Hamstring and Achilles Management: Diagnostics and Treatment Application

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KEAN

MLS

Part 1: Medical Hamstring & Achilles Management

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Disclosures

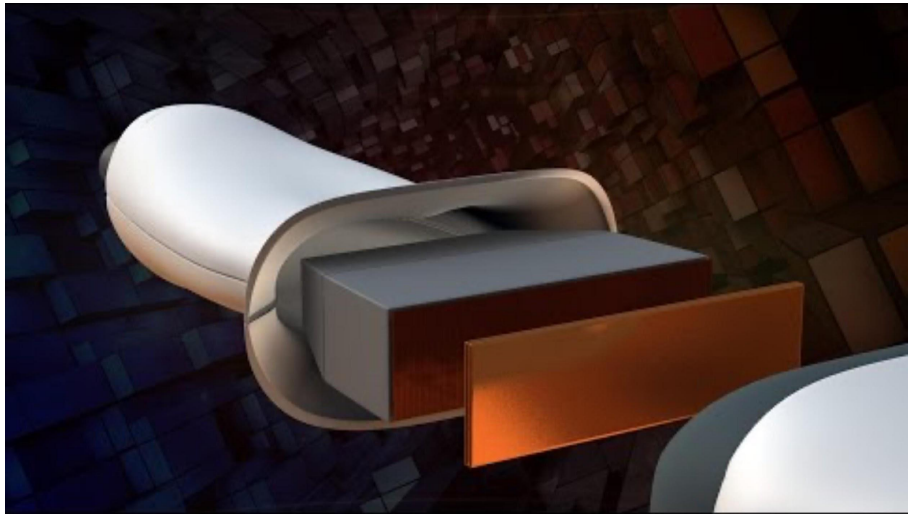
NONE.

THE ADVENT OF MSK US[1]

- The use of diagnostic and interventional musculoskeletal ultrasound (MSK US) in sports medicine has increased over the past several decades for a variety of reasons, including decreased equipment costs, increased educational opportunities, expanded research, patient safety initiatives, and technological advances leading to higher resolution images.

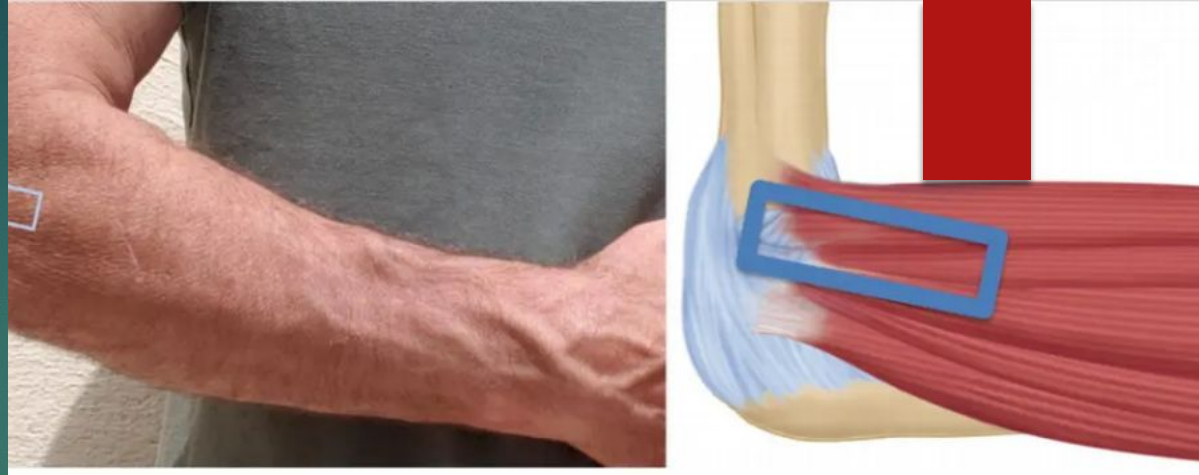
- Ultrasound can be used to diagnose disorders of bone, joints, tendons, muscles, ligaments, blood vessels, and nerves as well as guide interventions such as aspirations, diagnostic or therapeutic injections, tenotomies, releases, hydro-dissections, and biopsies.

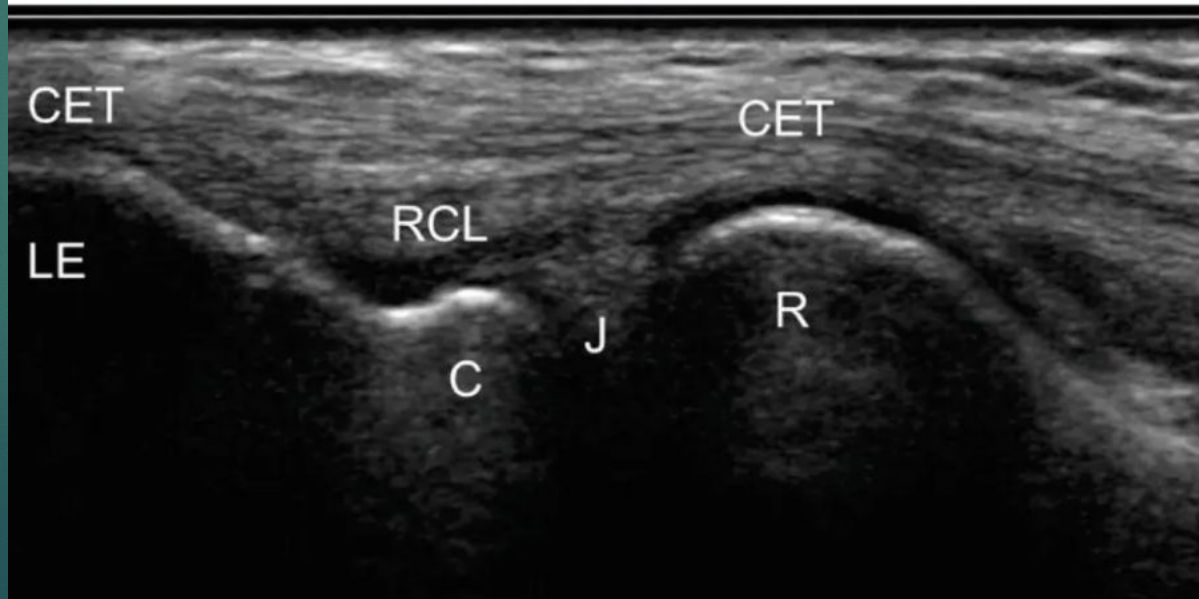
HOW IT WORKS



Video courtesy of the NIH: National Institute of Biomedical Imaging and Bioengineering

UNDERSTANDING ORIENTATION



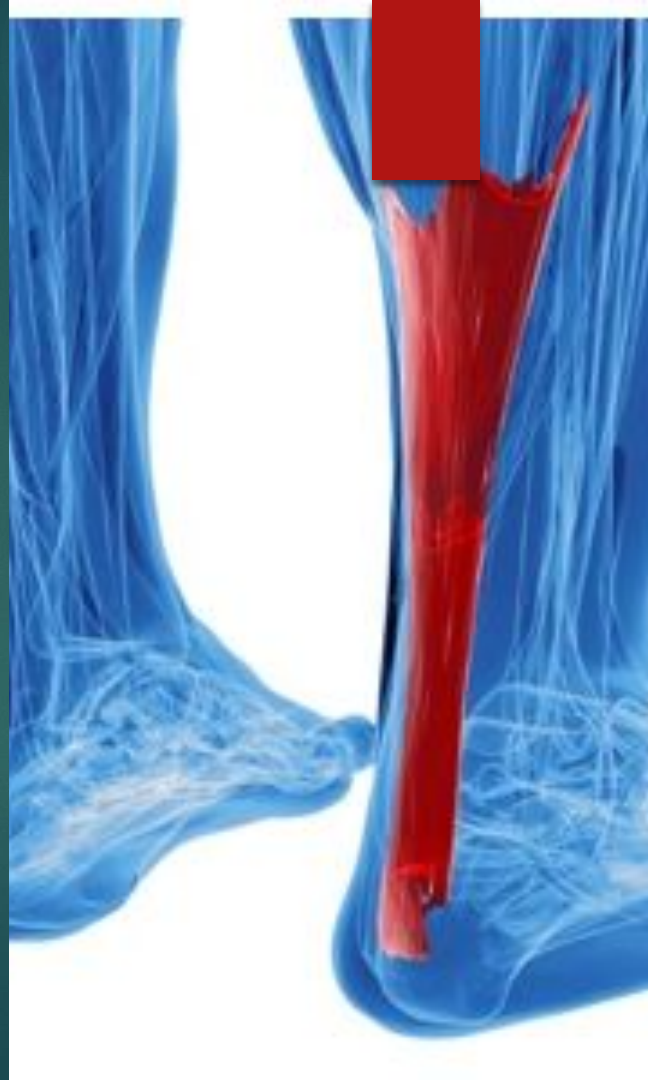


ACHILLES[2,3,4,5]

- A healthy tendon is predominantly composed of 90% collagen type I. Following a tendon rupture, there is an increased amount of collagen type III formed.
- In the initial phases of healing, inflammatory cells infiltrate the rupture site with neutrophils and macrophages. In the later stages of recovery, fibroblasts, responsible for producing collagen, proliferate within the tendon tissue.
- Patients with diabetes have increased stiffness of the muscle-tendon unit, severe thickening of the Achilles tendon and plantar fascia, and disorganized distribution of tendon fibers.

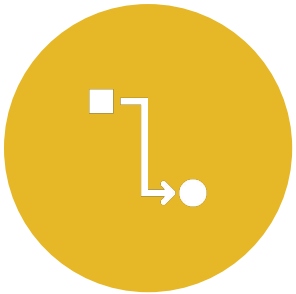
ACHILLES[6,7]

- More than 20% of ruptures are misdiagnosed.
- Studies report a rate of up to 40 patients per 100,000 patient population annually.
- The significant increase in ruptures this past decade is thought to be linked to the increased number of individuals engaging in sporting activities, particularly adults older than 30.
- During recreational sports, 75% of ruptures occur in men between the third and fourth decades of life.



ACHILLES[8,9,10,11,12,13]

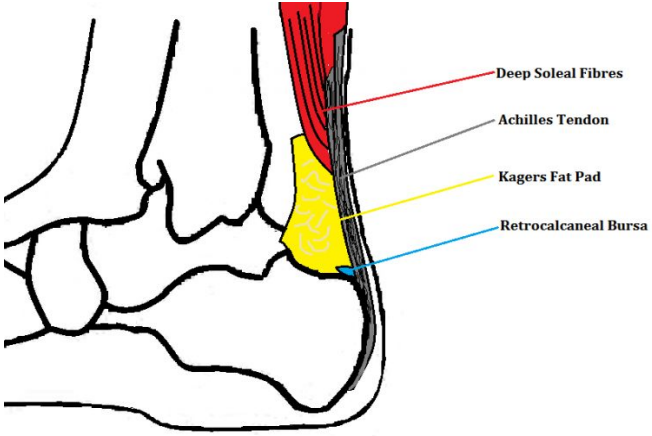
MECHANICAL FACTORS

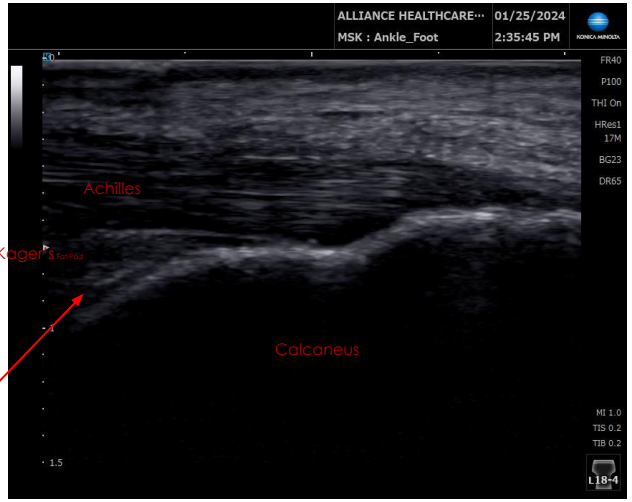


STRUCTURAL FACTORS

BIOMECHANICAL FACTORS

ACHILLES





Retrocalc Bursa

IMAGE COURTESY OF DR. MARK HARRINGTON, DO, ATC

SEEING MUSCLE CONTRACTION

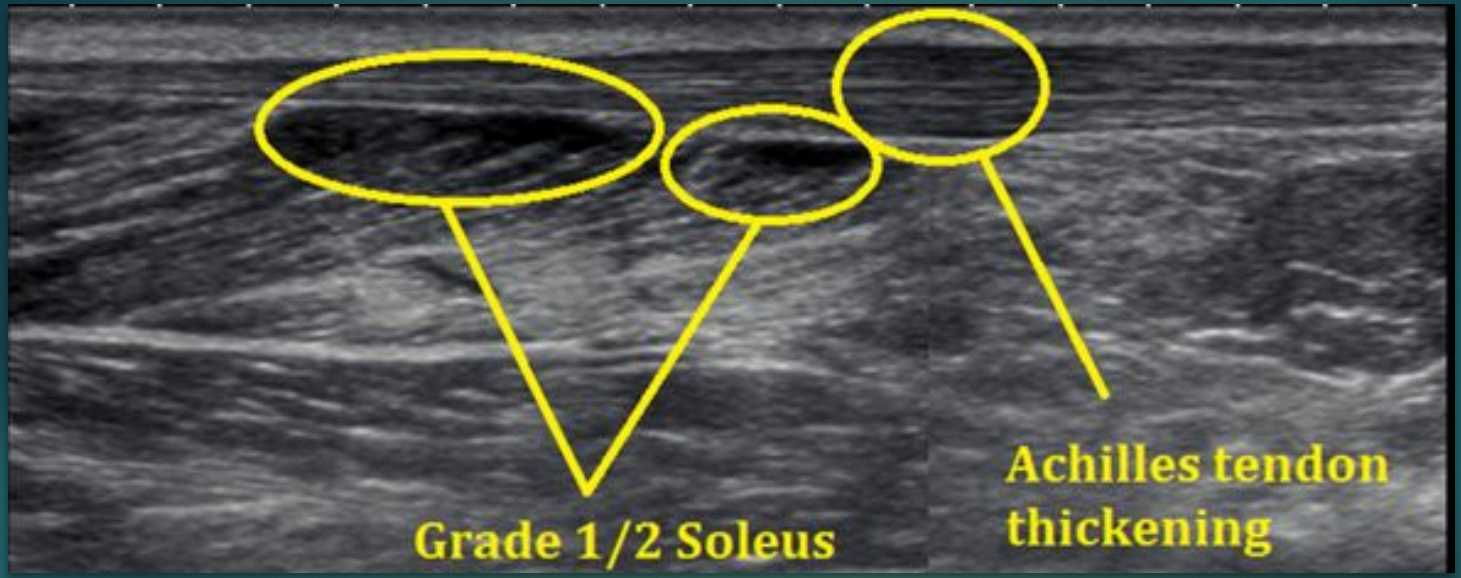
← Cephalad

Gastroc

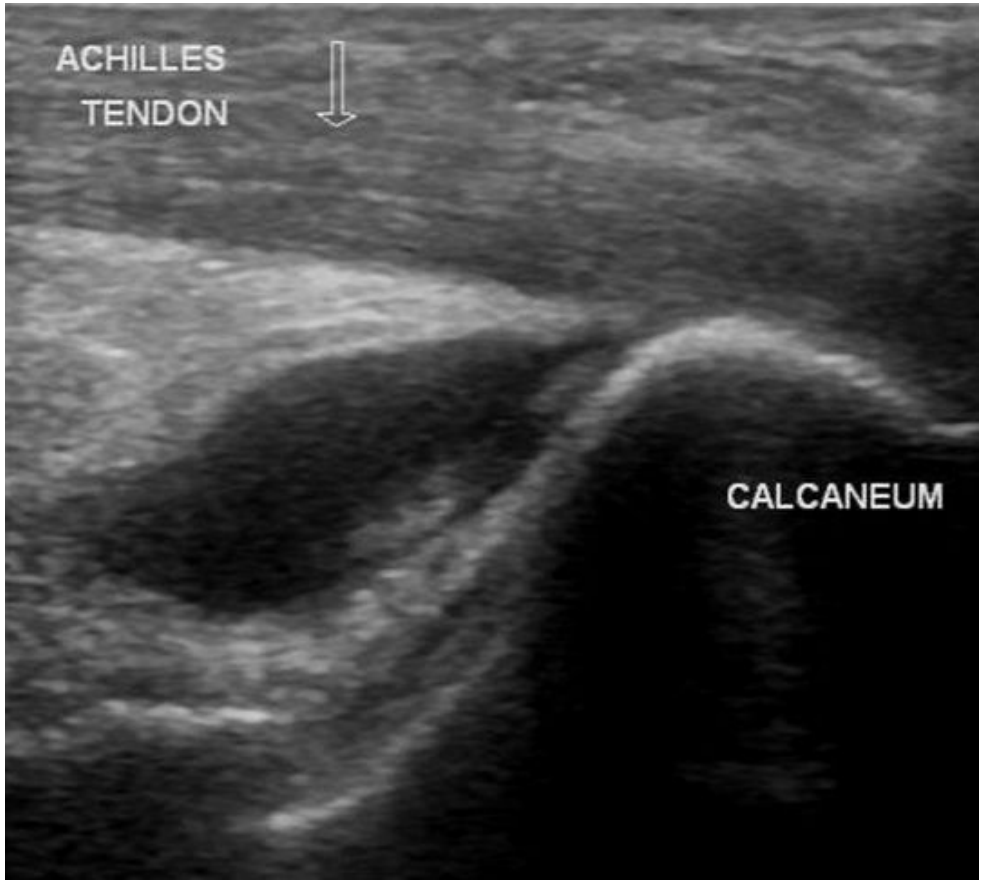
Caudad →

Soleus

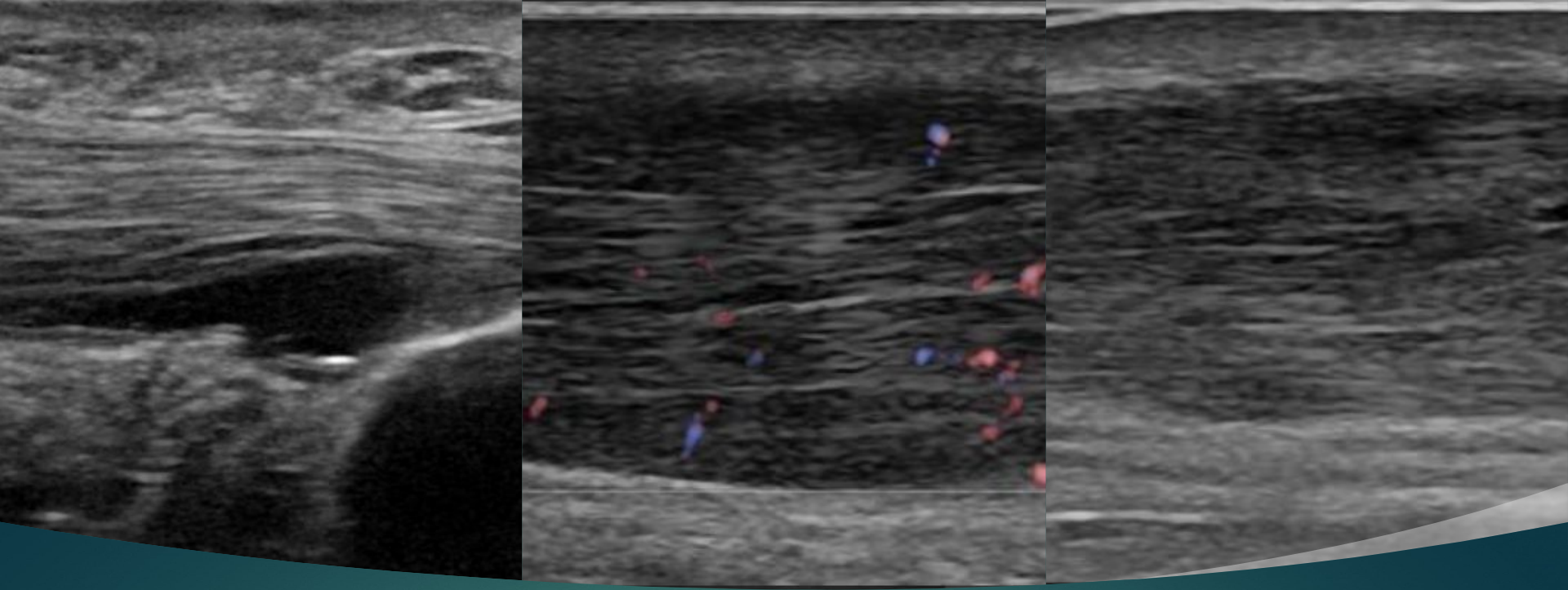
courtesy of Dr. Mark Harrington, DO, ATC



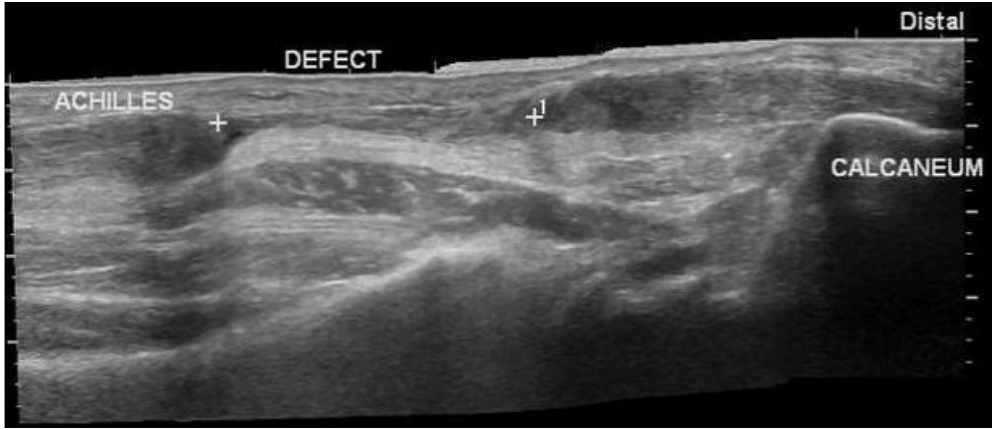
PATHOLOGY - SOLEUS STRAIN[14]



PATHOLOGY - RETROCALC BURSITIS



PATHOLOGY - ACHILLES TENDINITIS VS PARTIAL TEAR



PATHOLOGY - ACHILLES RUPTURE

ACHILLES MANAGEMENT OPTIONS[15,16,17]

Operative versus non-operative

- Overall surgical approach is favored regarding faster return to activity, reduced risk of re-rupture, increased efficacy in strength.
- Non-operative treatment is generally utilized with patients at high risk for operative intervention due to health concerns.

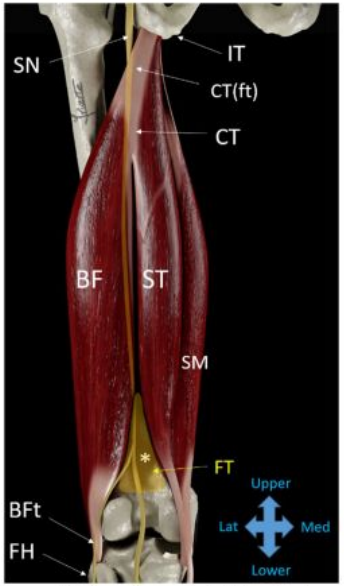
Adjunctive treatment and modalities

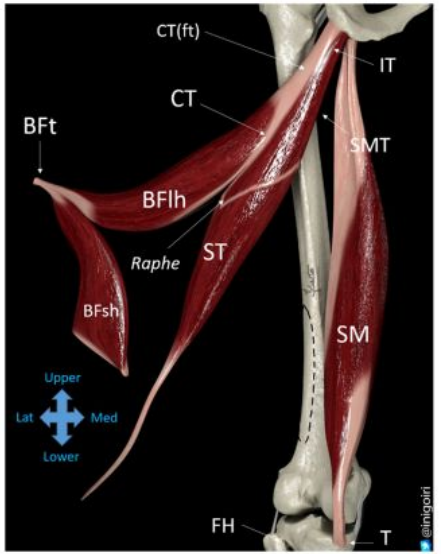
- Orthobiologics
  - PRP, mixed data without clear reproducible results showing overall efficacy.
  - BMAC, some clinical evidence of improved clinical function and reduced foot and ankle pain.

Rehabilitation

- To be discussed later in the presentation with Alex.

PROXIMAL HAMSTRING[18]





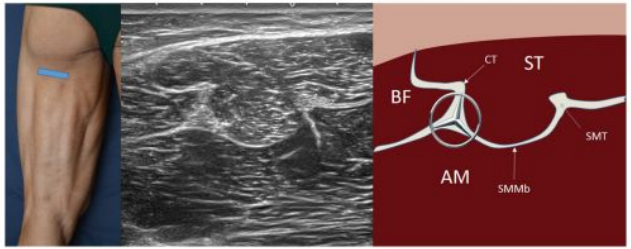
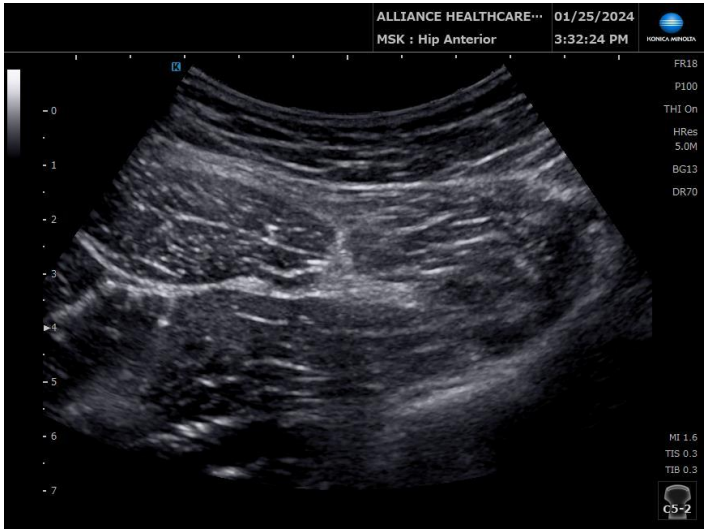
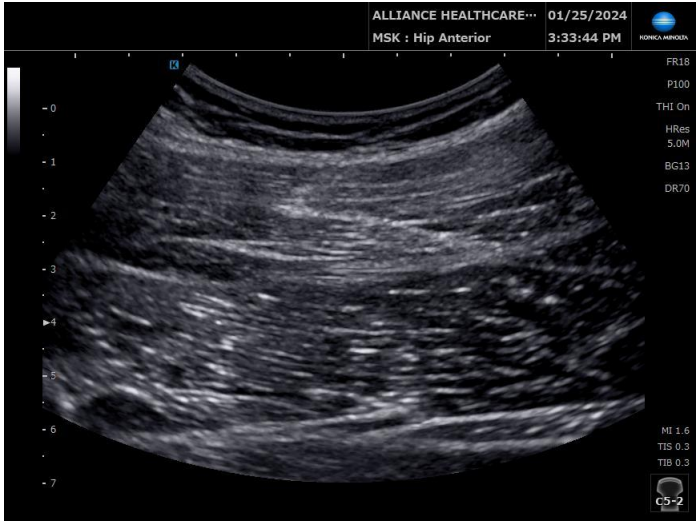


Fig. 5 Short-axis ultrasound view of the proximal-mid third of the back thigh with comparative diagram. The section of the sciatic nerve can be seen like the main landmark (remember the iconic Mercedes Benz logo). *BF* biceps femoris muscle, *ST* semitendinosus muscle, *AM* adductor magnus muscle, *CT* common tendon, *SMMb* semimembranosus membrane, *SMT* semimembranosus tendon. The photograph on the left of the figure indicates probe positioning



SONOGRAPHIC PROXIMAL HAMSTRING ANATOMY[18]



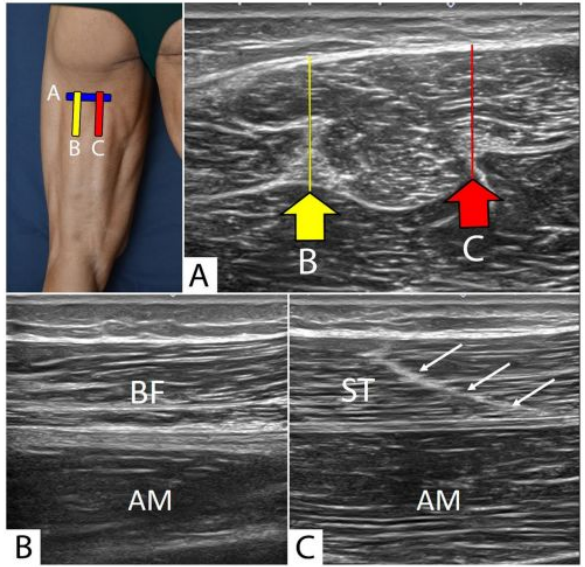


Fig. 6 **a** Short-axis ultrasound view of the proximal third of the back thigh. **b** By placing the probe in the long axis over the sciatic nerve, the biceps femoris muscle can be located. **c** By placing the probe in the long axis over the semimembranosus tendon (C), the semitendinosus muscle with its raphe can be located. The adductor magnus is located ventral to these structures. *BF* biceps femoris muscle, *ST* semitendinosus muscle, *AM* adductor magnus muscle, *White arrows* raphe of the semitendinosus. The photograph in the top left of the figure indicates probe positioning

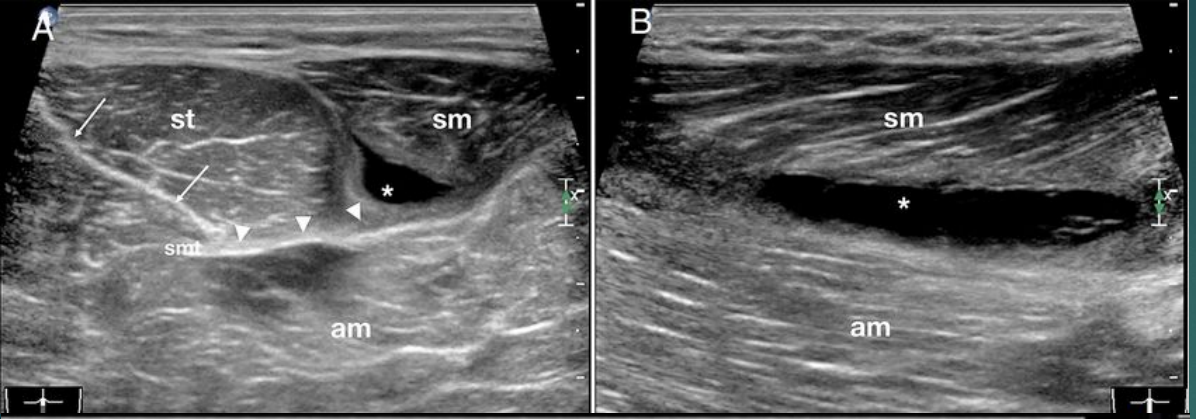
PROBE LOCALIZATION AND ST RAPHE

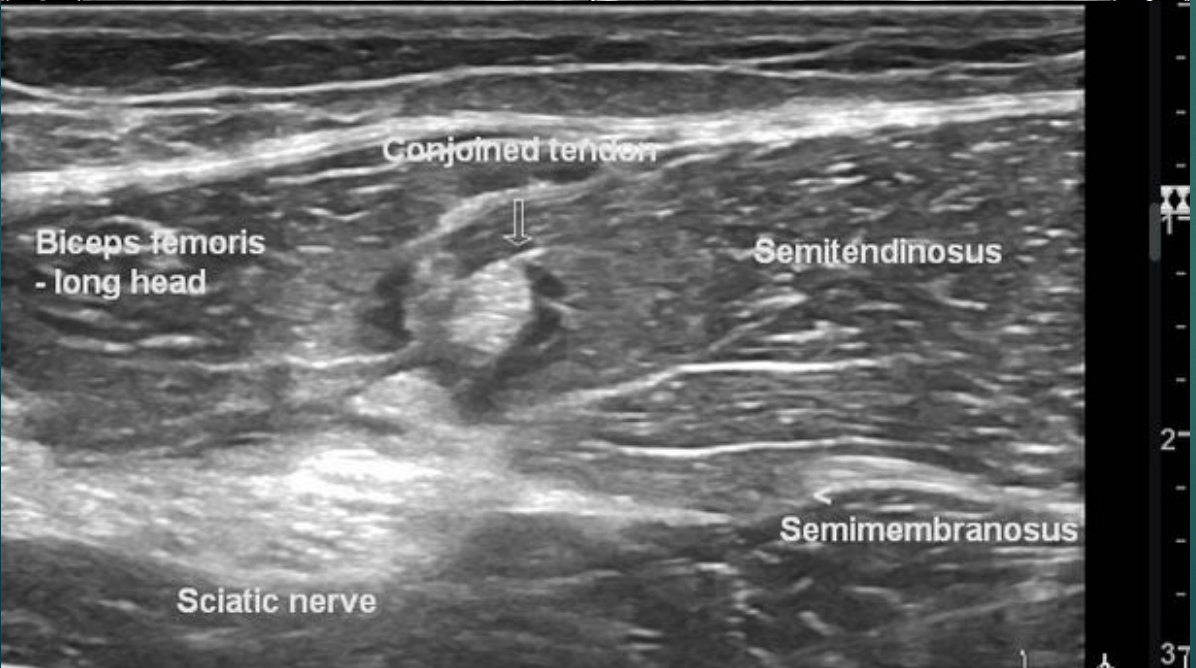
LOCATION OF HAMSTRING TENDON PATHOLOGY

STRETCH TYPE INJURIES

SPRINT TYPE INJURIES

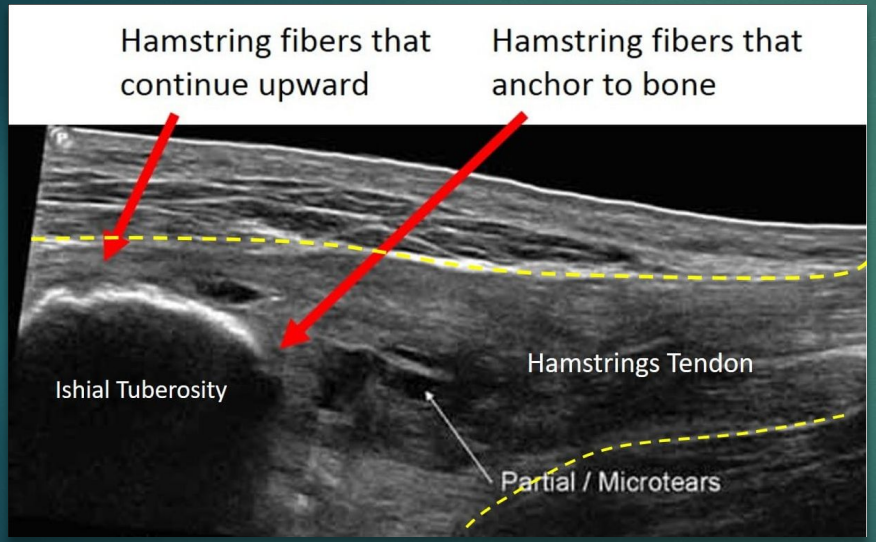
INJURY DATA[19]





CONJOINT TENDON INJURY AND SM STRAIN

CRITERIA FOR MANAGEMENT[20]



- For partial-thickness tears, treatment options include non-surgical and surgical treatment. Non-surgical treatment is typically indicated for single-tendon tears, or 2-tendon tears with less than 2 cm of retraction.

HAMSTRING TREATMENT OVERVIEW[21]

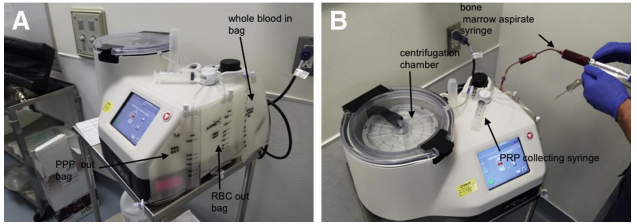
Traditional treatment methods for PHT are by the majority comparable to those of other tendinopathies.

Eccentric exercise programs with musculotendinous junction strengthening and promotion of intratendinous collagen fiber cross-linkage.

Proprioceptive training was shown to be beneficial for neuromuscular control. Tendon stem cells are suspected to play a major pathogenic role also in PHT.

PRP[22]

- Haunschild, E.D.; Huddleston, H.P.; Chahla, J.; Gilat, R.; Cole, B.J.; Yanke, A.B. Platelet-Rich Plasma Augmentation in Meniscal Repair Surgery: A Systematic Review of Comparative Studies. Arthrosc. J. Arthrosc. Relat. Surg. 2020, 36, 1765–1774.
  - Initial definition of PRP consisting of a platelet concentration above baseline
  - PRP is currently characterized by its absolute platelet concentration values to a **minimum platelet concentration of more than 1 × 10^6/μL or an approximately five-fold increase in platelets from baseline**



PRP[23,24]

- Rodeo S. A., Lebaschi A., Carballo C., et al. What's new in orthopaedic research. The Journal of Bone & Joint Surgery. 2015;97(19):1972–1978.
  - PRP containing relatively low platelets and **few leukocytes** stimulate chondrocyte anabolism
  - PRP containing high platelets and **high leukocytes** stimulate chondrocyte catabolism
- Sakata R., McNary S. M., Miyatake K., et al. Stimulation of the superficial zone protein and lubrication in the articular cartilage by human platelet-rich plasma. The American Journal of Sports Medicine. 2015;43(6):1467–1473.
  - **Both** leukocyte rich and leukocyte poor PRP **stimulate** the secretion of superficial zone protein, a lubricant found in articular cartilage

Name	Abbreviation	Function
Platelet derived growth factor	PDGF	Enhances collagen synthesis, proliferation of bone cells, fibroblast chemotaxis and proliferative activity, macrophage activation
Transforming growth factor β	TGF-β	Enhances synthesis of type I collagen, promotes angiogenesis, stimulates chemotaxis of immune cells, inhibits osteoclast formation and bone resorption
Vascular endothelial growth factor	VEGF	Stimulates angiogenesis, migration and mitosis of endothelial cells, increases permeability of the vessels, stimulates chemotaxis of macrophages and neutrophils
Epidermal growth factor	EGF	Stimulates cellular proliferation, differentiation of epithelial cells, promotes cytokine secretion by mesenchymal and epithelial cells
Insulin-like growth factor	IGF	Promotes cell growth, differentiation, recruitment in bone, blood vessel, skin and other tissues, stimulates collagen synthesis together with PDGF
Fibroblast growth factor	FGF	Promotes proliferation of mesenchymal cells, chondrocytes and osteoblasts, stimulates the growth and differentiation of chondrocytes and osteoblasts

PRP

PRP STUDIES

Author/Journal	Diagnosis	Formulation	Outcome
Vertrano 2013 AJSM	Patellar Tendinopathy	Leukocyte Rich	Significant difference
Schepull 2011 AJSM	Achilles Tendon Rupture	Leukocyte Rich	No difference
DeJonge 2011 AJSM	Achilles Tendinopathy	Leukocyte Rich	No difference
De Vos 2010 JAMA	Achilles Tendinopathy	Leukocyte Rich	No difference
Mishra 2014 AJSM	Elbow Tendinopathy	Leukocyte Rich	Significant difference
Creany 2011 BJSM	Elbow Tendinopathy	Leukocyte Poor	No difference
Peerbooms 2010 AJSM	Elbow Tendinopathy	Leukocyte Rich	Significant difference
Auriemma 2020 Regen Med	Hamstring Tendinopathy	Leukocyte Rich	Significant difference

US GUIDANCE BENEFITS

Image guided accuracy 96.7% vs. anatomic 81% (knee)

48% less procedural pain with US guidance

36% increase in therapeutic duration

50% reduction in cost per responder per year

Emerging Data: POCUS helping with RTP

Value of Sonography Combined With Clinical Assessment to Evaluate Muscle Injury Severity in Athletes

Yannick Guillodo, MD; Ronan Bouttier, MD; Alain Saraux, MD, PhD

J Athl Train (2011) 46 (5): 500–504.

https://doi.org/10.4085/1062-6050-46.5.500

Results: The 93 patients had 95 injuries, caused by muscle contraction in 86 cases and impact in 9 cases. Only 7 injuries had normal sonogram findings. Late sport resumption was associated with 4 clinical criteria (bruising, tenderness to palpation, range-of-motion limitation compared with the other limb, and increased pain with isometric contraction during passive limb straightening) and 4 sonographic criteria (disorganized fibrous tissue, intramuscular hematoma, intermuscular hematoma, and power Doppler signal). The Spearman rank correlation coefficient between predicted and actual times was 0.669 ($P < .0001$) for mild exercise resumption and 0.804 ($P < .0001$) for full sport resumption.

Conclusion: A combination of physical and sonographic data collected during the acute phase of sport-related muscle injury was effective in predicting time to sport resumption.

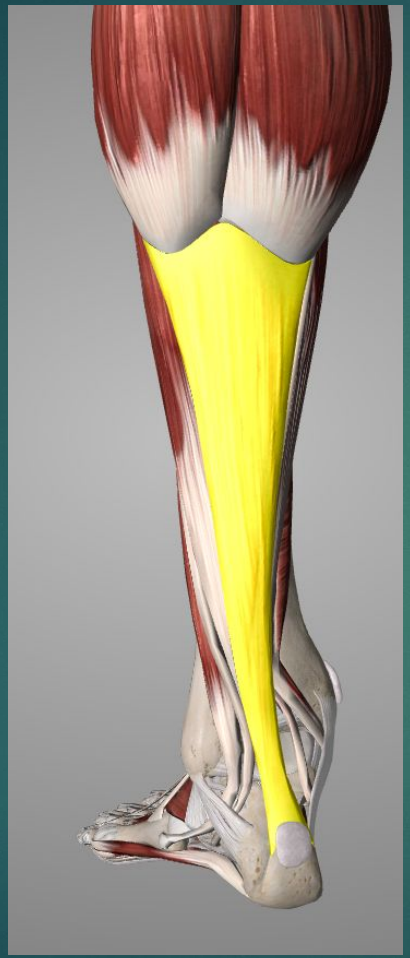
ALLIANCE ORTHOPEDICS

Part 2: Conservative Hamstring & Achilles Management

DR. ALEXANDER LETO PT, DPT, CSCS

Objectives:

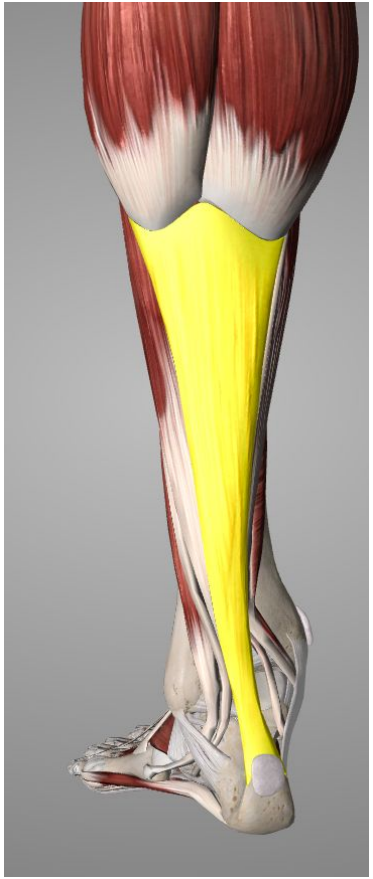
- Compare and contrast tendinous versus muscular rehabilitation plans of care
- Establish what a Functional **Diagnosis** is and discuss examination options to determine one
- Address **passive and active interventions** for two common posterior chain injuries.



Essential Anatomy 5

Achilles[31]

- Tendinous tissue
  - Type I Collagen
  - Elastic
- Posterior Chain / Superficial Back Line
- Gastrocnemius crosses Ankle and Knee
- Rupture Mechanism: Eccentric overload of dorsiflexion in weight bearing
- Tendinopathy Mechanism: Lack of preparedness, Acute vs. Chronic
- Functional Predisposing Factors: History of previous injury, Anatomy/Genetics, Biomechanics

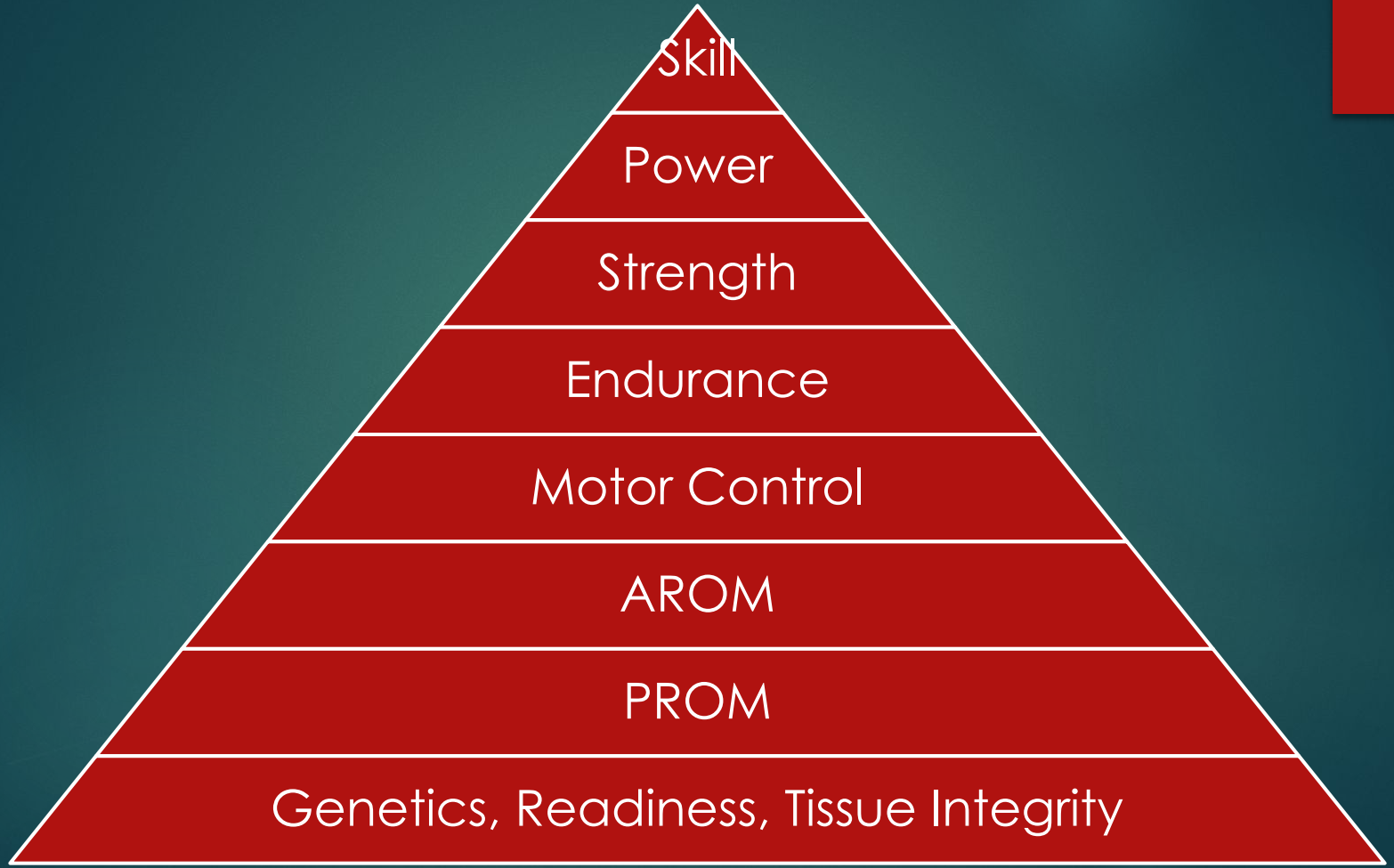


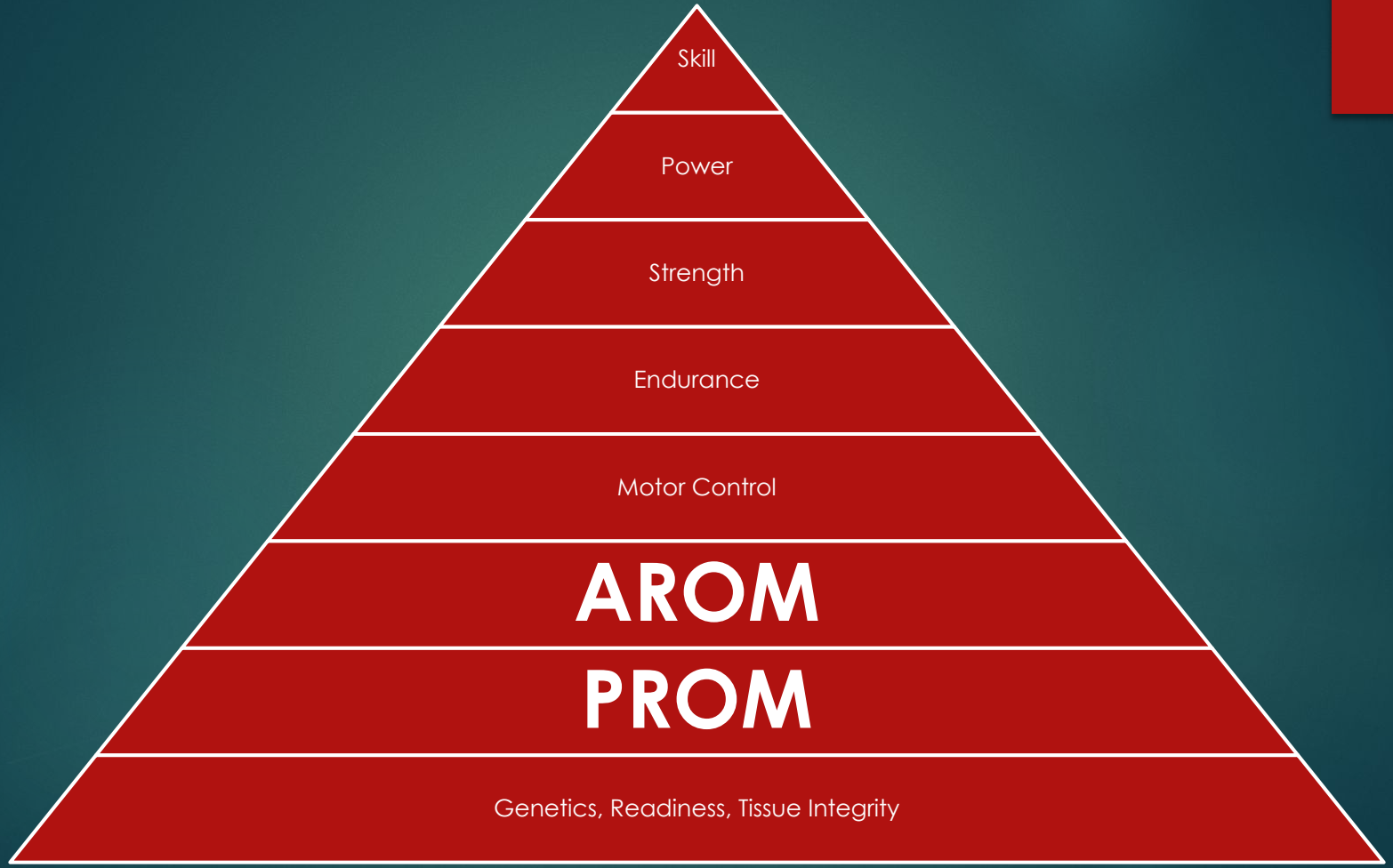
Hamstring[32]

- Muscle group (Muscular Tissue)
  - Wrapped in Fascia
  - Neural influence
- Posterior Chain / Superficial Back Line
- Crosses Knee and Hip
- Strain Mechanism: Eccentric overload at longer muscle length
- Functional Predisposing Factors: History of previous injury, Lack of mobility, Fatigue, Strength imbalance, Pelvic stability

Functional Diagnosis

Medical: Structural	**Functional: Mobility, Coordination, Capacity**	Performance: Coach


Skill
Power
Strength
Endurance
Motor Control
AROM
PROM
Genetics, Readiness, Tissue Integrity


Skill
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Strength
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AROM
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Testing Options - Mobility

Goniometry:

- AROM & PROM
- Normative Data
- Interlimb Symmetry
- Rehabilitative

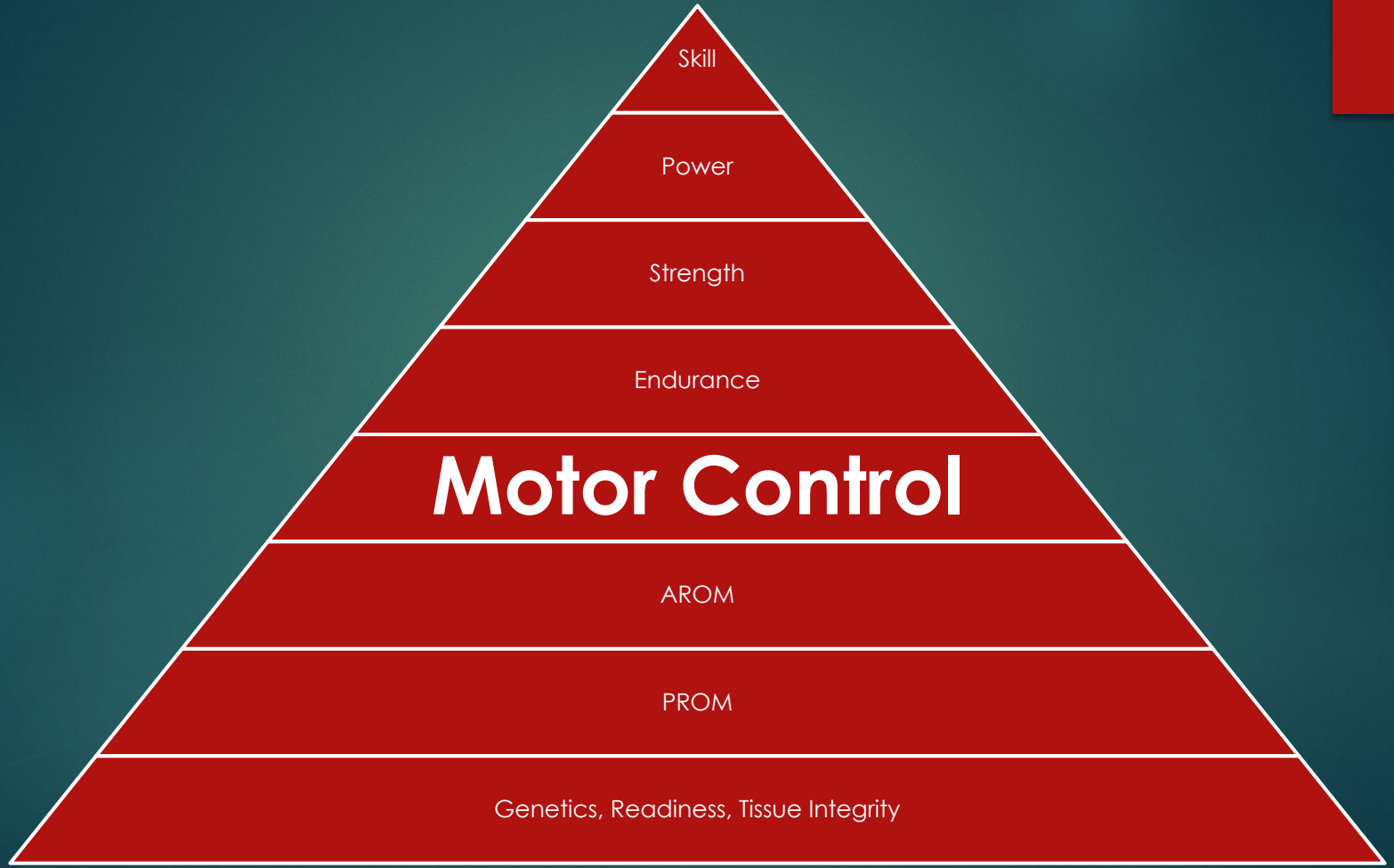
Testing Options - Mobility

HK Knee to Wall

- Grade
  - Bad: Can't touch Knee to Wall with Fist
  - Good: Can touch knee to with fist
  - Great: Can touch knee to wall with thumb
- Failure options:
  - Hypertonic Calf Complex
    - Fibrotic, Nerve, Metabolic
  - Hypomobile Talocrural joint
    - Fibrous, Effused, Irritated

Testing Options - Mobility

- Multisegmental Flexion
  - Grade
    - Bad: Can't touch ground
    - Good: Can touch ground with tightness
    - Great: Can touch ground comfortably
  - Failure options:
    - Hypertonic Posterior chain
    - Hypomobile Femoroacetabular joint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Testing Options – Stability[33]

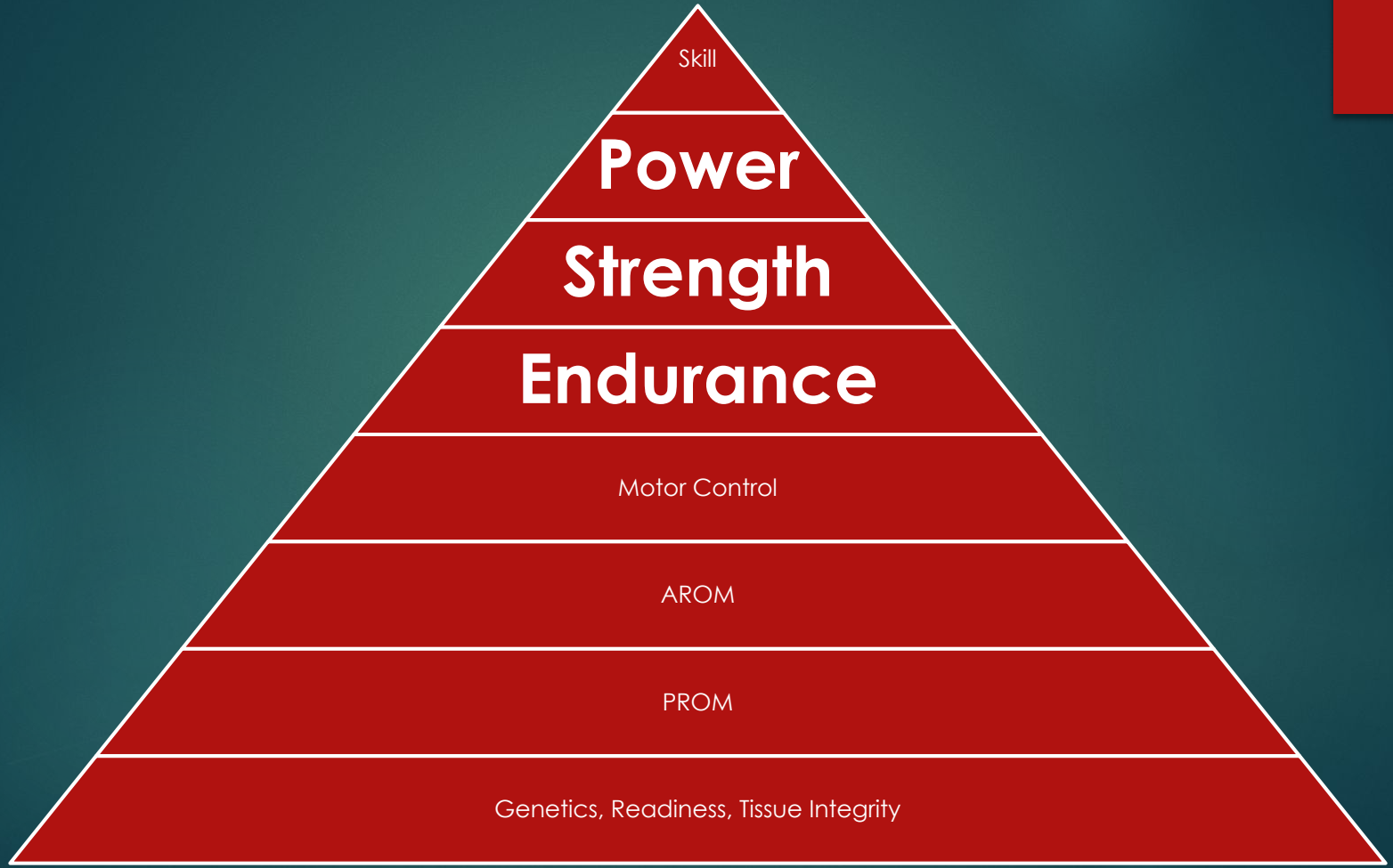
Y-Balance

- Three Dimensional
- Quantifiable symmetry
- Repeatable

Testing Options - Coordination

Video Analysis

- Postures
- Shapes
- Segments
- Landmark Positions
- Movement Pathways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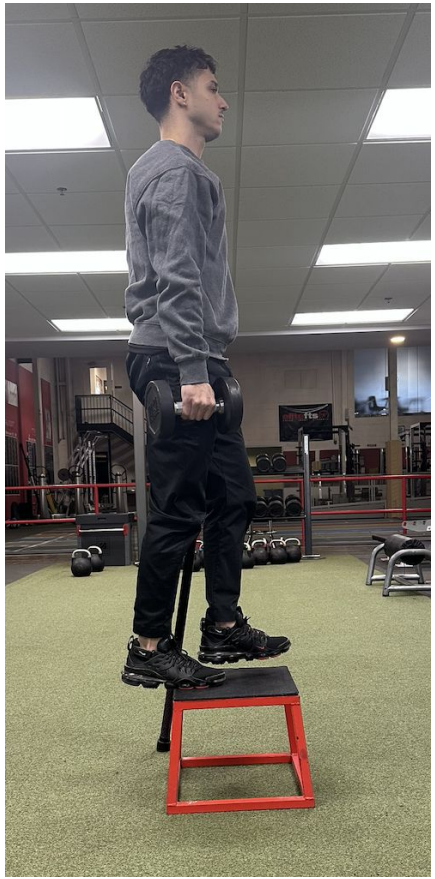
Endurance – Isometric Hold

- For Time
- Mid or End Range
- Interlimb Asymmetry
- Minimal Motor Control involved



Endurance – AMRAP[34]

- Interlimb Asymmetry
- Moderate Motor Control involved
- Researched Tests

Strength – Isometric Peak Force

- Quantitative
- Isolated
- Mid Range
- Inter and Intralimb Asymmetry
- Cueing for slow ramp up, maximum output

Strength – 1RM

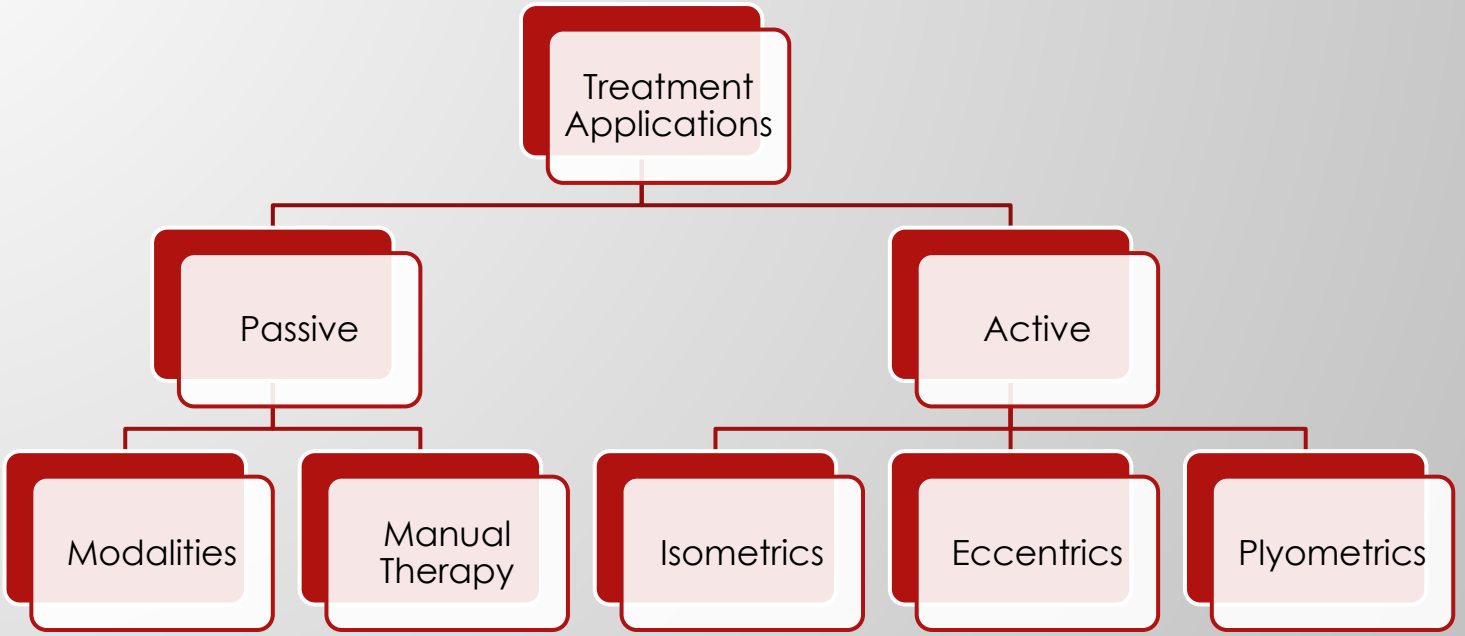
- Isolated or Integrated
- Moderate Motor Control involved

Power – Isometric RFD

- Same for Peak Force, mostly.
- 0.150s
- Cueing for quick ramp up

Power – Hop Testing

- Common Testing battery
  - Single
  - Triple
  - Crossover
  - 6m for time
- Deceleration of Shin
- Horizontal Force Production
- Could also be vertical and multiplanar


Treatment Applications
Passive
Active
Modalities
Manual Therapy
Isometrics
Eccentrics
Plyometrics

Passive Interventions – Modalities[35,36]

- Class IV Red Light Laser
  - 2-10 minutes
  - Analgesic via local heat
  - Biological effect via photobiomodulation
- Shockwave
  - Focused acoustic waves
  - Microtrauma to tissue increases collagen synthesis via fibroblast stimulation which facilitates regeneration and remodelling by improving density and organization of connective tissue

https://enovis.com/litecure

https://www.chattanoogarehab.com/us/intelect-focus-shockwave-21090-us

Passive Interventions – Manual Therapy[37,38]

STM

- Kneading to increase blood flow, mobilize tissue, and neural modulate

IASTM

- Smaller surface area, shearing, for blood flow, tissue mobilization, and neural modulation

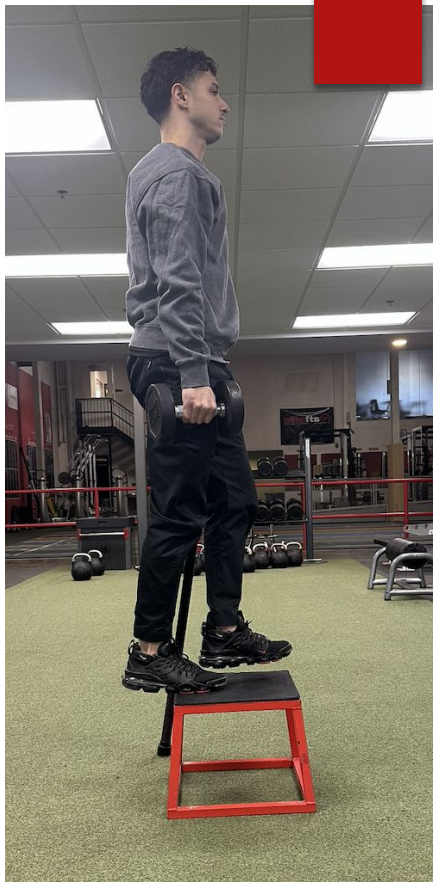
Cupping

- Decompressive, stagnant or moving, for blood flow, tissue mobilization, and neural modulation

Active Interventions – Isometrics[39]

Yielding

- "Holding"
- Longer Duration
- Position Specific
- Targeting Tendon Architecture
- Increase Stiffness
- Gait Pain



Active Interventions – Isometrics[40]

Overcoming

- "Pushing"
- Shorter Duration
- Long Lever
- Targeting Nervous System

Active Interventions – Eccentrics[41]

- Mobility
- Tempo
- More Volume
- Tendon Creep

Active Interventions – Eccentrics[42]

- Peak Force or RFD
- Overload
- Less Volume
- Sarcomere Addition

Active Interventions – Plyometrics[43]

Extensive

- High Volume, Low Force
- Lower Impact
- Stiffness and Reactiveness of tendon
- < 150 m/s GCT

Active Interventions – Plyometrics[44]

Intensive

- Low Volume, High Force
- Higher Impact
- Larger Joint Angles
- RFD via Nervous System
- > 150 m/s GCT

Thank you!

References:

1) Finnoff, J.T. et al. (2014) "American Medical Society for Sports Medicine (AMSSM) position statement: Interventional Musculoskeletal Ultrasound in sports medicine," British Journal of Sports Medicine, 49(3). Available at: https://doi.org/10.1136/bjsports-2014-094219.

2) Winnicki K, Ochała-Kłos A, Rutowicz B, Pękala PA, Tomaszewski KA. Functional anatomy, histology and biomechanics of the human Achilles tendon - A comprehensive review. Ann Anat. 2020 May;229:151461.

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