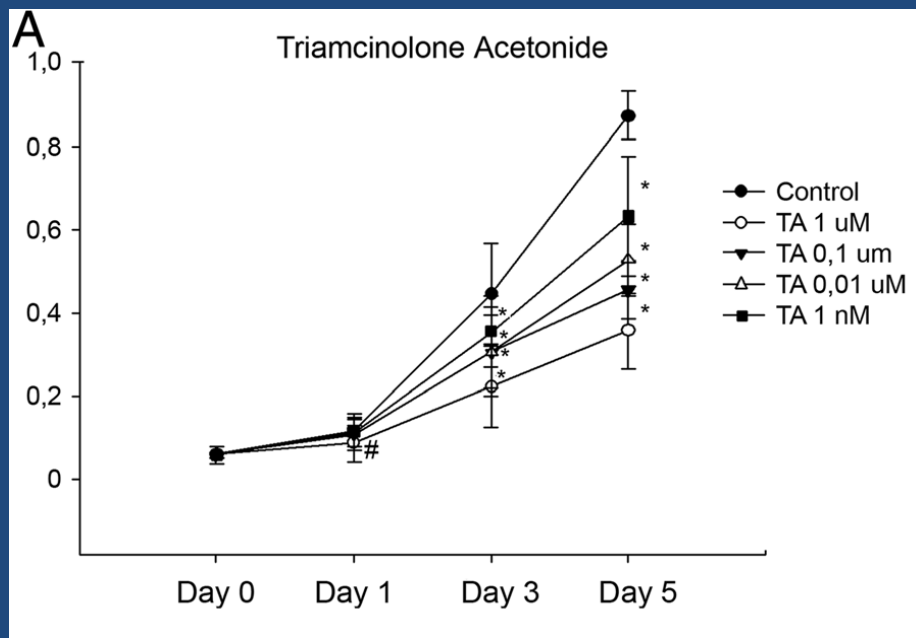
- Added growth factor (GDF-7) to promote stem cell → tendon
- Do anti-inflammatory block development of healthy tendon?

Yes!

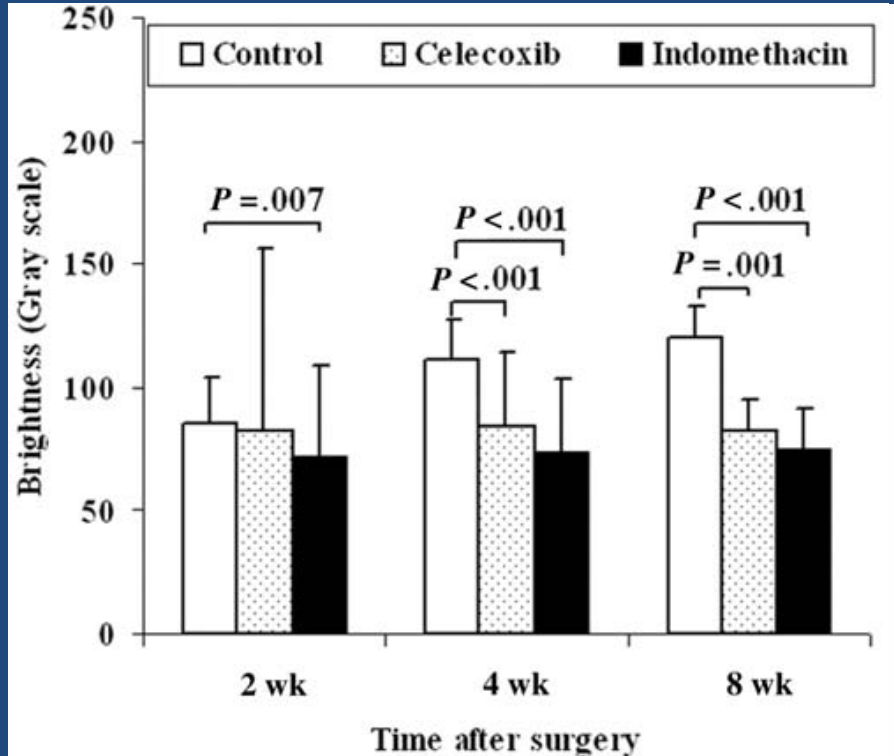


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Formed Adipose, Not Tendon



Cohen et al (2006)



- Indomethacin and Celecoxib Impair Rotator Cuff Tendon-to-Bone Healing
- Studied rats
- Looked at collagen brightness as measure of healthy interface between tendon and bone

Why not use NSAIDs?

- 3400 deaths/ year
 - For frame of reference, about 10% death rate of breast cancer
 - Mostly gastric bleeding
- Possible cardiovascular risk
- Don't actually work
 - Short term pain improvement
 - Long term healing cost

The “Credit Cards” of Medicine



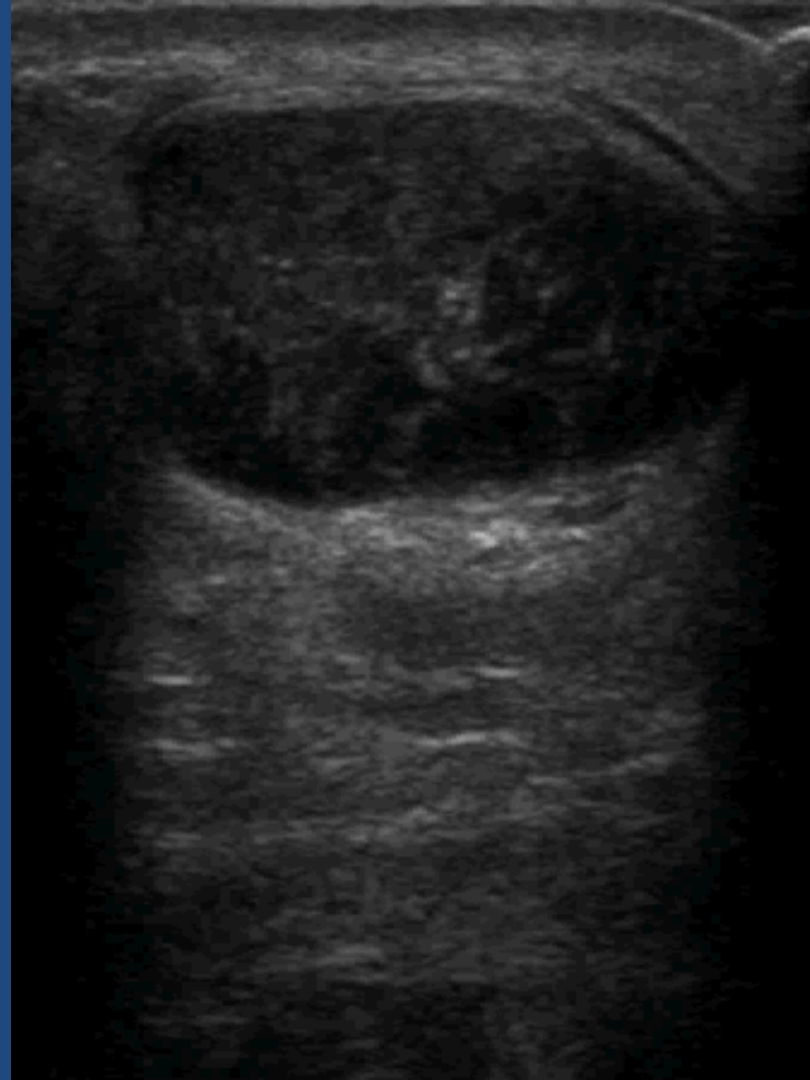
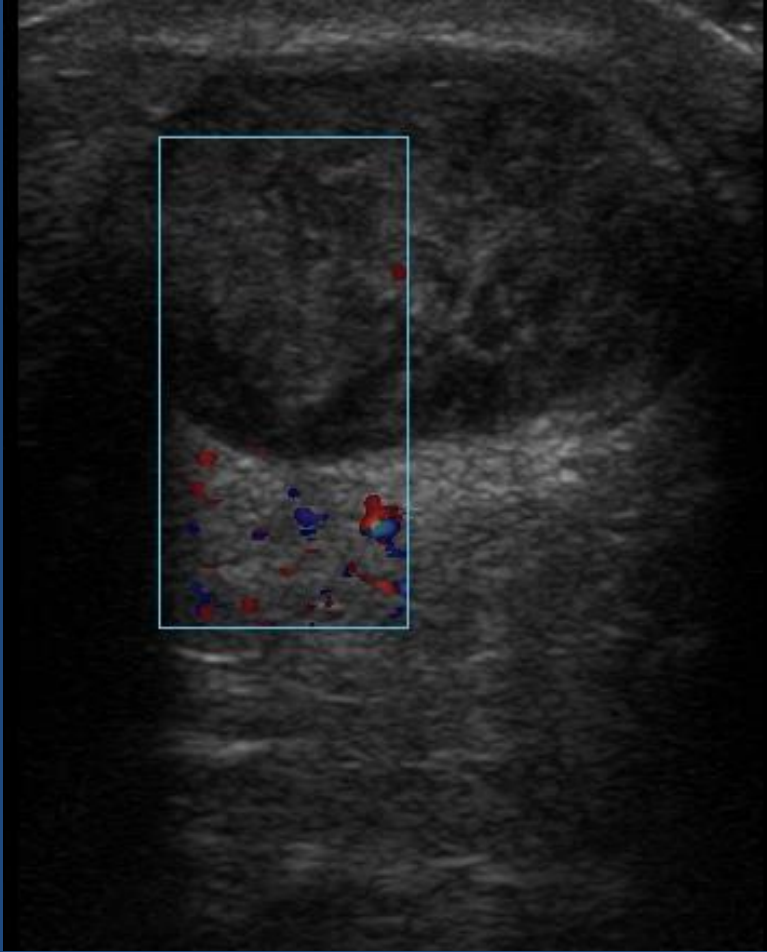
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Alright Hot Shot- what should I do?

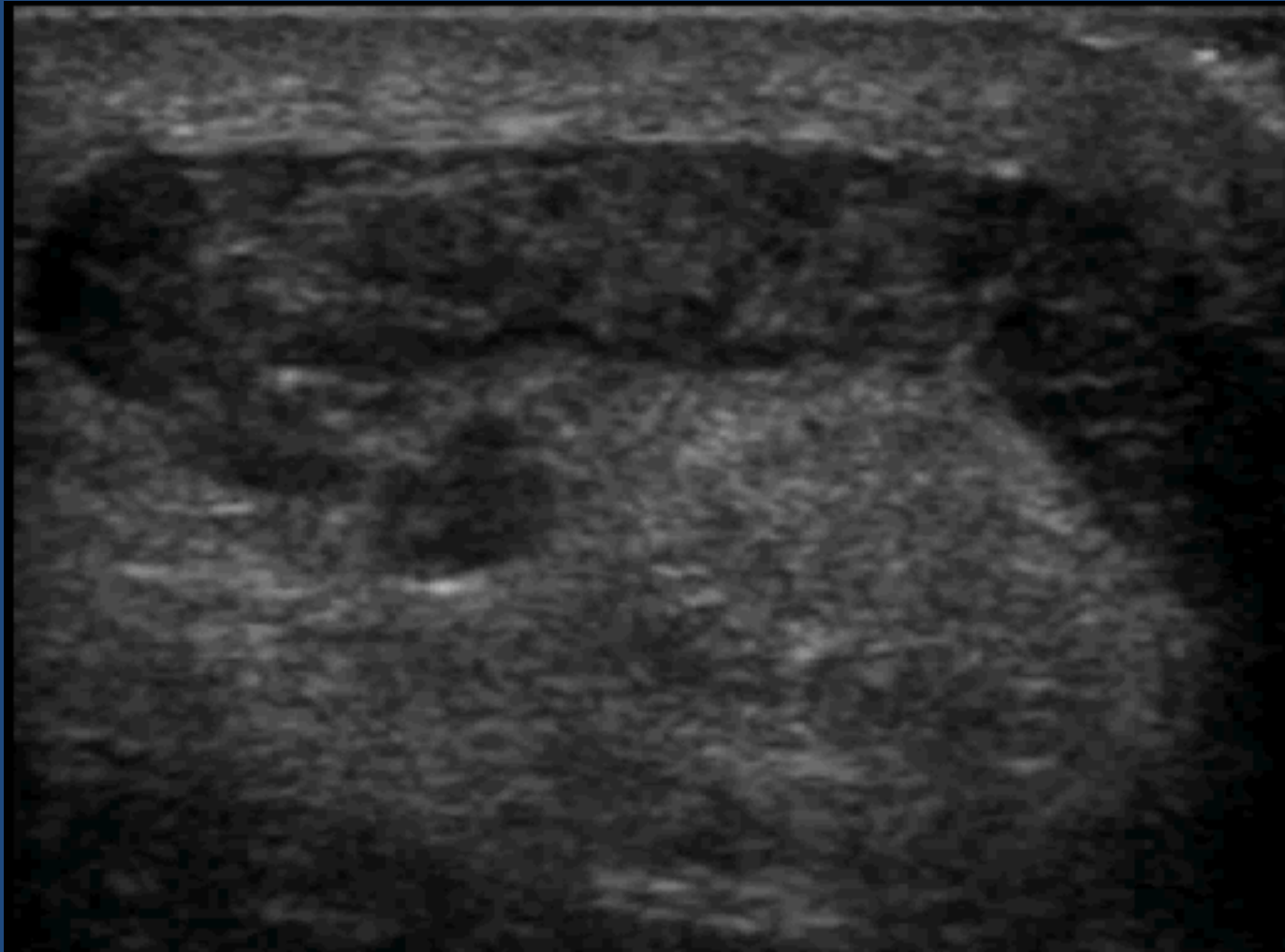


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Tendinopathy

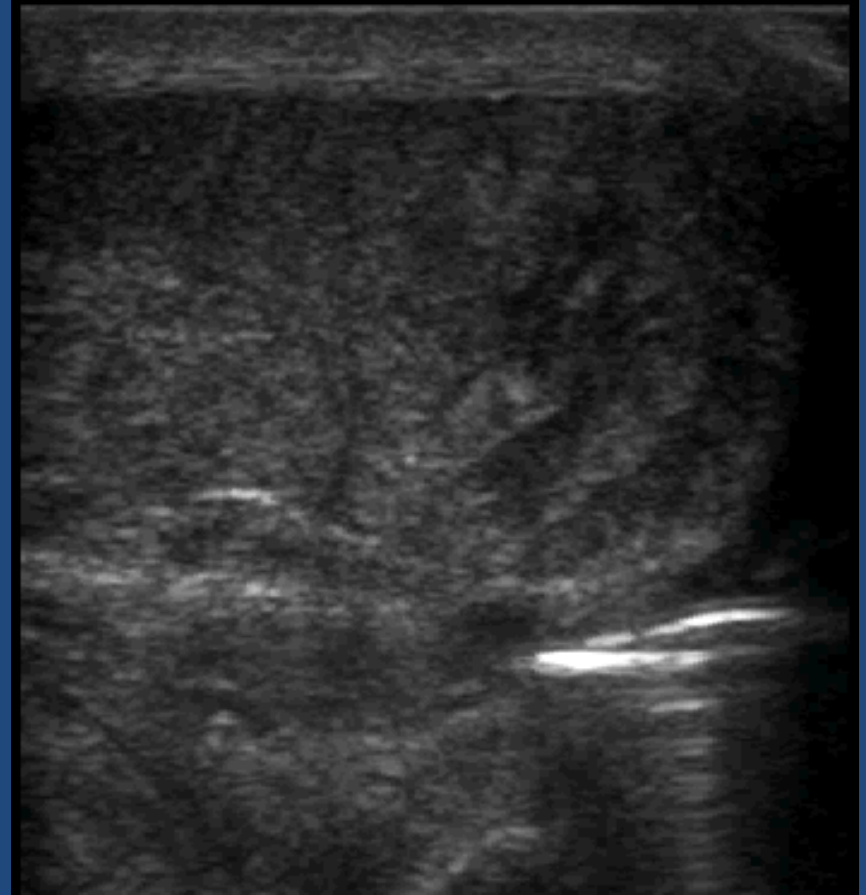
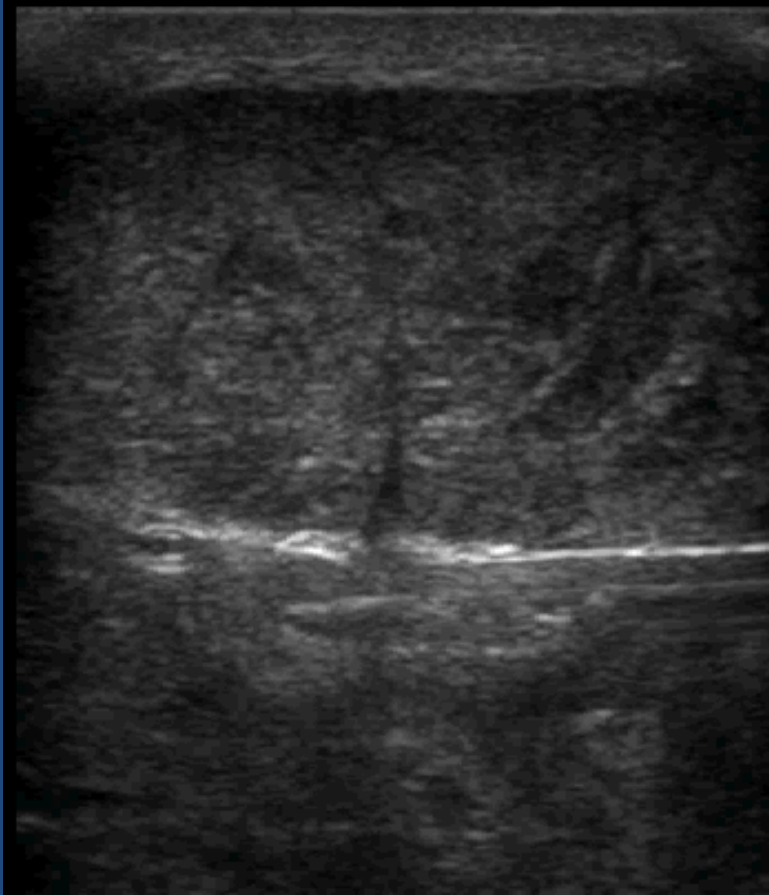


Cross Section



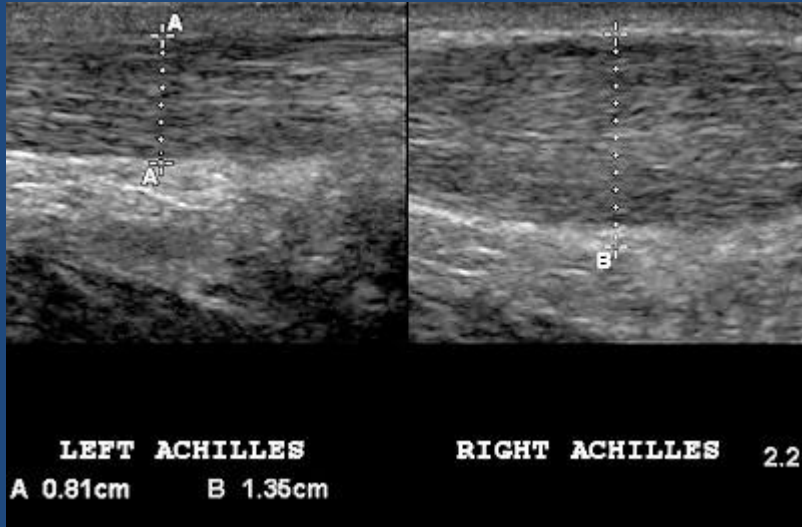
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Ventral Scraping



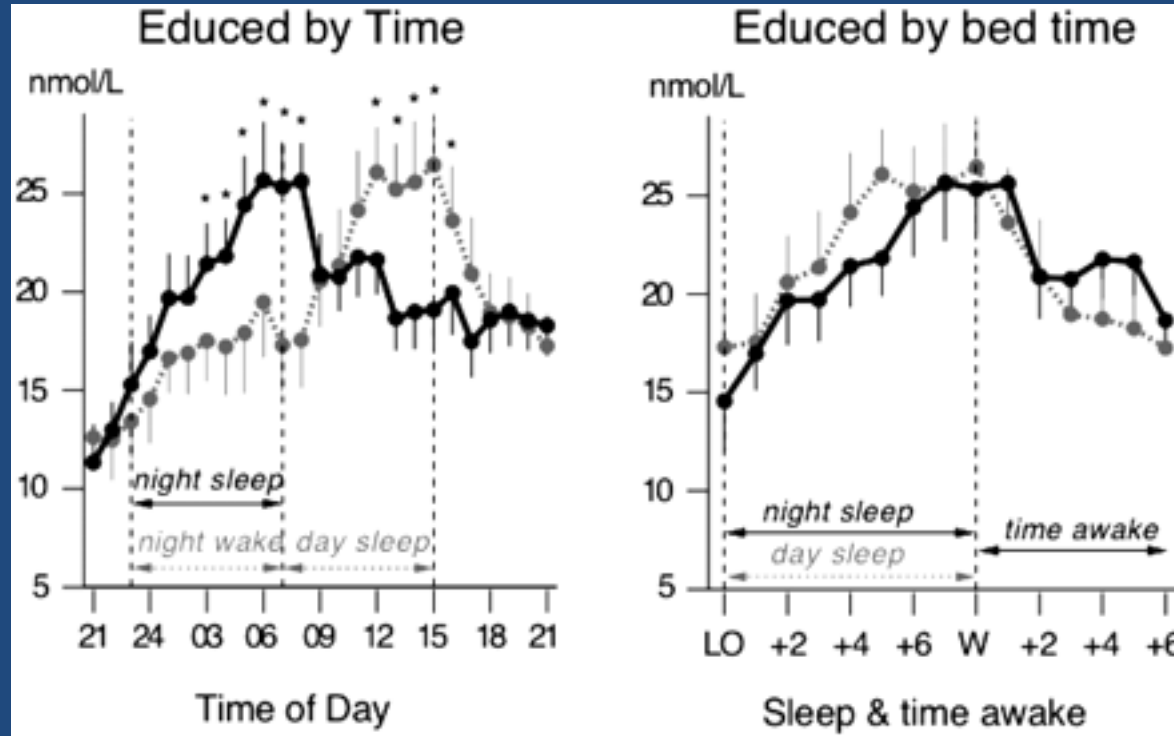
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Metabolic Assessment



- BMI > 30
- Waist circumference > 40"
- Hypertension
- Dyslipidemia
- Type 2 Diabetes/ impaired glucose metabolism
 - Low Vitamin D
 - Obstructive sleep apnea
 - Low testosterone
 - High CRP

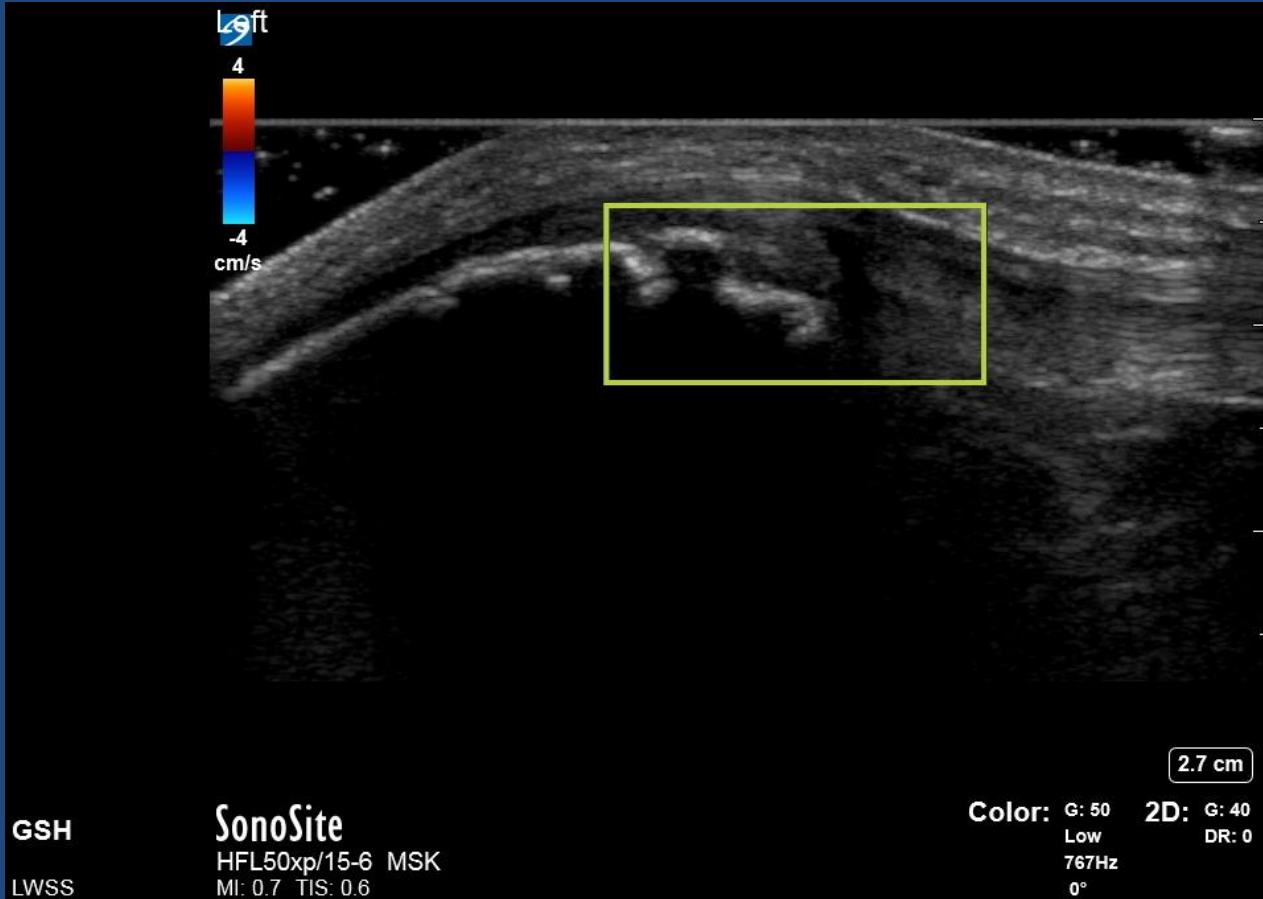
Testosterone and Sleep



Axellson et al (2005), Effects of Acutely Displaced Sleep on Testosterone, *The Journal of Clinical Endocrinology & Metabolism* 90(8):4530-4535

Case #2

11 year old Soccer Player
Knee Pain



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Left



1.9 cm

GSH

SonoSite

HFL50xp/15-6 MSK
MI: 0.8 TIS: 0.2

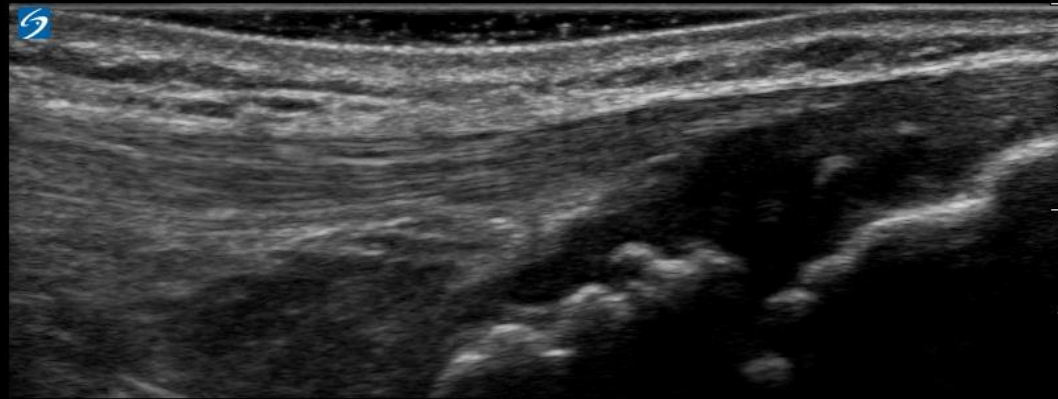
2D: G: 45
DR: 0
MB

LWSS



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Left
Patella



1.9 cm

GSH

SonoSite

HFL50xp/15-6 MSK
MI: 0.8 TIS: 0.2

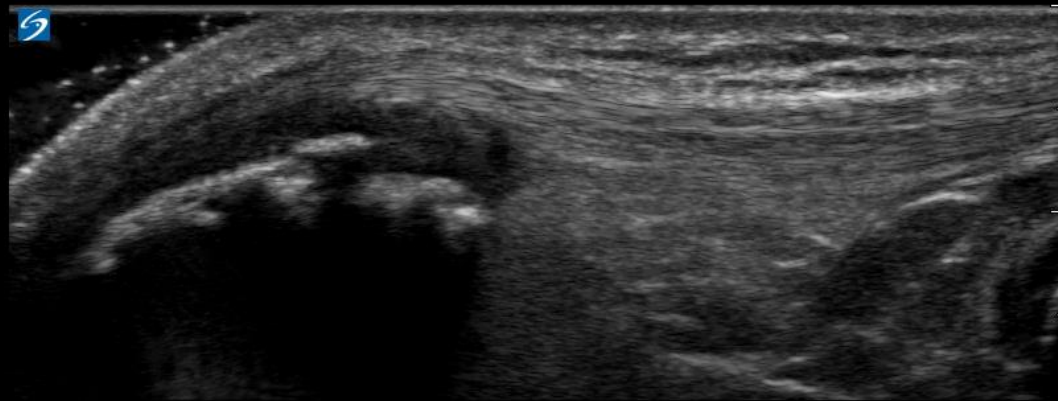
2D: G: 45
DR: 0
MB

LWSS



LAKE WASHINGTON
SPORTS & SPINE

Left
Patella



1.9 cm

GSH

SonoSite

HFL50xp/15-6 MSK
MI: 0.8 TIS: 0.2

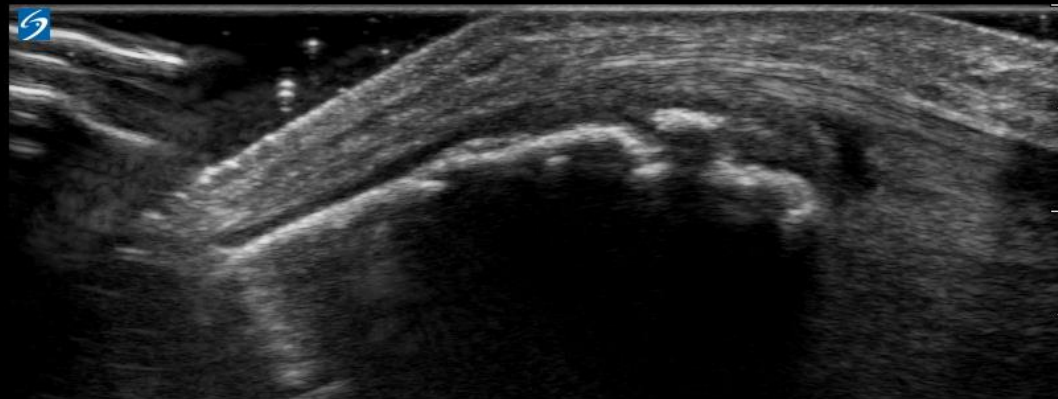
2D: G: 45
DR: 0
MB

LWSS



LAKE WASHINGTON
SPORTS & SPINE

Left
Patella



GSH
LWSS

SonoSite
HFL50xp/15-6 MSK
MI: 0.8 TIS: 0.2

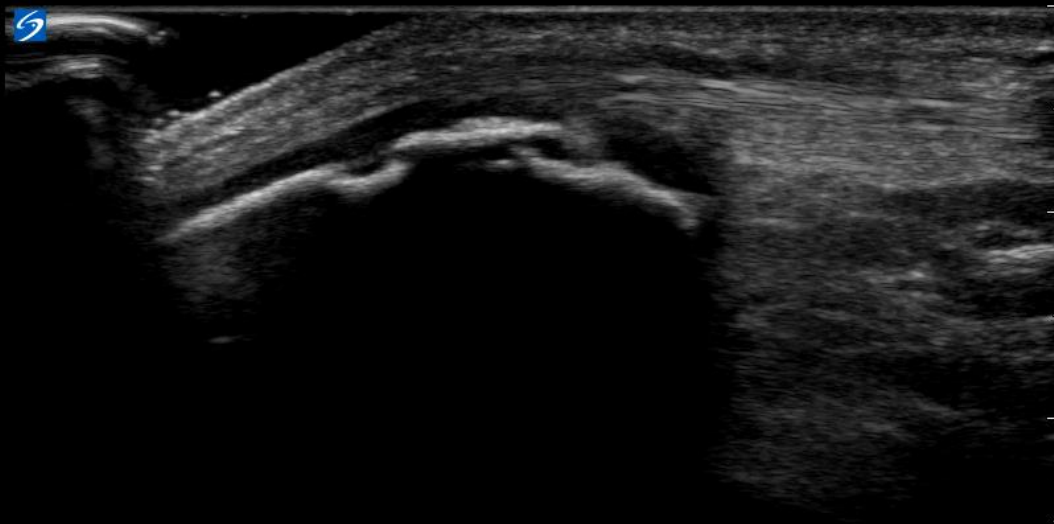
1.9 cm

2D: G: 50
DR: 0
MB



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SPORTS & SPINE

Left



2.7 cm

GSH

SonoSite

HFL50xp/15-6 MSK
MI: 0.8 TIS: 0.2

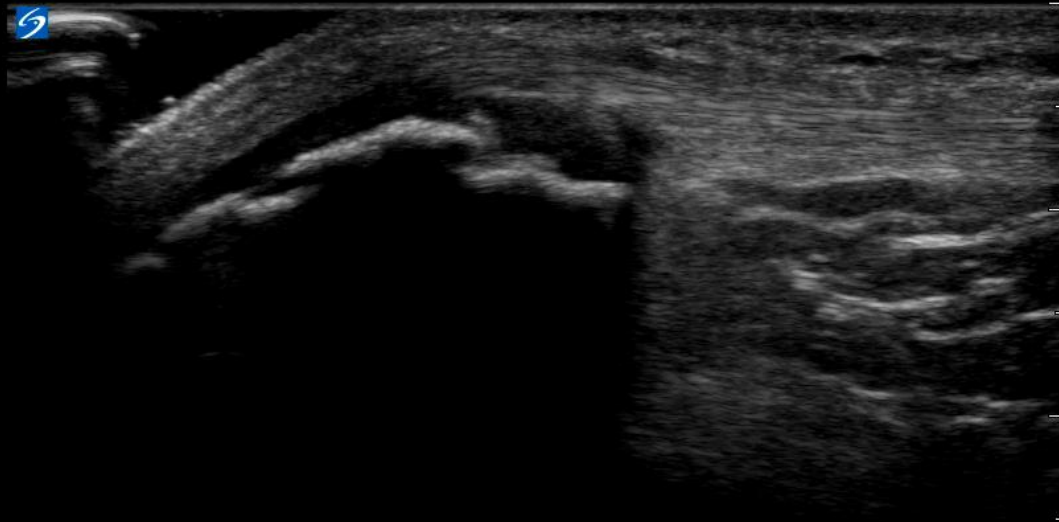
2D: G: 40
DR: 0
MB

LWSS



LAKE WASHINGTON
SPORTS & SPINE

Left



2.7 cm

GSH

SonoSite

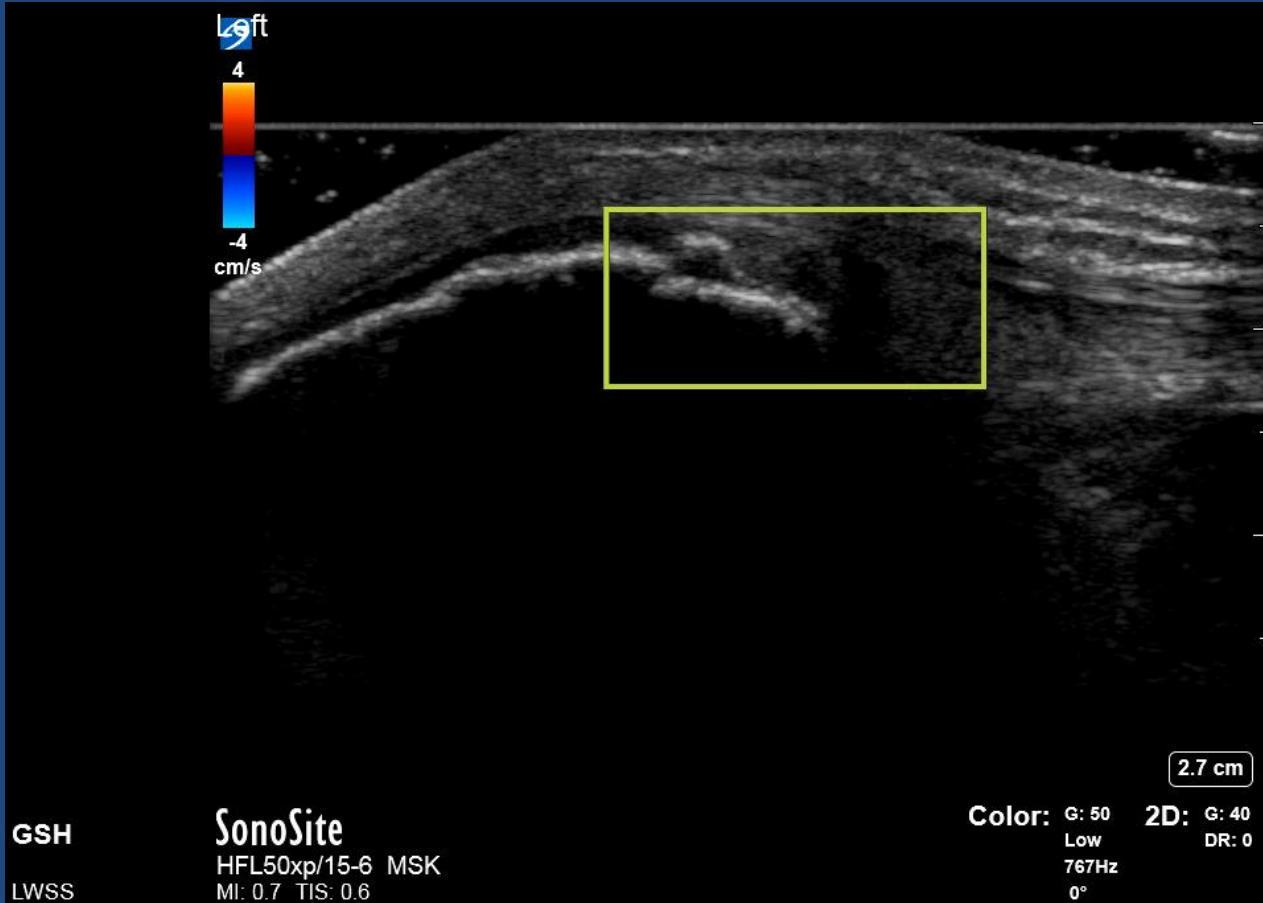
HFL50xp/15-6 MSK
MI: 0.8 TIS: 0.2

2D: G: 40
DR: 0
MB

LWSS



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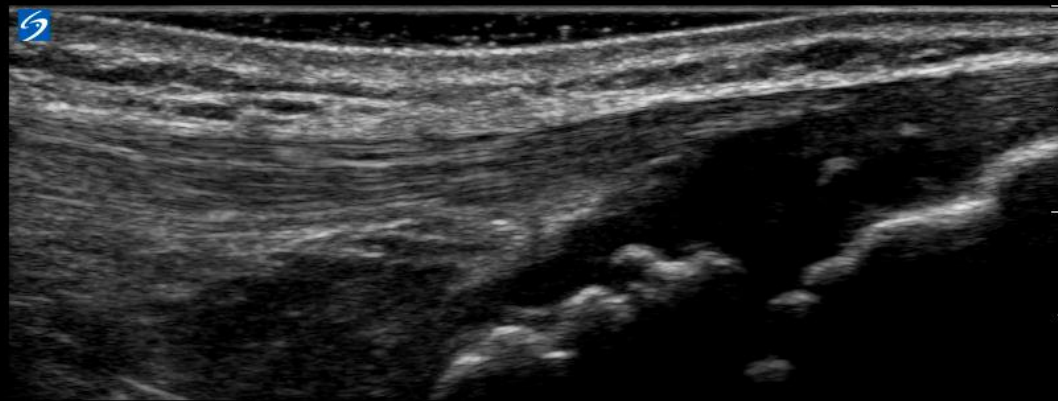


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HYMAN, JONAH I

22 Feb 2014 / 17:57

Left
Patella



1.9 cm

GSH

SonoSite

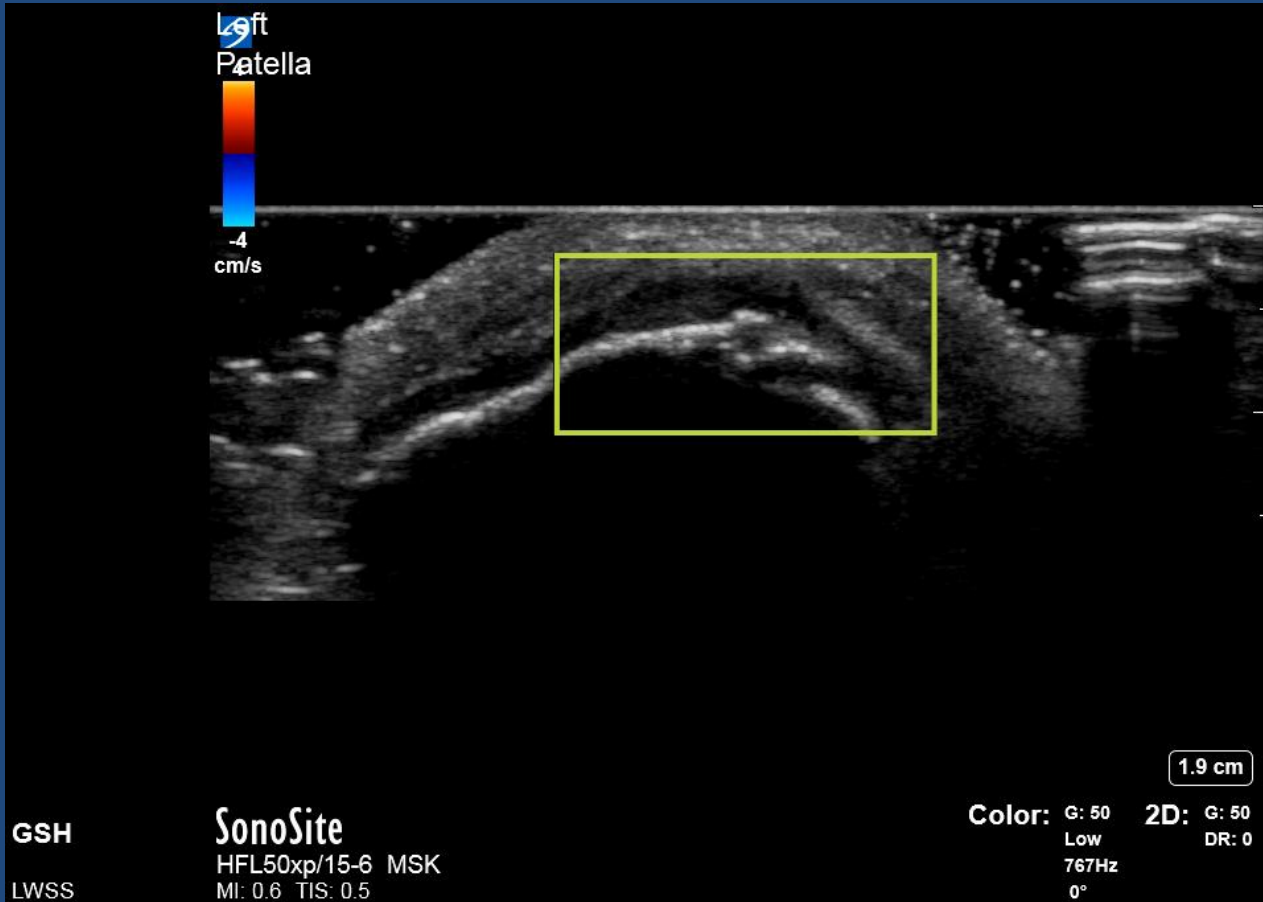
HFL50xp/15-6 MSK
MI: 0.8 TIS: 0.2

2D: G: 45
DR: 0
MB

LWSS



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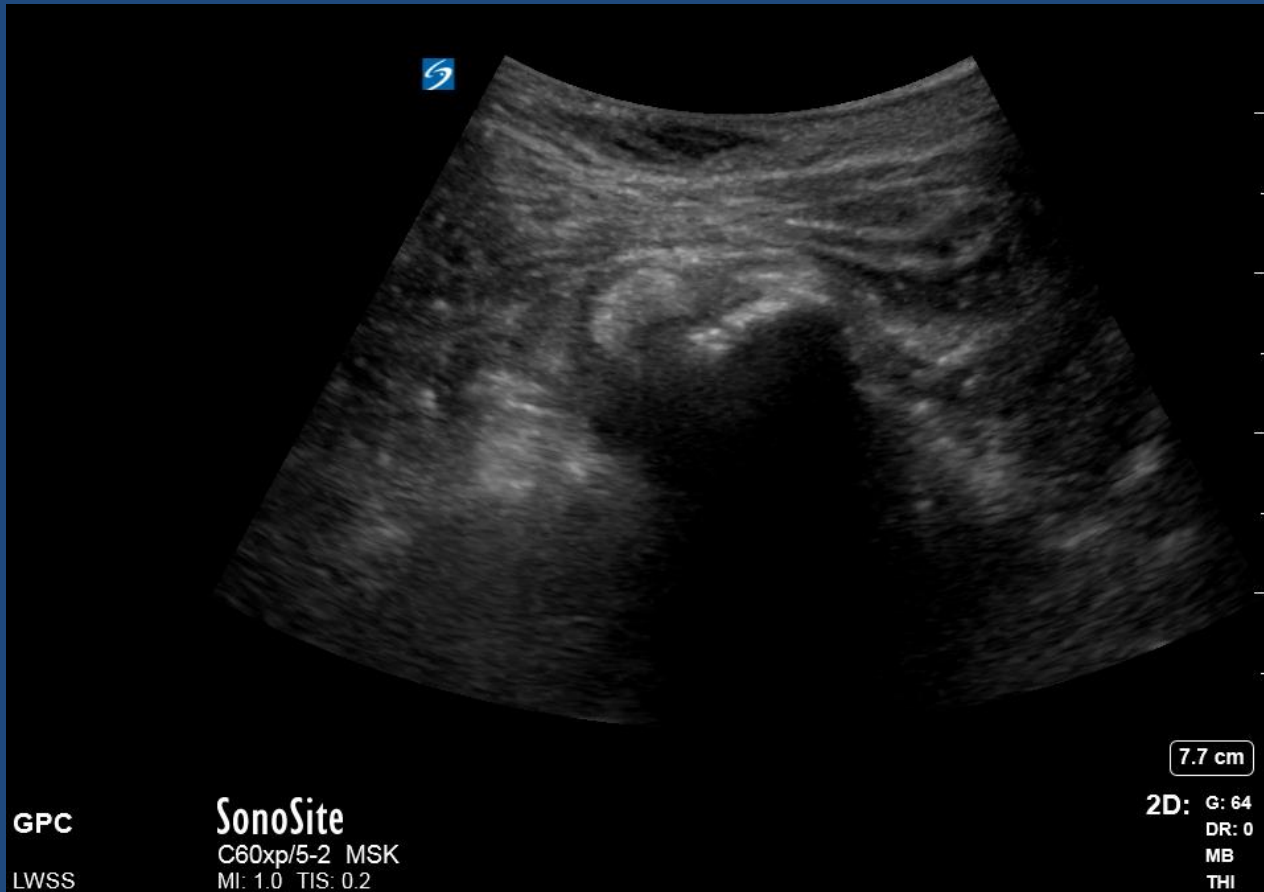


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Case #3

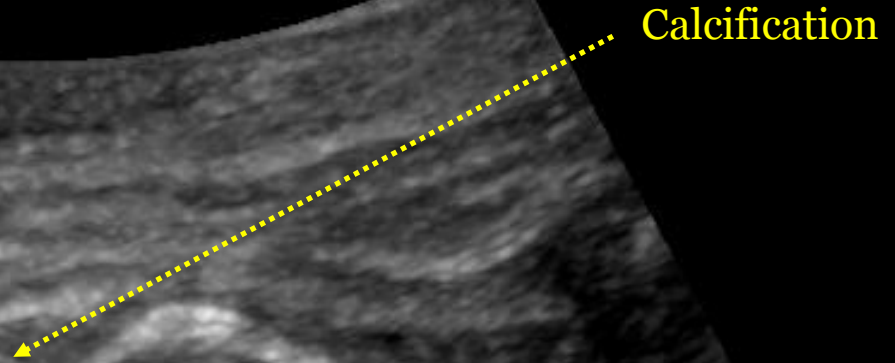
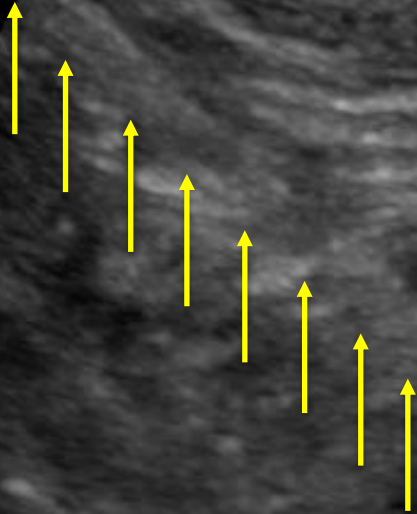
69 year old Runner
Persistent Buttock Pain

Calcification, Proximal Hamstring



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Needling IT

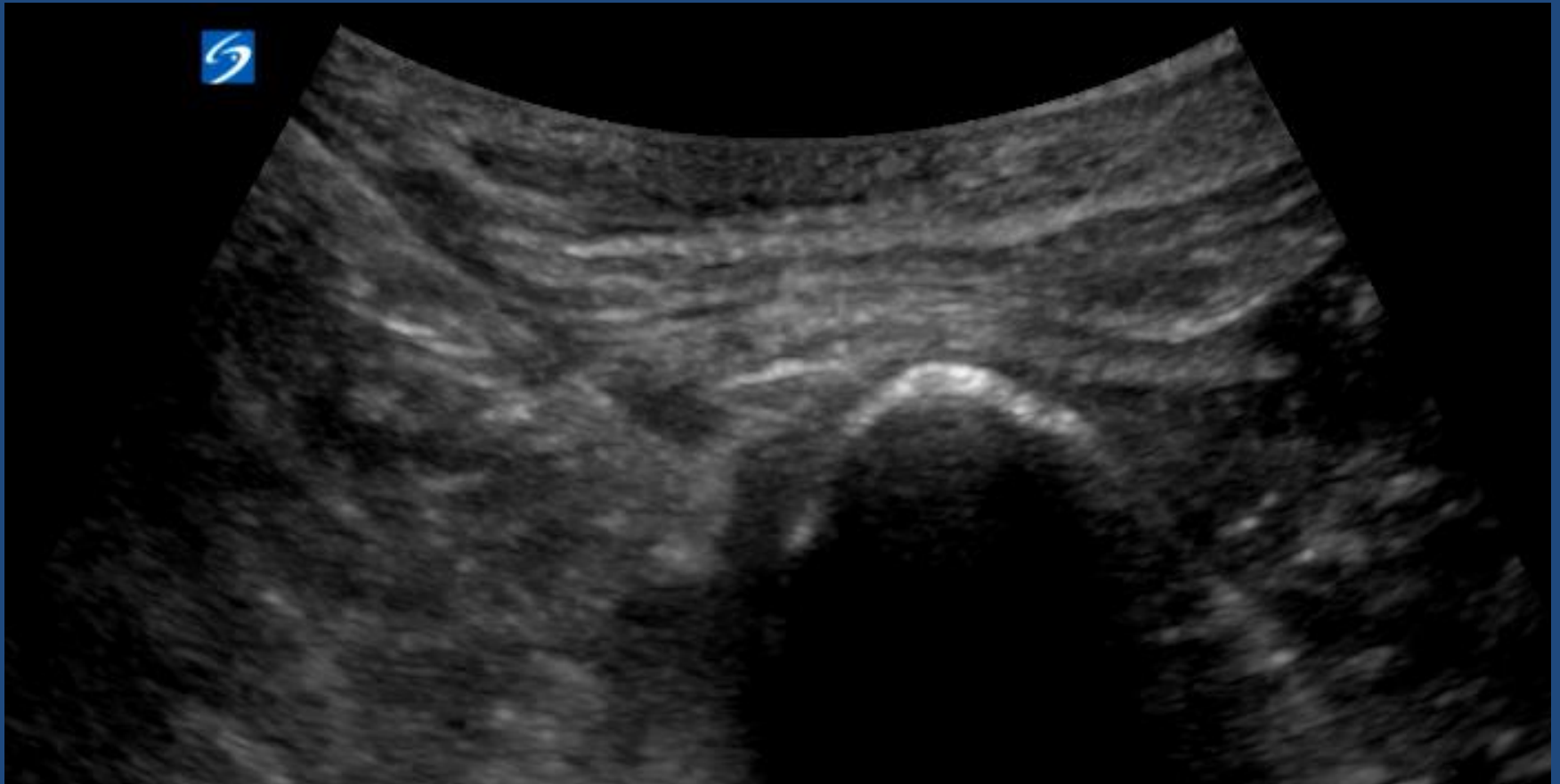


Ischial
Tuberosity



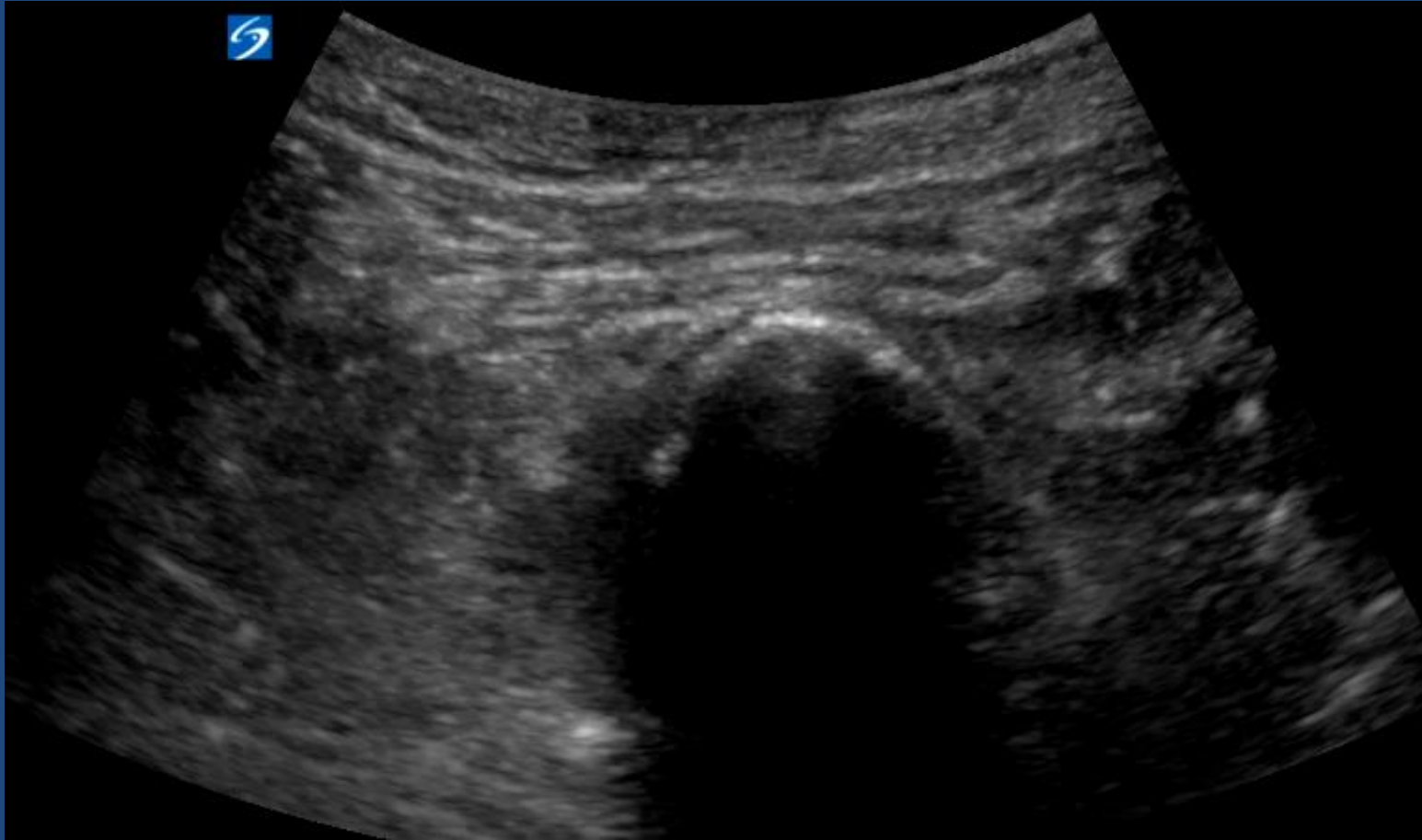
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Needling Video



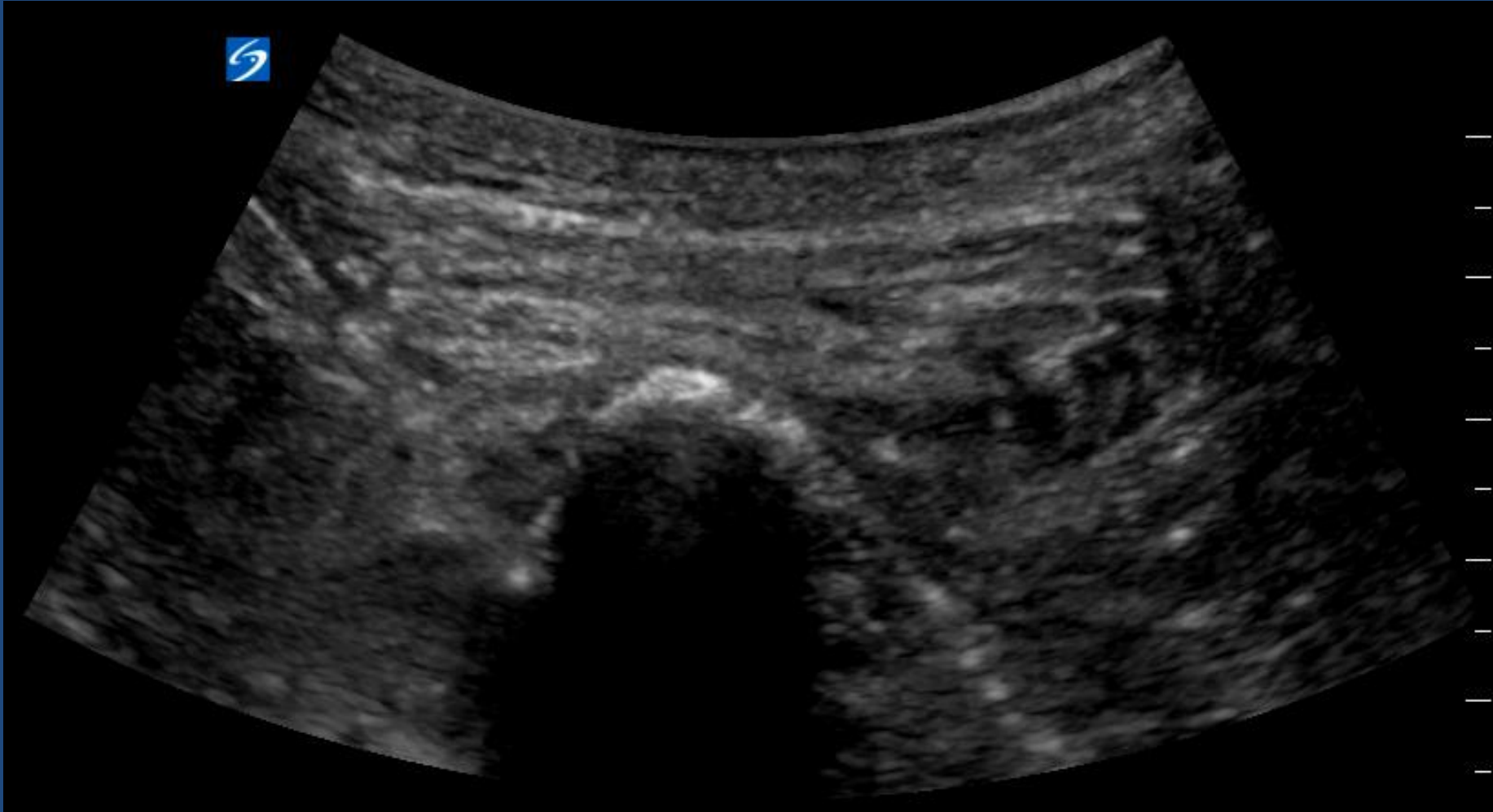
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Calcification Getting Smaller



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Injecting PRP



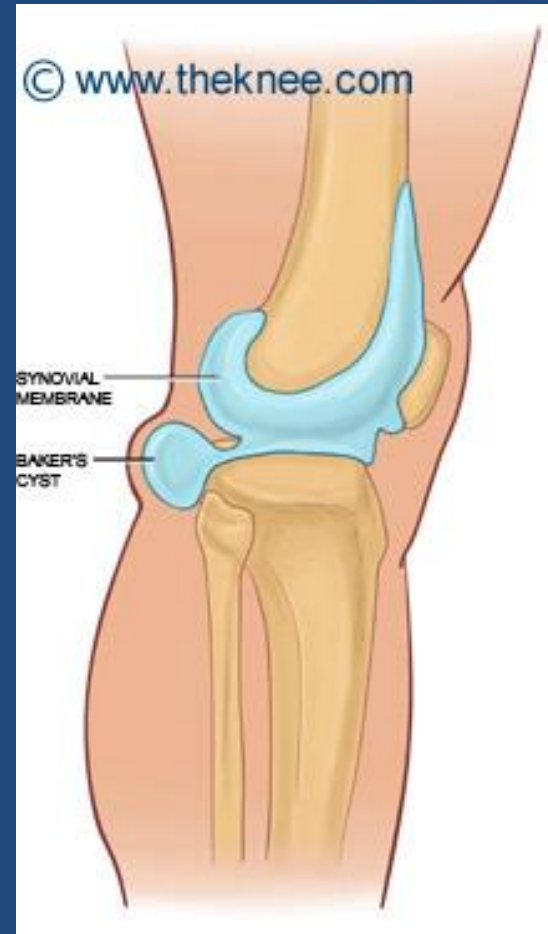
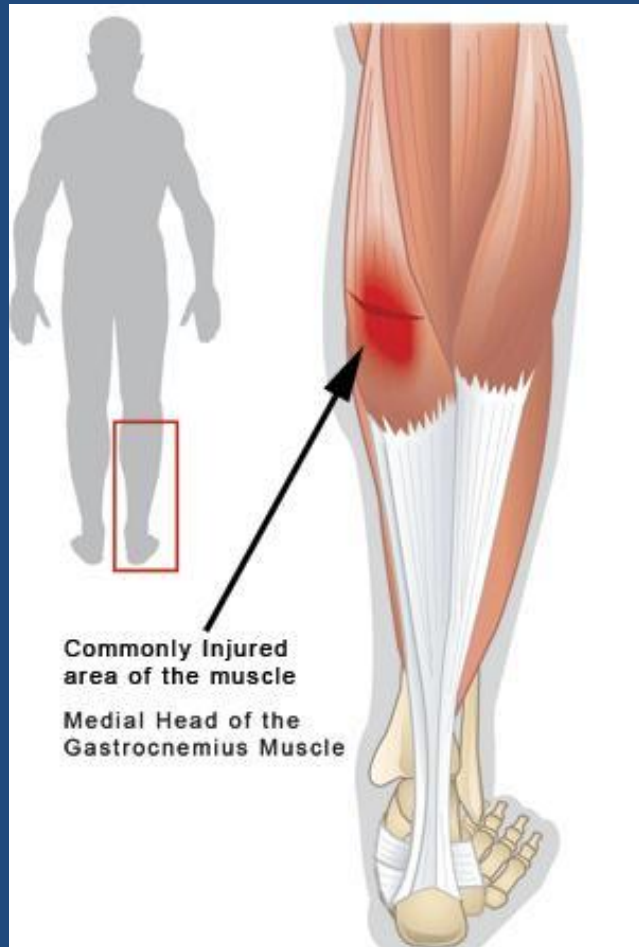
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Case #4

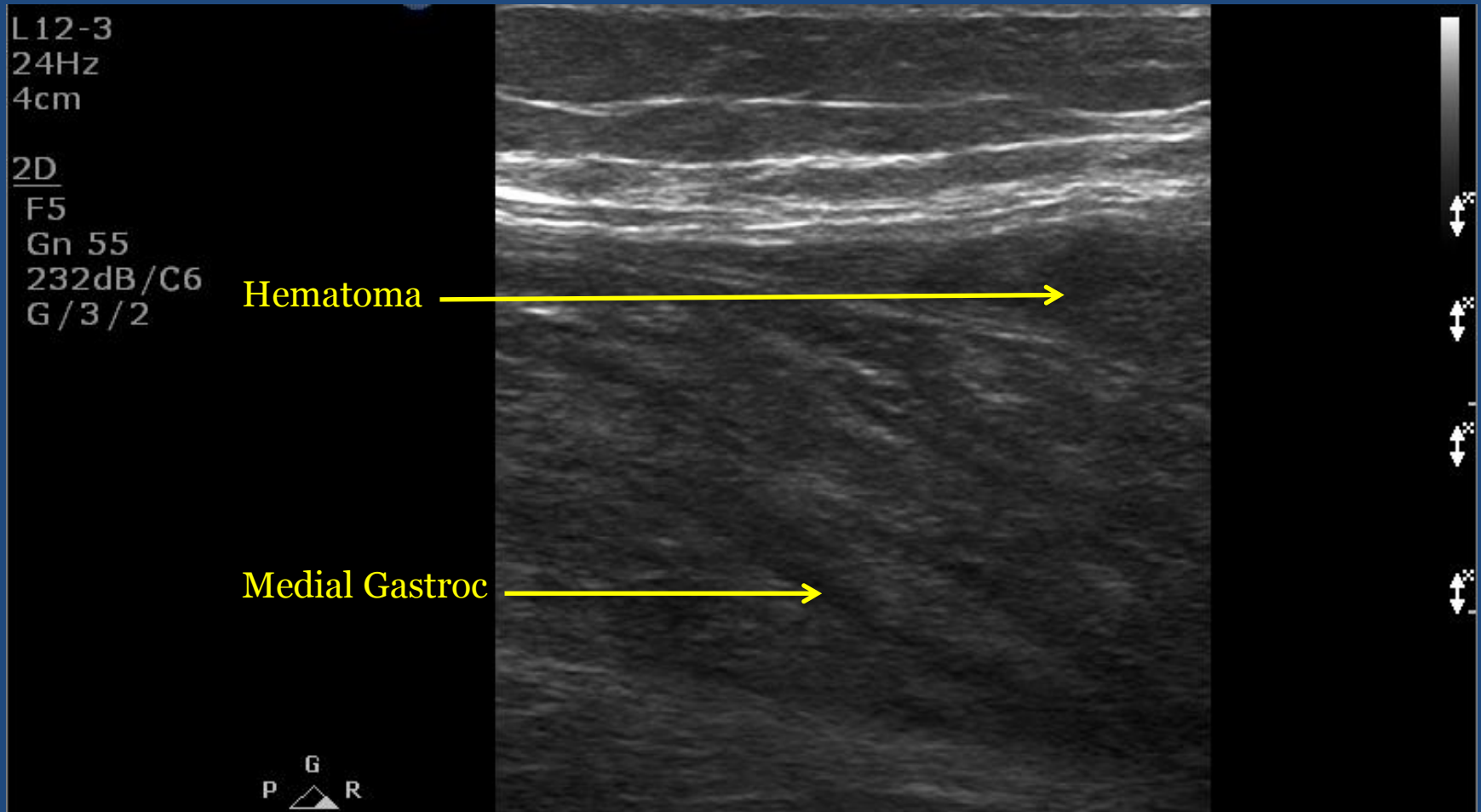
29 year old Tennis Player
Acute Proximal Calf Pain

Knee Joint

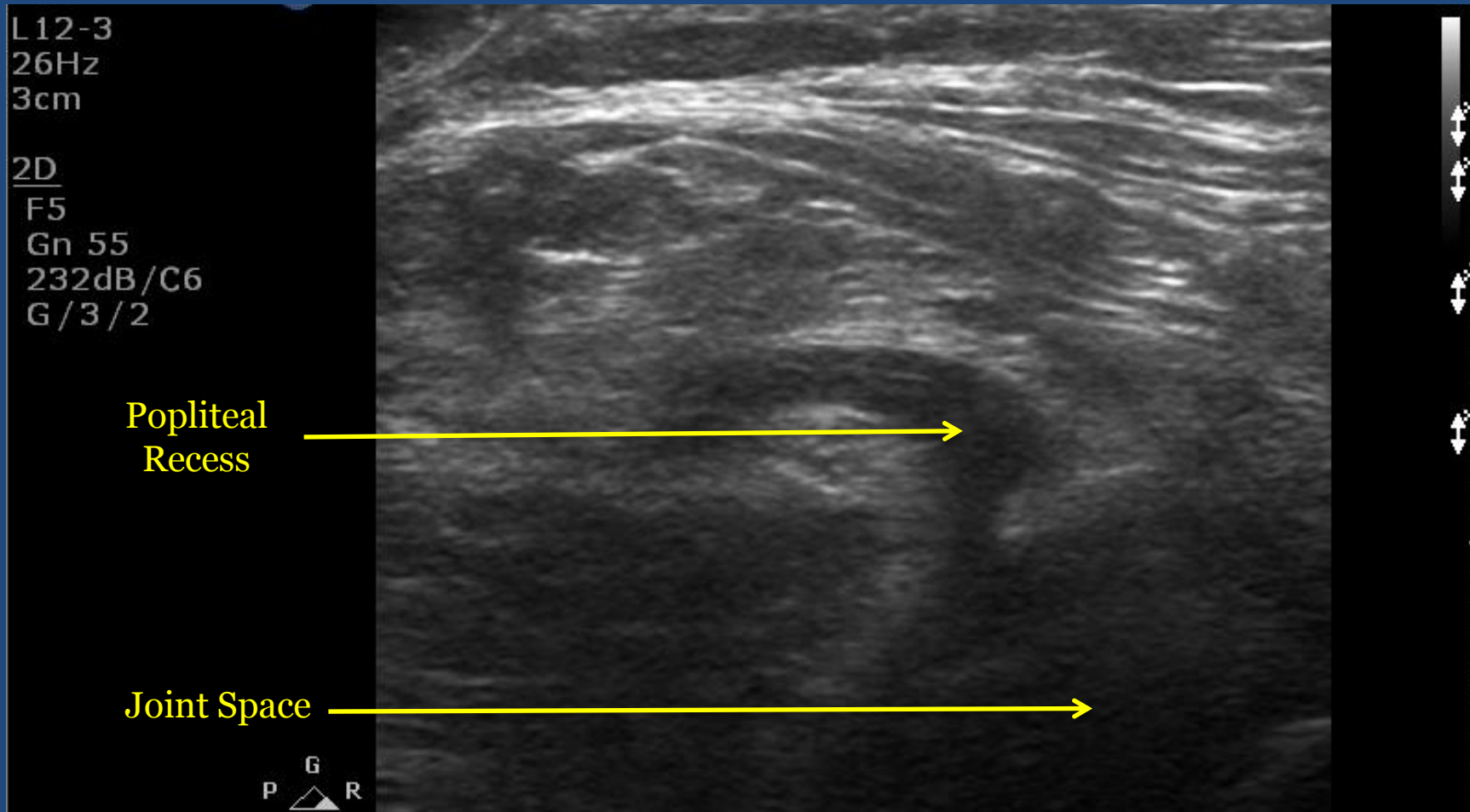
Calf Hematoma



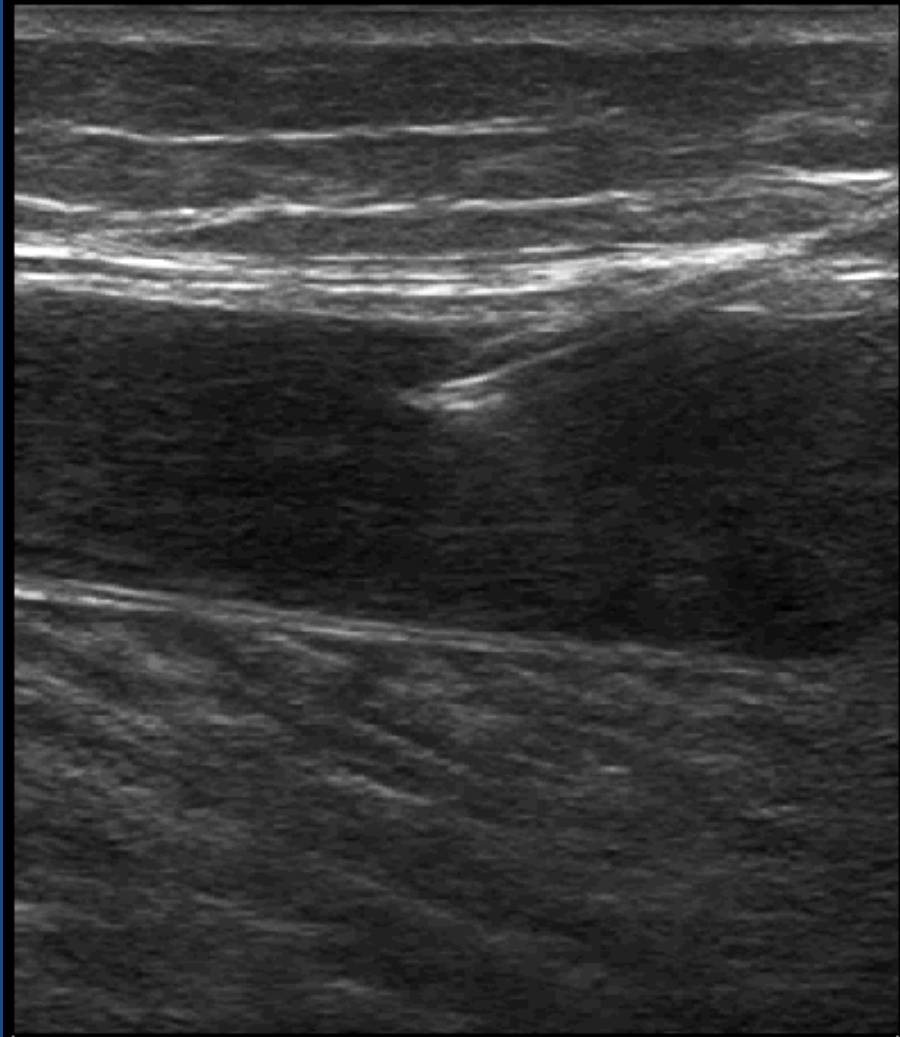
Hematoma



Assessing Recess



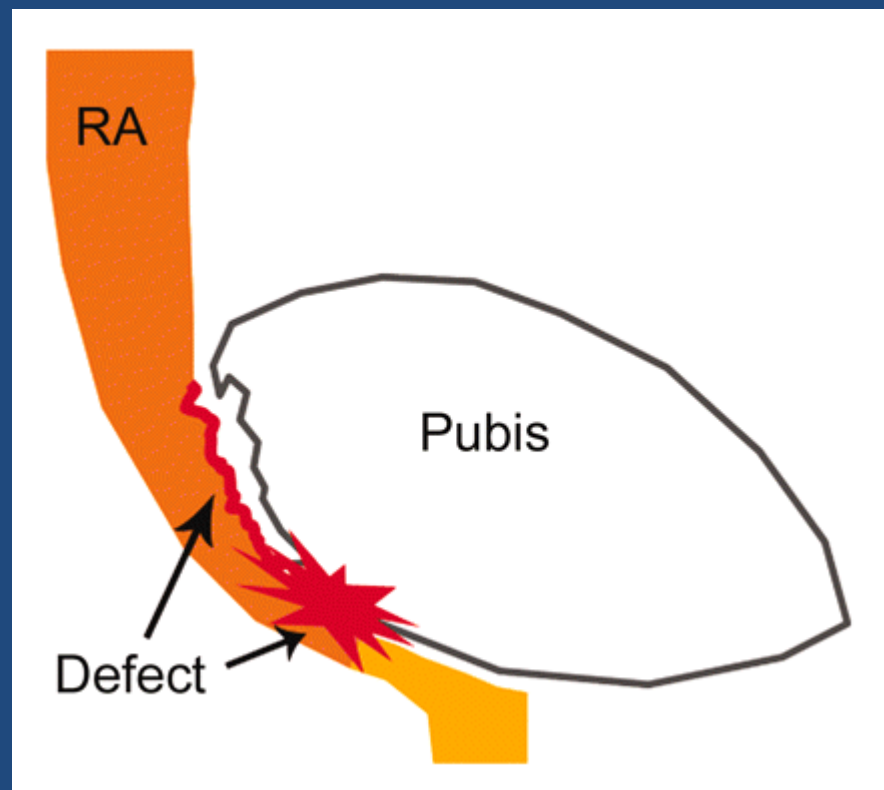
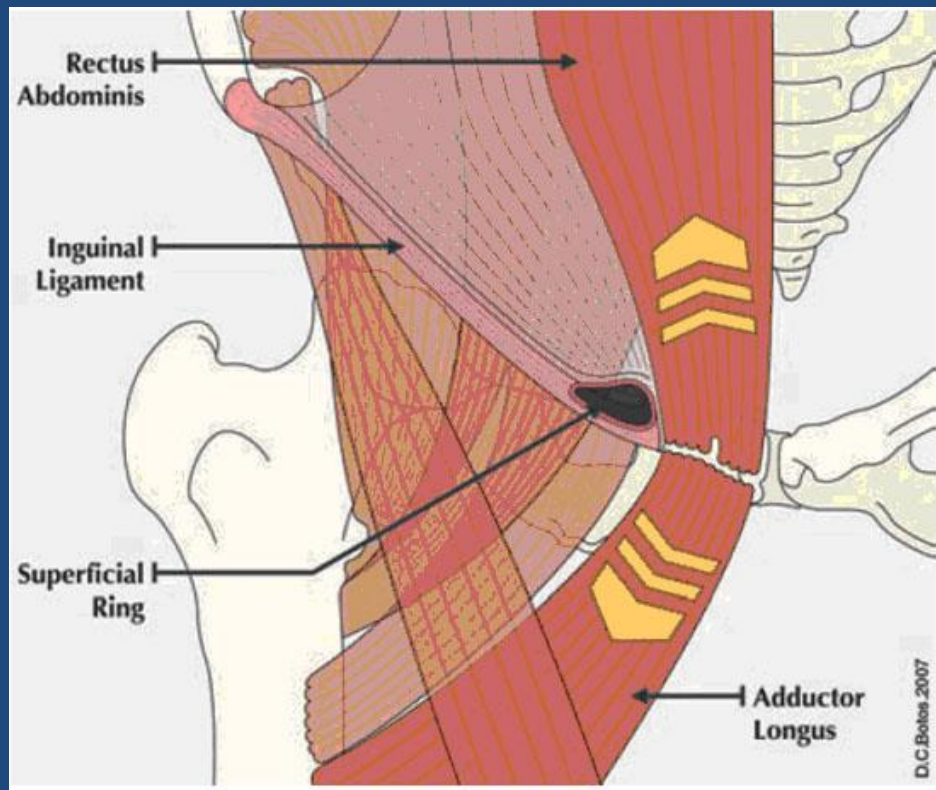
Draining Hematoma



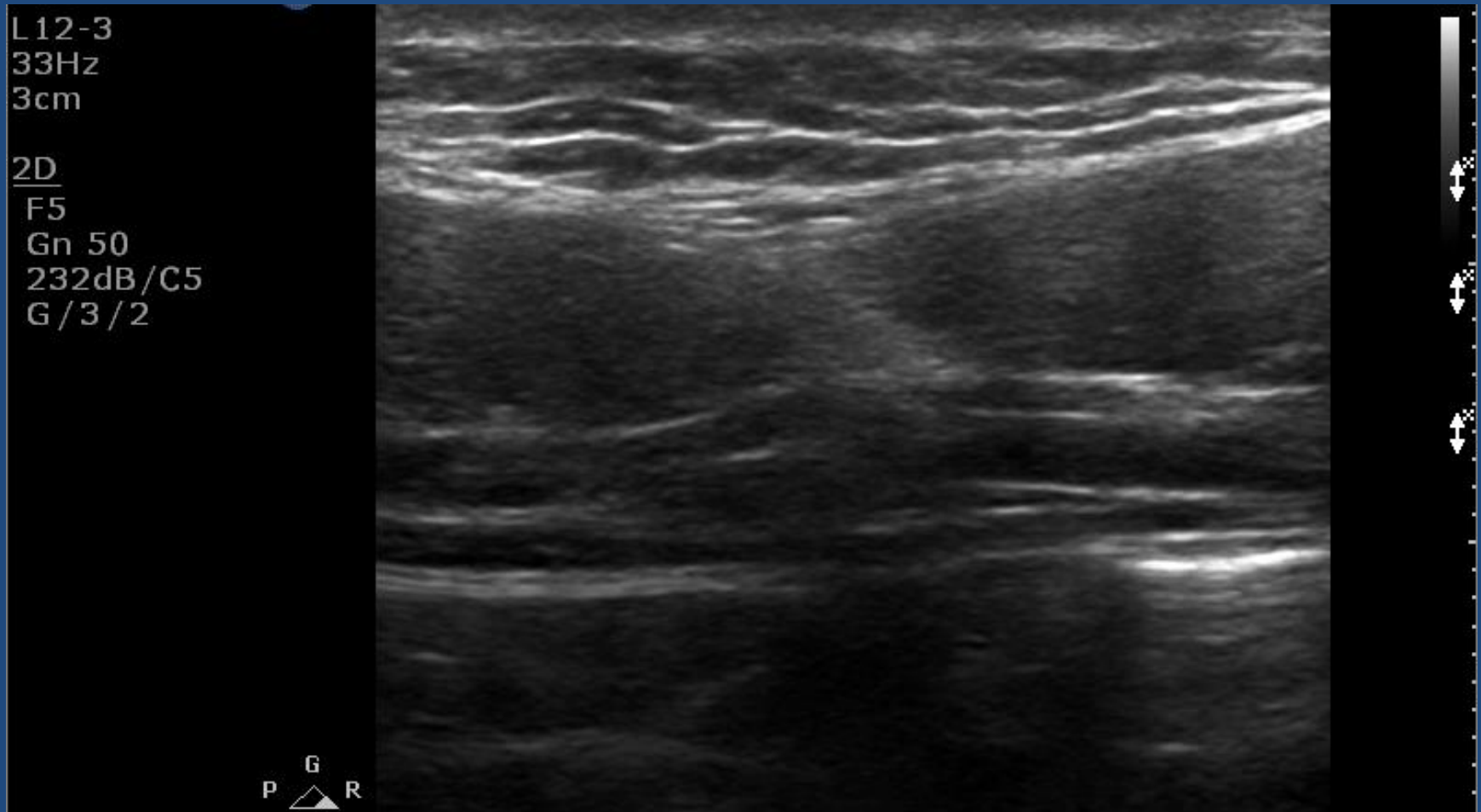
Case #5

25 year old Ultimate Frisbee Player
Groin Pain

Superior Pubic Ramus



Rectus Abdominus



Moving toward SPR

DR. G 13-10-14-143955 Lake Washington Sports & S TIS 0.5 2:43:15 PM

Shoulder

P

L12-3

33Hz

3cm

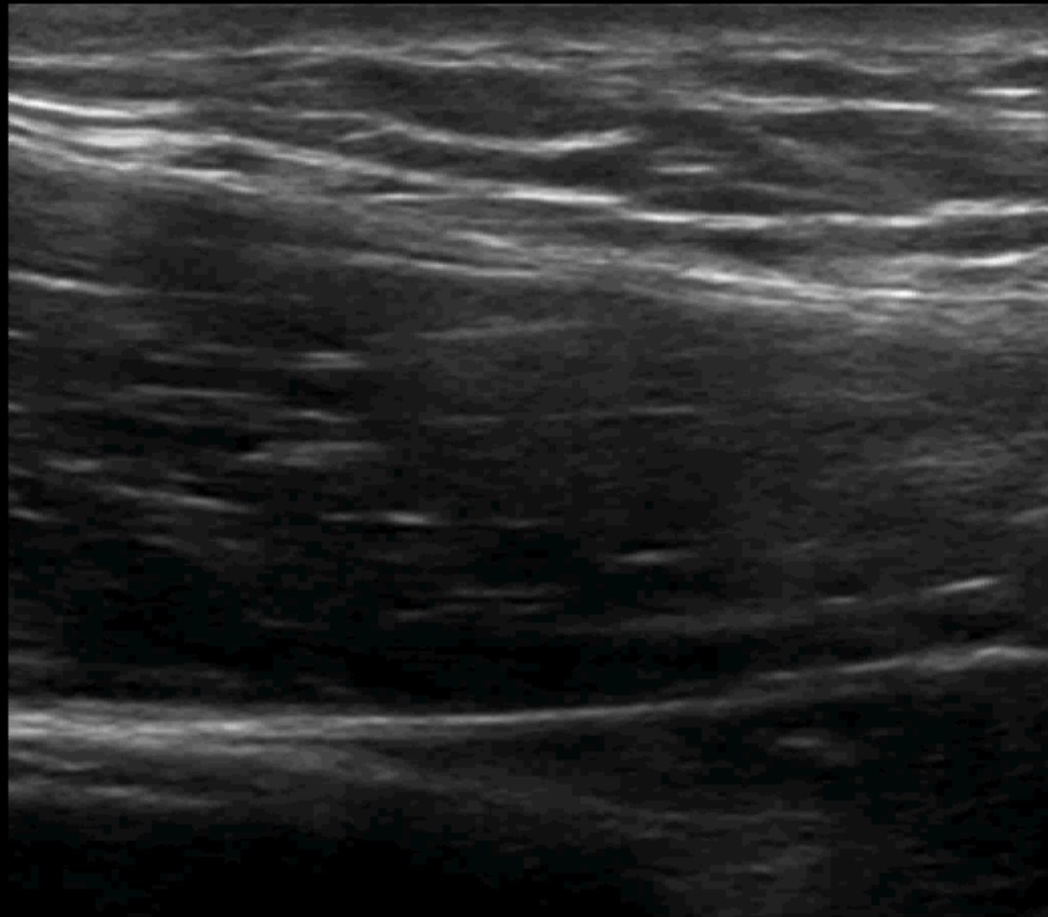
2D

F5

Gn 50

232dB/C5

G/3/2



G
P R
3.0 12.0



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Super Pubic Ramus

L12-3
33Hz
3cm

2D
F5
Gn 50
232dB/C5
G/3/2

Rectus
Abdominus



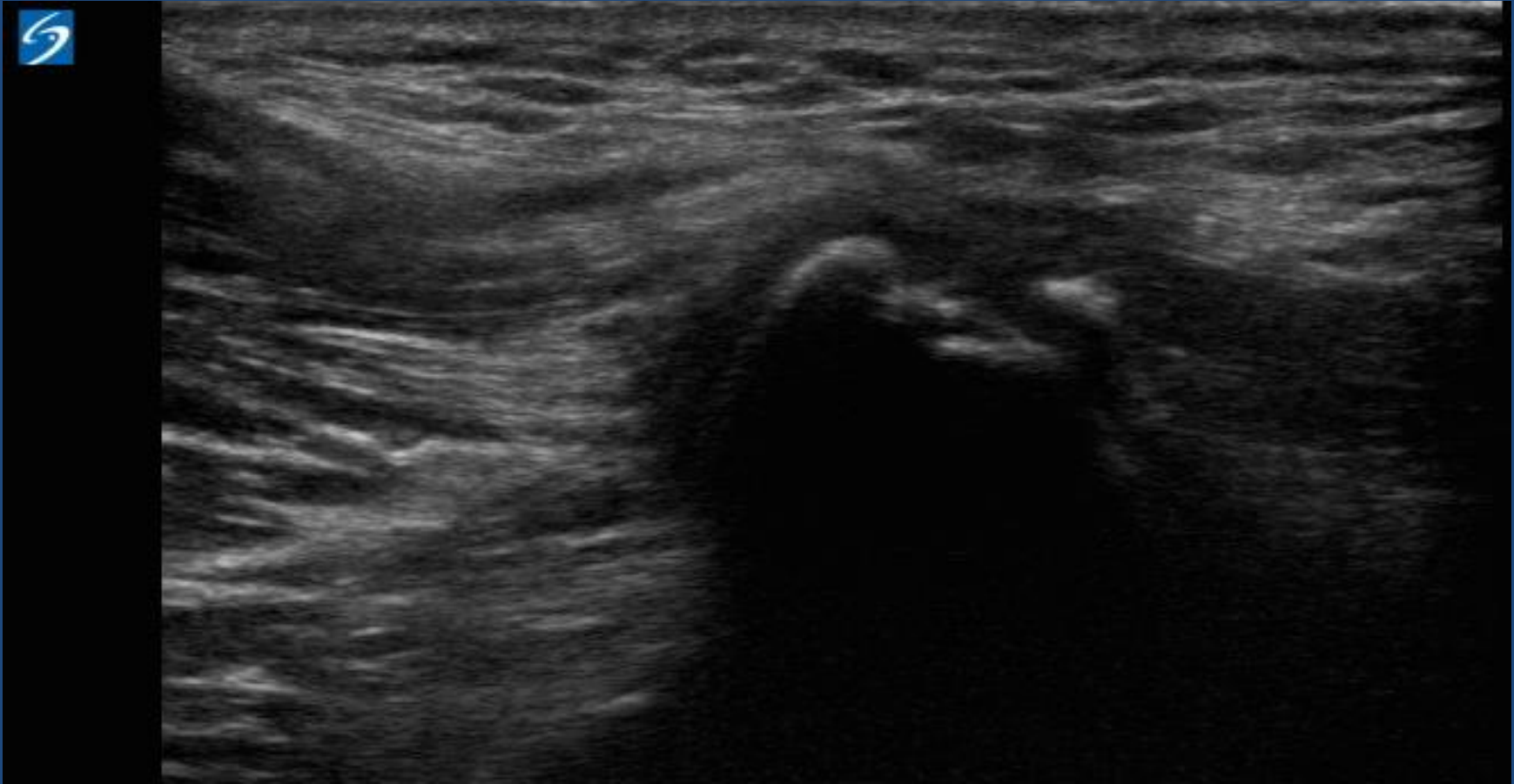
Ad Longus



Superior Pubic Ramus



Injury at Common Insertion



LAKE WASHINGTON
SPORTS & SPINE

Injecting at SPR

DR. G 13-10-14-143955 Lake Washington Sports & S TIS 0.8 3:11:44 PM

Shoulder

P

L12-3

33Hz

3cm

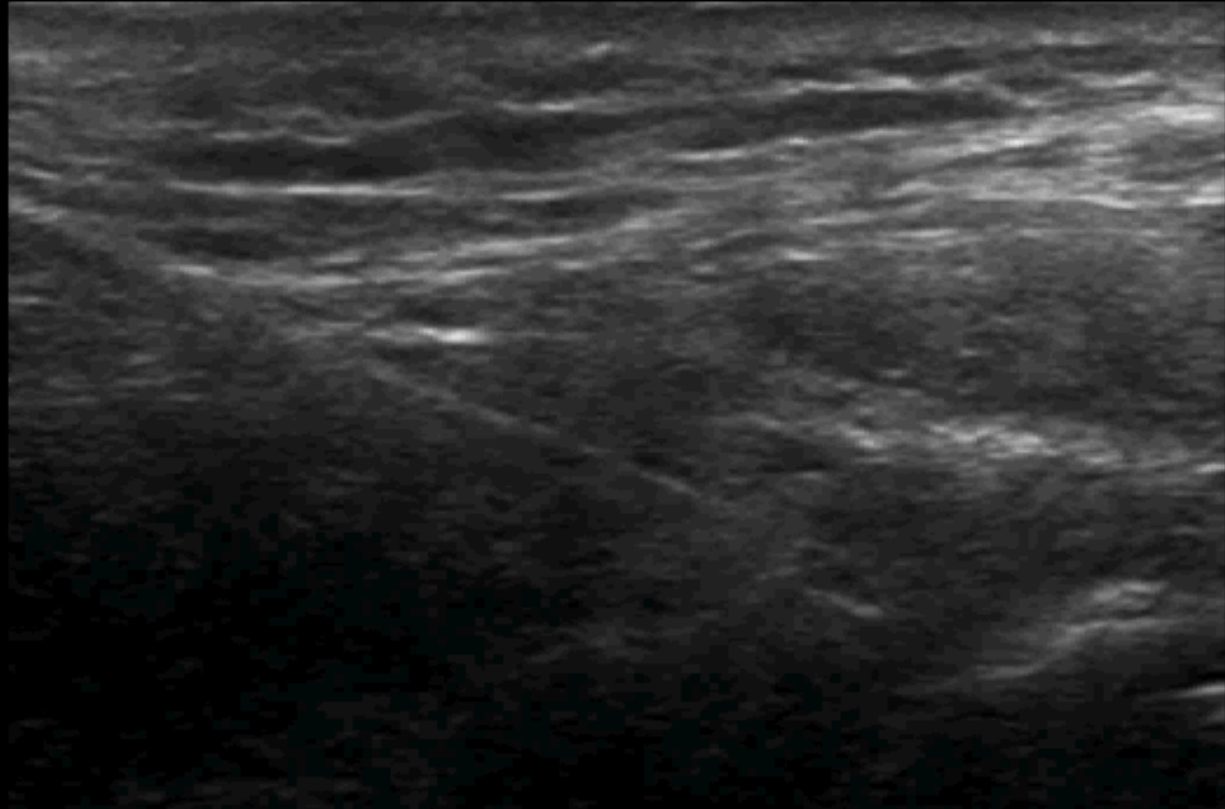
2D

F5

Gn 50

232dB/C5

G/3/2



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Thanks!