Objectives

- Identify current accepted treatment protocols following ACL and RC repair.
- Appreciate surgical techniques and the relationship to your patient's recovery.
- Recognize the intention behind your role in the rehabilitation process and the responsibility you have to the patient at all levels of recovery.
- Identify the use of "status quo" therapeutic exercise, physical agents, and manual therapy techniques with proposed alternatives for immediate implementation in practice.
- Launch a unique, functional, evidence based rehabilitation protocol; building credibility with the patient and the referring surgeon.

Educating Your Patient

- Is ACL Reconstruction Appropriate?
- What graft to choose?
  - CURRENT EVIDENCE AND DEBATE
- Timelines for:
  - General healing
  - Return to work
  - Return to function
  - Return to sport
- Pre-operative and acute post operative education

Graft Choice and Effect on Return to activity.

(Jeuritz et al 2016)

- Timelines for Return to
  - Jogging
  - Low level Agility
  - Plyometrics
  - Cutting
  - Return to Sport

Ligamentization *Rougraff Et al (2015)*

- Serial MRI examinations of individuals that underwent ACL reconstruction with allograft and autograft demonstrated signs of graft maturity earlier with autograft (two to six months) compared to allograft reconstructions (nine to 12 months). *(Joreitz et al 2016)*
- Graft itself is not vascularized at the time of reconstruction.
- Vascularization Phase
  - 3 weeks-3months
- Remodeling phase
  - 3-12 months.
- Maturation Phase
  - Between 9 and 18 months following surgery.

Graft Comparison *(Kaeding et al 2017)*

- Odds of ipsilateral re-tear were 5.2 times greater for an allograft ($p<0.01$) compared with a bone-patellar tendon-bone (BTB) autograft;
- Odds of re-tear were not significantly different between BTB autograft and hamstring autograft
- Cohort Study with N=~2700

Younger Population Allo vs Auto

- 788 Autograft
- 228 Allograft
- Mean Age - 21.7
- Follow-up - 24 - 51 months.
- The pooled failure prevalence was
  - 9.6% (76/788) for autografts
  - 25.0% (57/228) for allografts.

Common Surgical Techniques

- Open or Arthroscopic
- Graft
  - Autograft
    - Hamstring
    - Patella Tendon
  - Allograft
- Menisectomy or Meniscus Repair
- Microfracture

Rehabilitation Overview

- Early mobilization to prevent arthrofibrosis (maintenance of articular cartilage nutrition, retention of bone mineralization)
- Progress, controlled loading of graft to stimulate collagen healing and regeneration. ***"ligamentization"***
- Progression to full weight bearing as quickly as allows or as pain permits (exception meniscus repair, collateral injuries, co-morbidities, etc.)
- Care taken to keep open chain extension non-resisted/very light to avoid significant anterior tibial displacement
- Loss of mechanoreceptors of joint with loss of original ACL's function. Train proprioception and return to activity specifics before full return to unrestricted activities

Early Rehabilitation (Surgery-6 weeks)

- Goals
  - Restore full terminal knee extension
  - Protect graft site/fixation
  - Minimize deleterious effects of immobilization
  - Control pain and inflammation
  - Educate patient regarding future rehabilitation
  - Begin to restore normalized gait pattern
  - PWB with axillary crutches

Evidence Based Priority (First 6 weeks)

PREVENT SECOND ACL RECONSTRUCTION SURGERY

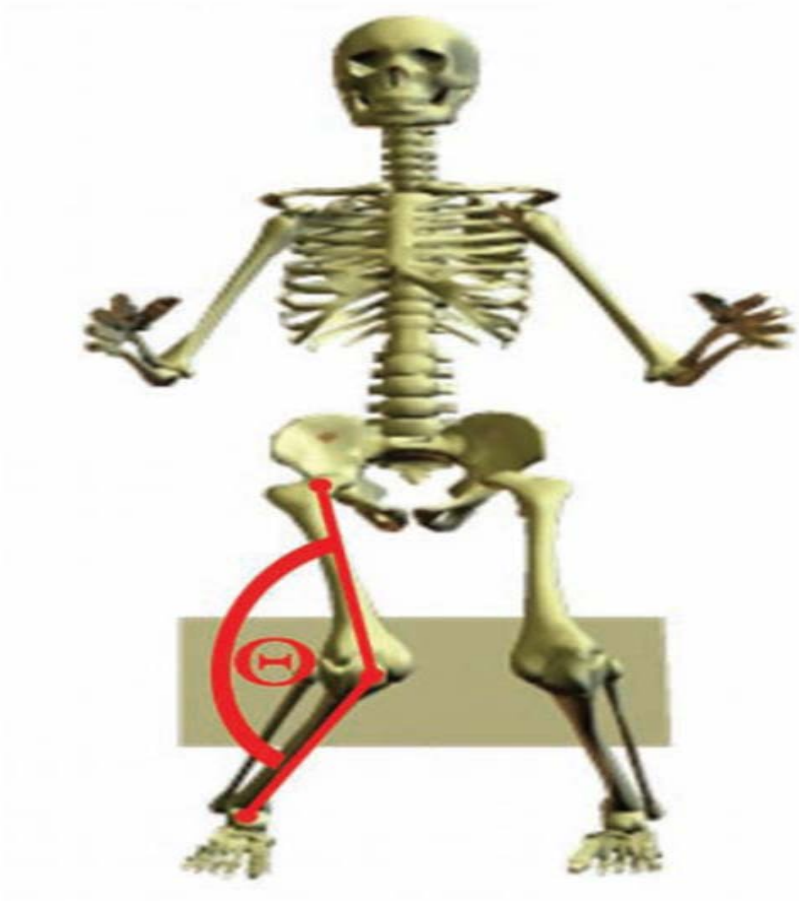
i. There a multiple risk factors associated with surgical failure.

ii. A Therapist has the ability to control movement.

iii. The movement impairments associated with failure is “Dynamic Valgus”.

Risk for Re-Injury *(Joreitz et al 2016) (Paterno et al 2010) (Harput et al 2016)*

- "Dynamic Valgus"
  - Aberrant movement patterns with low knee flexion excursions .
  - The lower chain requires eccentric control of a large vertical ground reaction force in order to maintain midline.
  - Failure to control this force can result in:
    - Femoral internal rotation and adduction.
    - Excessive pronatory moment at the mid foot.



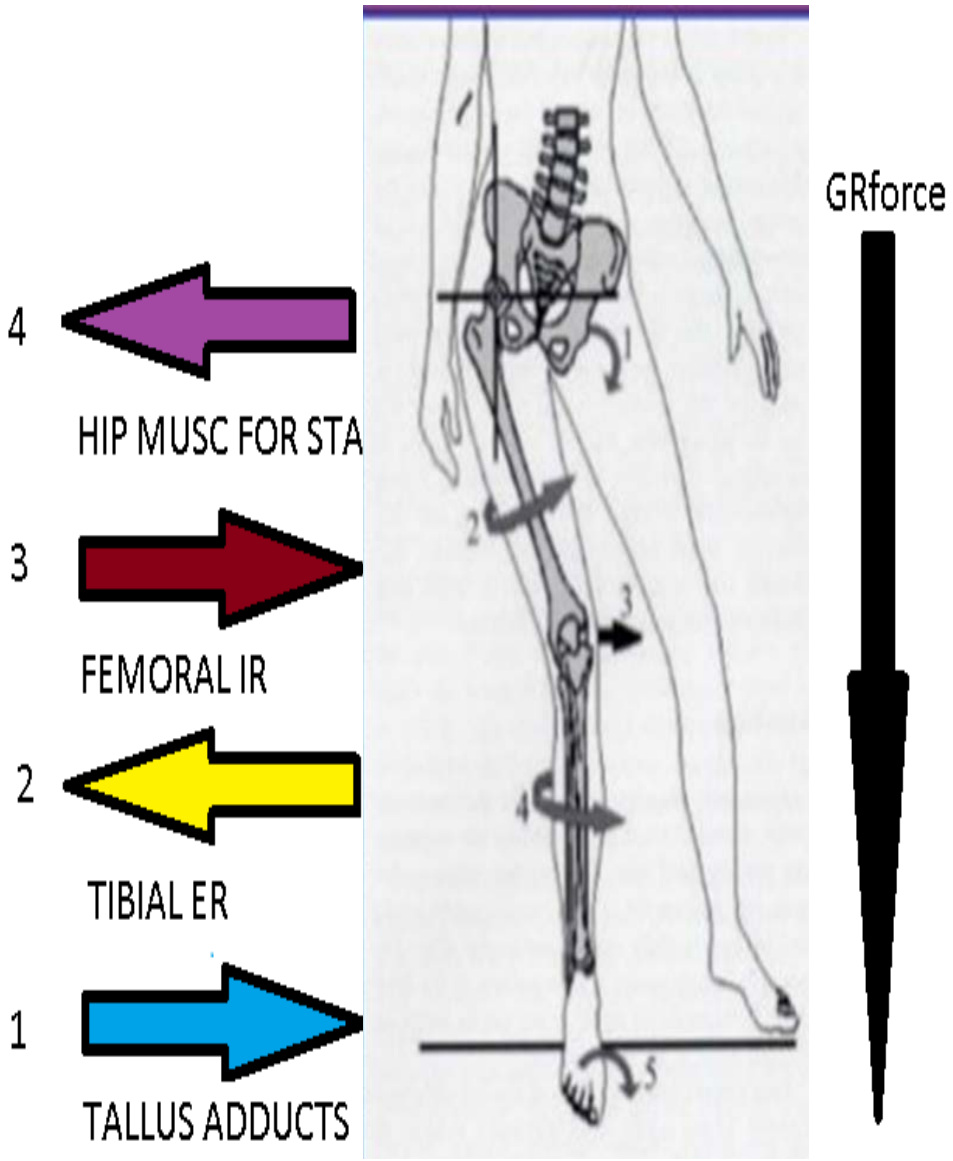
Dynamic Valgus

- Dynamic valgus observed during landing from jumps and cutting maneuvers is associated with greater ACL injury .
- Poor postural stability, weakness of the hip musculature (Harput et al 2016), and dynamic valgus landing mechanics increase the risk of sustaining a second ACL injury.
- Poor neuromuscular control can lead to a lateral trunk lean increasing the knee abduction moment and strain placed on the ACL.

Bracing

- Current Evidence is Lacking On Brace Specifications
- Clinical Commentary suggests *(Nyland et al 2015)*
  - Bracing is necessary during the acute phase due to quadriceps deficits and potential for knee “buckling” or hyperextension.
  - Proprioception and Neuroplasticity is linked to the ability to train and habituate.
  - Habituation and integration techniques are most effective when functional.
  - Bracing beyond the acute phase should be individual, sport and/or patient specific.

	“Acute”	Day 1 Post Op →Walking	~1-6 Weeks
Goals	Normal ROM	Symmetrical Gait	Early NM Re-Education
Status Quo Therex	Stretch Tight Muscles	Cone Drills and Balance	Internal vs. External Cueing
Evidence Based Therex	Strength Brings Motion	Neuro – plasticity and re-defining movement patterns	Targeted Re-education to the core, hip, and whole lower chain.
Manual Therapy	Control Pain, Control Outcomes	MRE to ensure appropriate progress	Facilitation via “tools”. (K-tape)



Ground Reaction Force and normal distribution of weight.

Cueing for maintaining Midline - Weight distribution through medial foot.

Propped Extension

Quad Set/SLR

Calf Raise

Seated Calf Stretch

Weight Shift

Terminal Knee Extension

Maintain Midline

Calf Stretch in Weight Bearing

Initiate Weight Bearing with attention to Quality and Function

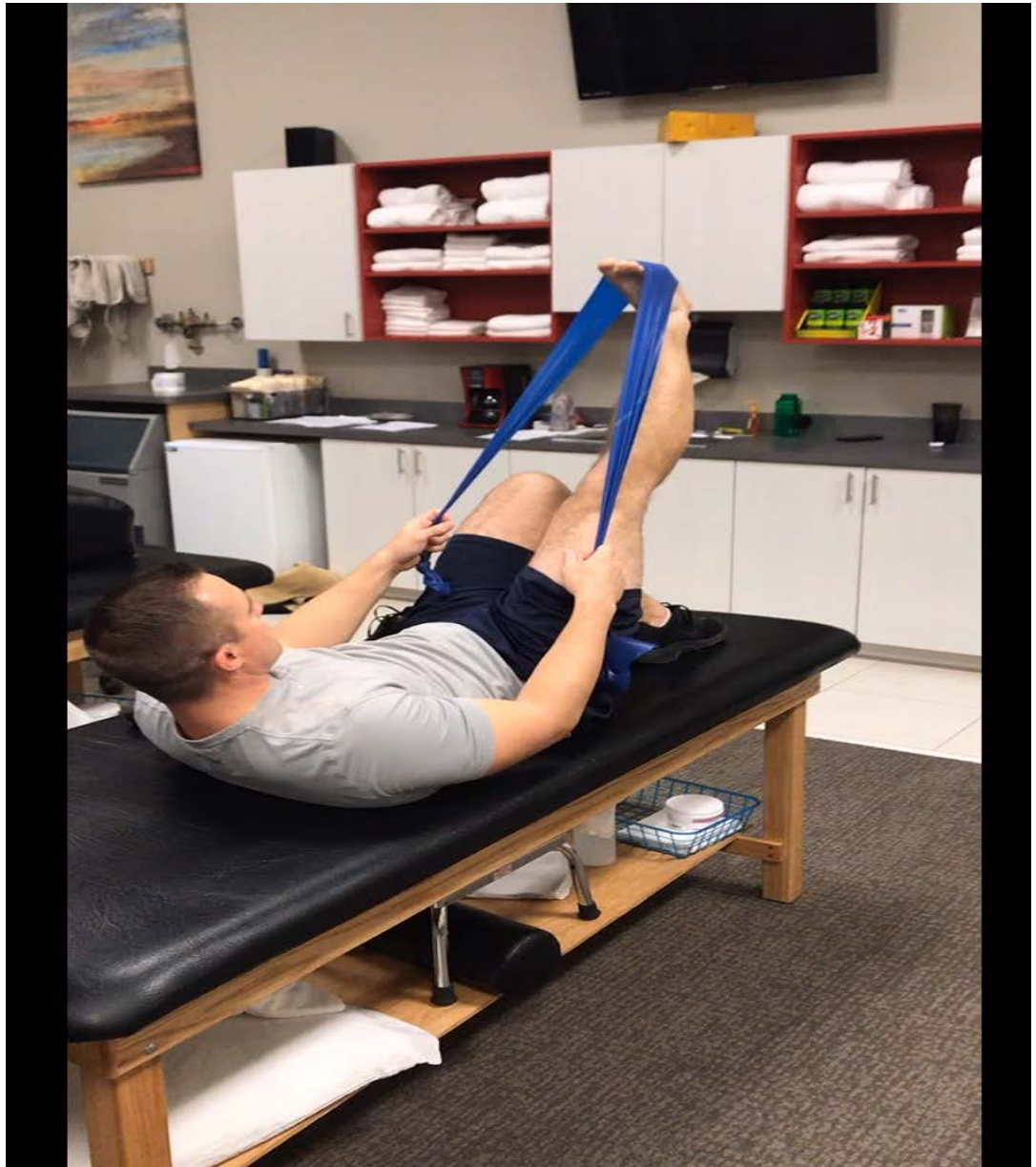
Lateral Fascia Stretch

ITB Stretch

Calf Stretch

Hamstring Stretch

Prone Knee Hang



Thera-band and Bare-Foot

Combination Movement

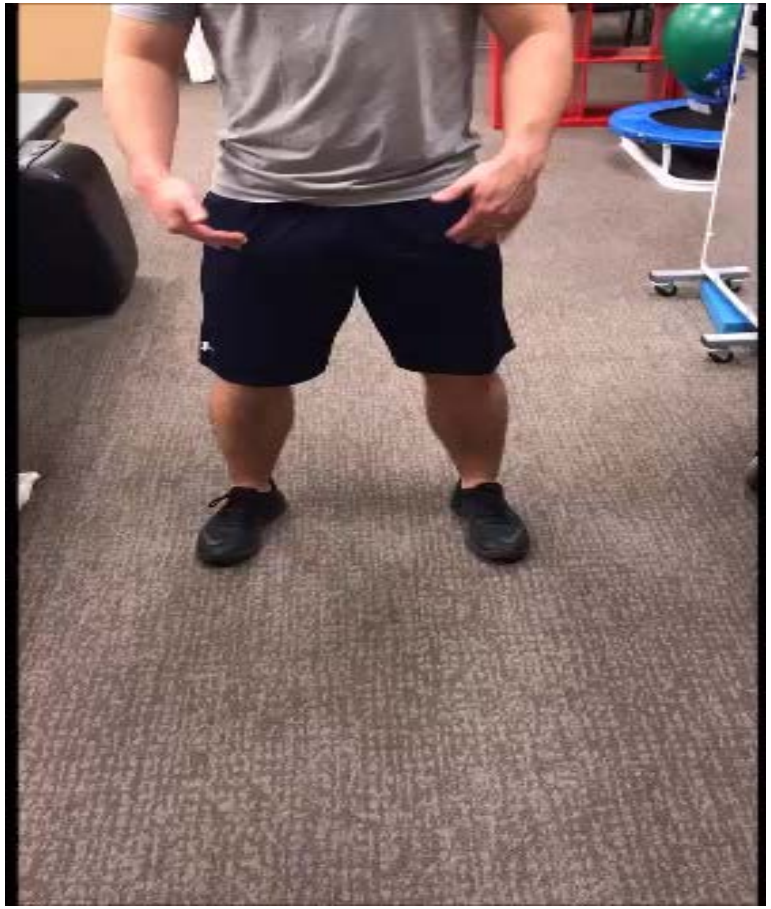
- ***Ankle Eversion***
- ***Knee Extension***
- ***Hip Adduction***

Pull greater lateral than medial

Address whole chain

Therapeutic Exercise

Mini Squat



Manual Resisted Exercise Hamstring and Quads

- Demonstration

Ball Roll

Heel Slides

Seated Knee Flexion

Hamstring Curl

Anterior Fascia Stretch

Attention to the Anterior Fascia

Brace on if indicated

Use Strap to Ensure PROM

Manual Therapy

- ROM
  - AAROM and Passive Motion beyond patient's internal ability to perform.
  - PF Joint
    - Mobilization with respect to superficial soft tissue damage.
    - Emphasis typically with medial and inferior glide.
  - TF Joint
- Soft Tissue
  - Avoid healing incisions unless inspecting the incision site or re-dressing.
- Muscle Contraction/Strength
  - Facilitation of contraction with manual cueing
  - Strengthen Adjacent Joints
- Edema Control
  - Effleurage and lymphatic draining techniques

Further Examples of Early NM Re-education

Incline plank with progressions

Sub Acute Phase (2- 8 weeks)

- Goals
  - Restore normal gait pattern
  - Restore full AROM
  - Protect graft site/fixation
  - Improve kinetic chain strength, endurance and proprioception for return to functional activity
  - WBAT, with axillary crutches, with emphasis on weaning from crutches at 2 weeks post-op

Sub-Acute Weeks 8-12

- Goals
  - Initiate/progress high level strength training in the sagittal and frontal planes
  - Full ROM
  - Control of knee motion in the closed chain.
    - 0-45 degrees
    - Without pain or dynamic valgus
  - Walking/Gait on the treadmill without deviation or pain.
  - Natural Progression from Baseline exercises with emphasis on balance, cueing, and proprioception.
  - Begin Transverse Plane exercise at 12 weeks.

Cueing – Internal vs. External

- Internal (Focus On The Movement)
  - Example
    - Stand on One Leg, slowly bend your knee while keeping knee cap behind your toes.
- External (Focus On the Effect)
  - Example (using a visual cue)
    - Stand on One Leg, reach towards the cone with your knee cap, gently tap the cone without knocking it over.

Cueing – Internal vs. External EXAMPLE

- Internal (Focus On Movement)
  - Hip Hinge/Deadlift
  - Squat
  - Hip Leveler
- External (Focus on Effect)
  - Hip Hinge/Deadlift
  - Squat
  - Hip Leveler

Proprioception

- Altered neuromuscular control due to disruption of mechanoreceptors within the ligament.
  - Recent surgical change to not debride native ACL remnants.
- Higher levels of cortical activity during movement tasks in knees status post ACLR as compared to non-injured knees. *(Grooms et al 2014)*
  - Suggested that the decreased sensory input available following ACL injury requires the patient to rely on visual feedback and increased conscious cortical involvement in order to effectively regulate control.
- Further theorized that this would play a role in knee proprioception with more difficult tasks, such as return to sport.

Proprioception

- Theorized Rational
  - Removing Native Mechanoreceptors
  - Altered Cerebral Cortex Activity
    - Hypo and Hyperfunction with knee flexion/extension excursions.
  - Altered Mechanics/Motor Control
  - Disuse Atrophy and diminished sensory input from adjacent joints.

Motor Learning and Neuroplasticity

- Recent JOSPT article by Grooms et al. 2017
  - MRI Imaging of ACLR vs. Normal
  - Significant changes in activity of:
    - Disruption of sensory input, and the development of altered motor control strategies to compensate for the associated biomechanical insufficiencies (strength, range of motion),
    - The processing demands on the motor cortex may increase to maintain even simple motor control integrity.
- Significant with Functional Rehabilitation geared towards a “high stimulus” environment.
- Clinically, we will use mostly visual spatial cues.

Therapeutic Exercise Goals

- Increase Knee Extension
  - Isolate and identify points of restriction above and below the knee.
    - Common Adjacent Deficits
      - Loss of Hip Extension, overuse injury with hip flexion, anterior innominate torsion.
      - Gastroc/soleus motion deficits, antalgic gait with overuse injury to the peroneals.
  - Prescribe exercise while taking into account:
    - Gravitational assistance
    - Ease of Reproduction
      - Incorporate cues with gait and utilizing various Assistive Devices
    - Dual Purpose Activity
      - i.e. balance and stretch at the same time
    - Match the patient's goals and PLOF-providing provisions to the most mundane activities.

Manual Therapy Goals

- Scar mobilization once the most superficial healing occurs.
  - Avoid cross friction initially, move in parallel to the incision
  - HEP to desensitize and self mobilize.
    - Use cryotherapy to assist
- TF Mobility
  - Posterior glide to the tibia in multiple degrees of flexion
- PF Mobility
  - Assertive mobilization of the patella, mostly medial and inferior.
- Symptom Management –local and global
  - DDN, KT, Soft tissue mobilization, scraping (“A-stym”), MF decompression (cupping)

Ice Massage

5-10 minutes

Small overlapping movements

Small treatment areas

Stop when patient experiences analgesia
at 10 minutes.

Cryotherapy Evidence

Martinbianco et al (2015)

- Decrease in NPRS and pain medication use 48 hours post surgical
- Not Dependent upon mode of delivery.

Paradigm Shift - NWB

- Knee Flexion with Open Chain Extension from 90-50 does not place undo translation on the ACLR graft and do not exert an unsafe anterior translation force on the tibia. *(Escamilla et al.)*
  - Non-weight bearing exercises between 90 degrees and 60 degrees of knee flexion should be implemented immediately after ACLR to provide isolated resistance to the quadriceps. *(Joreitz et al IJSPT 2017)*
- At four months post-ACLR as the graft remodeling phase peaks, the range of motion for NWB exercise can be progressed about five degrees per week to slowly increase the load experienced by the ACL. *(Joreitz et al IJSPT 2017)*
  - The amount of resistance selected should be based upon the presence of any patellofemoral pain.

Not so Shifty _Closed Chain

- Quadriceps strengthening exercises
  - 0 degrees to 45 degrees (avoid tibial translation)
  - Hamstrings are active in more extended ranges of the knee.
- Gradual Progression from 45 degrees at 3 months post-op
  - Graft Maturation occurring by this point.

Therapeutic Exercise (weeks 6-12)

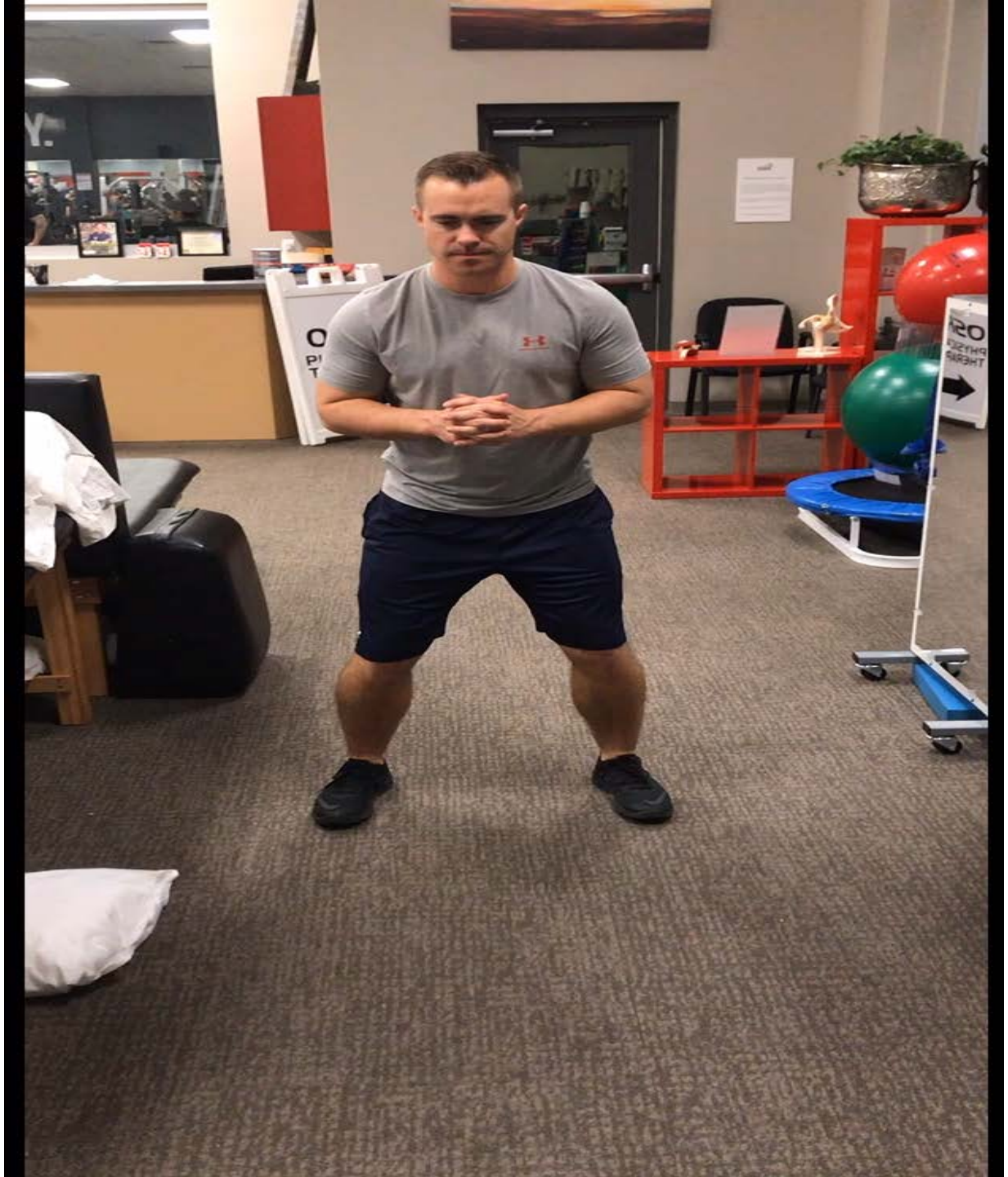
- Natural Progression from baseline exercise
- Initiate more dynamic activity towards the end of this phase (6-8 weeks)
- Emphasis on quality and communication with respect to HEP upgrades.
- Begin to deviate your exercise prescription based on the patients trajectory/goals.

Squat

Deadlift

Step up/down

Lunge



Mini Squat + Ballistic

Table Top Bridge

Squat

Deadlift

Step up/down

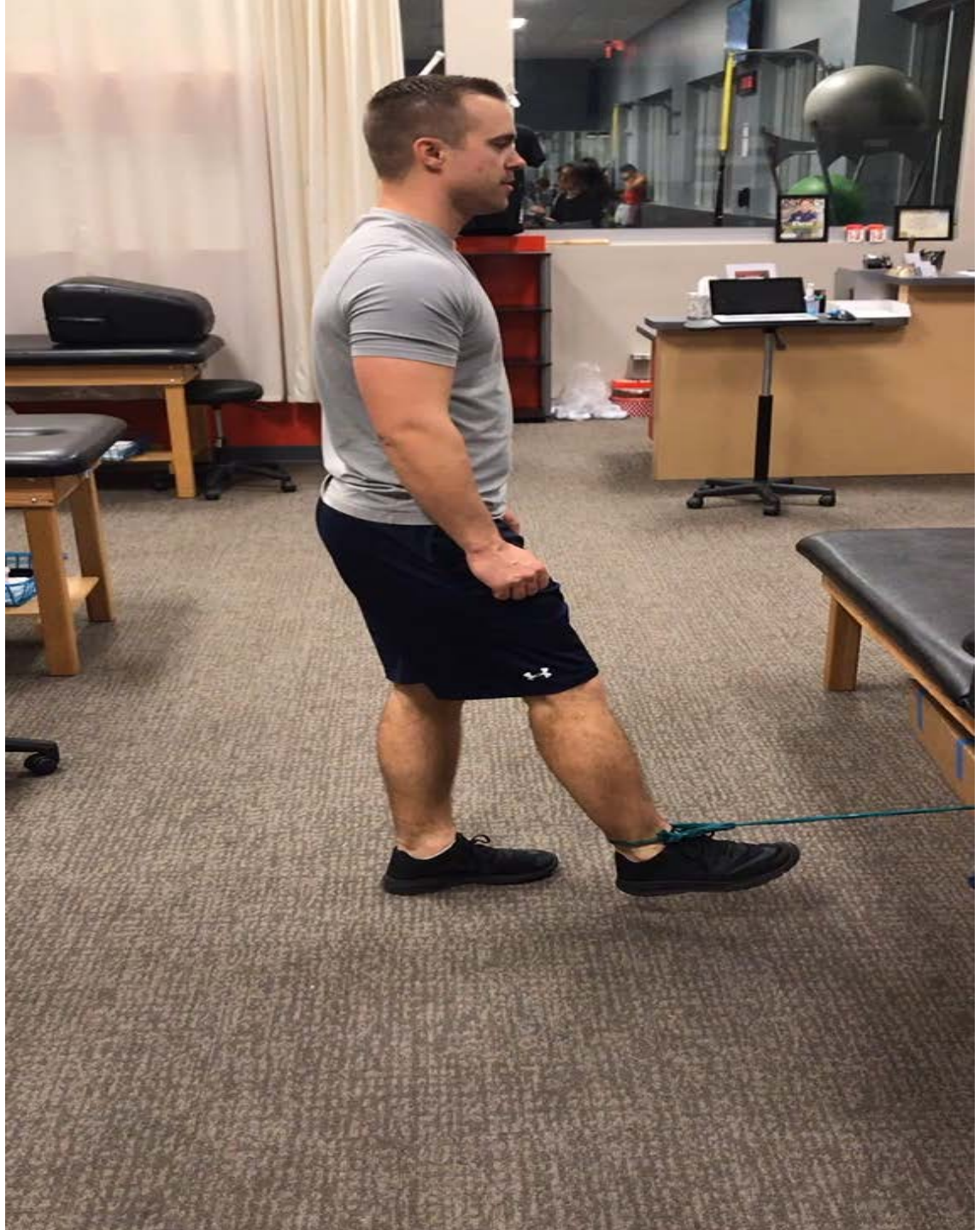
Lunge

Squat

Deadlift

Step up/down

Lunge



Pawing

Iso-Lunge Series

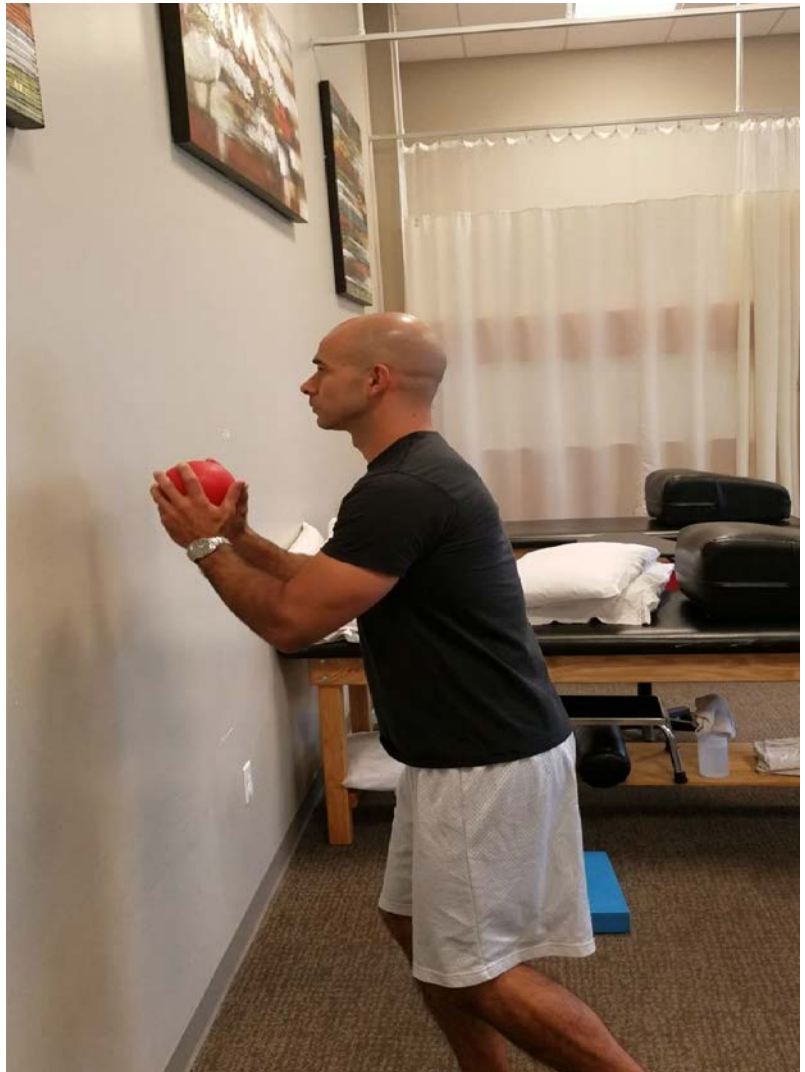
Squat

Deadlift

Step up/down

Lunge

Hamstring/Gluteal Strength



E-stim Use - Indications

NMES with Functional Movements

IFC and TENS assist

- IFC
  - Bracket Site

- TENS
  - Proximal - Dermato

Patella Mobilization and Effusion

Multi-Angle Glides Grade I-II

High Volt Galvanic Current

- Polarity
  - Proteins in the Interstitial Space are negatively charged.
  - Galvanic Effect
  - Osmotic Gradient
  - Best with elevation
  - Negative electrodes distal, positive proximal.

	“Chronic”	Twisting→ Running→ Return to Sport	Week 12-24
Goals	Build Mass	Pain Free Symmetrical Running	Goal/Sport Specific Training
Status Quo Therex	Strength in all planes	Treadmill, Elliptical, Stair Climber	Discharge planning with personal trainer or coach
Evidence Based Therex	Use of functional outcome tools to guide therex prescription.	Use of functional outcome tools to evaluate readiness	Use of functional outcome tools to evaluate readiness

Return To Running Indications

- Typically at 12-16 weeks.
- Normal pain free treadmill gait.
- Control of dynamic valgus through 45 degrees of closed chain loading.
- Use Leg Symmetry Measurements to help decision making.

Progression to Running *(Joreitz et al 2016)*

- **Goal at 4-6 months post-op (depending on graft type): PASS SCREENING TEST TO BEGIN RUNNING**
- No abnormal gait patterns while walking as fast as they can on the treadmill for 15 minutes
- 30 step and holds without loss of balance or excessive motion outside of the sagittal plane
- 10 consecutive single leg squats to 45° of knee flexion without loss of balance, abnormal trunk movement, Trendelenburg sign, femoral IR or the knee deviating medially causing the tibial tuberosity to cross an imaginary vertical line over the medial border of the foot
- ≥ 80% 1-repetition maximum (1-RM) on the leg press (90-0°)
- 80% 1-repetition maximum (1-RM) on the knee extension machine (90-45°)

Y Balance Test

- Score = (anterior reach + posteromedial reach + posterolateral reach)/(3 x limb length)

- ≥ 90% composite score on Y-balance test for progression to running.

Leg Symmetry Index

Used to Calculate Readiness for Progression

- 90% as a benchmark for Progression *(Herrington 2011)*
  - Step Testing
    - Step Down
    - Retro Step Down
  - 1 RM power measurement
  - Hop Testing

Calculation

- (Involved/Uninvolved)x100

Return to Sport

- It is the role of the practitioner to understand the demand placed upon their patients.
- We may not be experts of (insert sport here), but we are movement experts.
- It is our job to take the time to understand the patient's goals, and provide our expertise with respect to movement impairment.
- 90-100% scores with power and symmetry

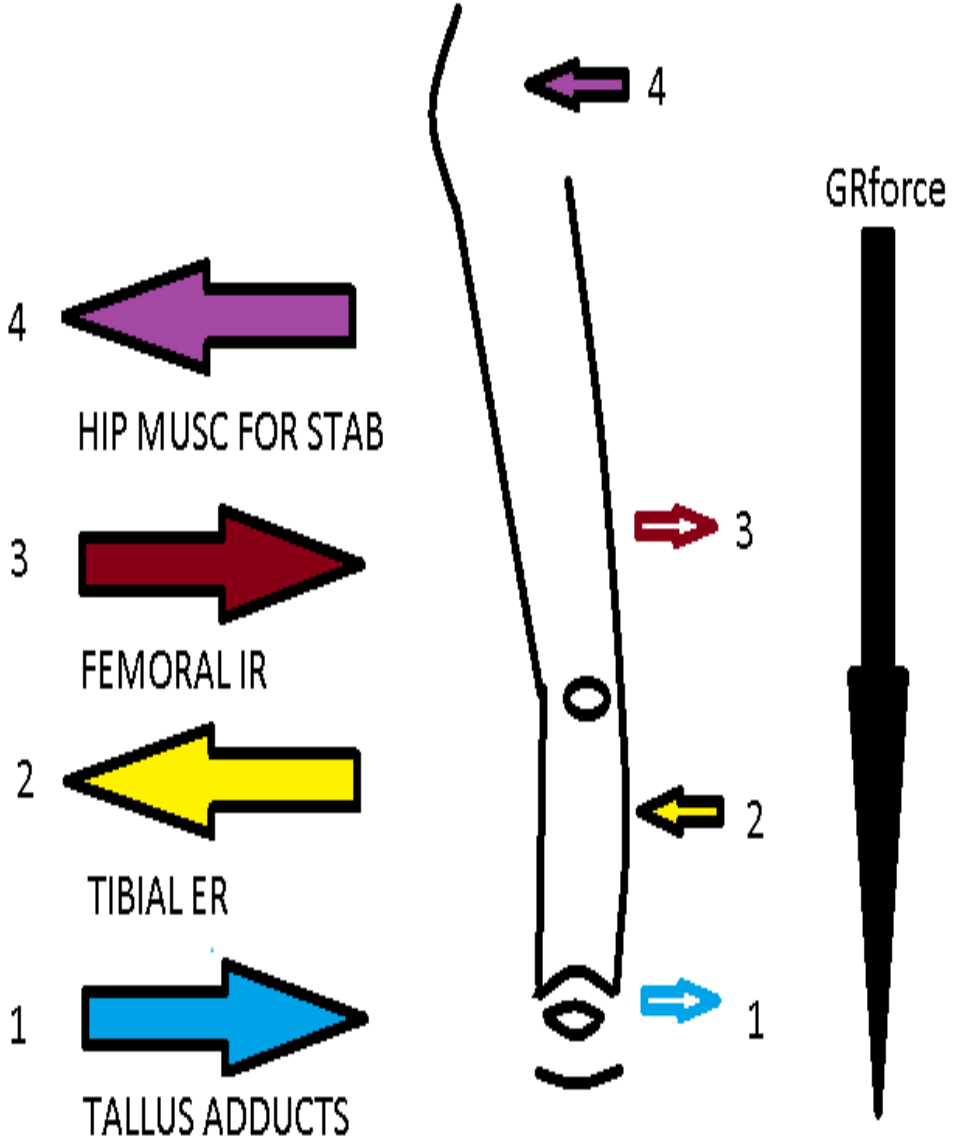
ACL Comorbidities and Return to Sport

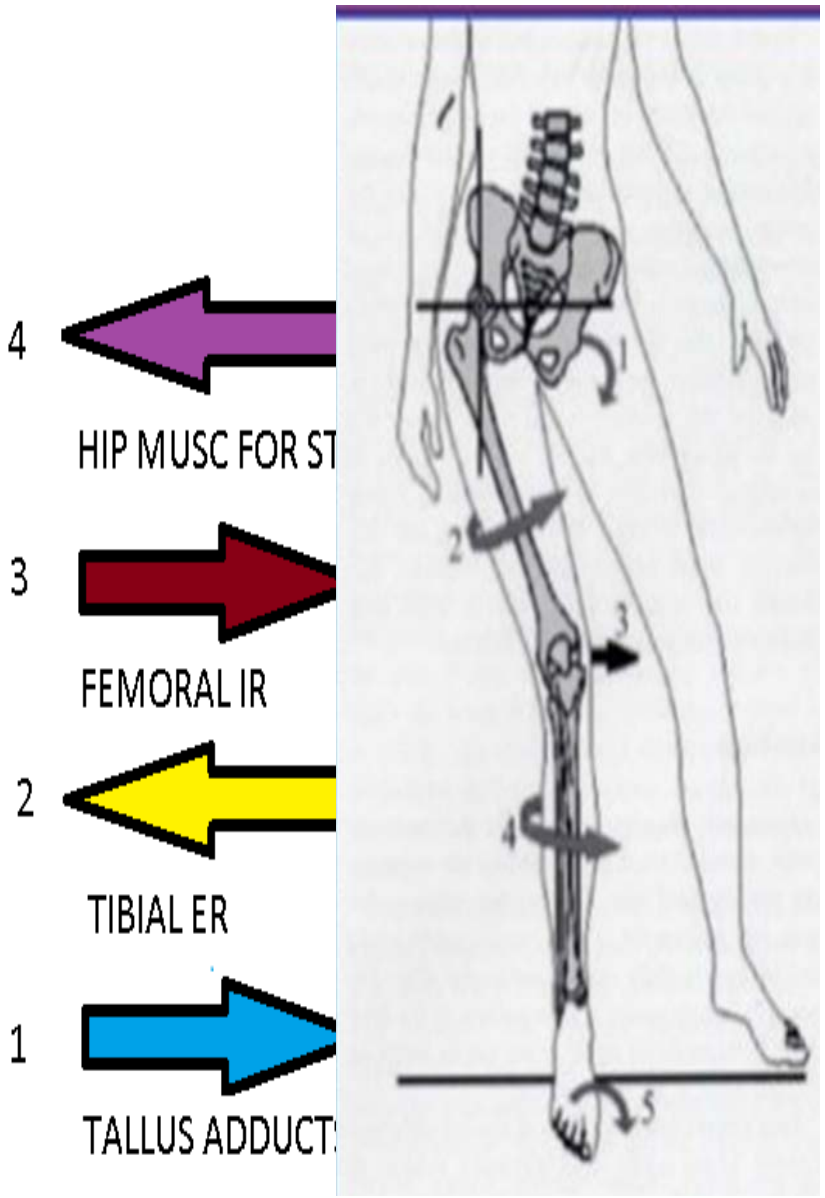
- Risk of re-injury both Contralateral and Ipsilateral
- Risk of Developing PFJ osteoarthritis.
- Return to Sport Re-Injury Risk
- Injury Risk with a 3rd ACLR

Prognosis and Comorbidities

- Surgical Pain
  - Typically 6-8 weeks with full maturation of the bone tunnels.
- Pain
  - Dependent on success with early phases of rehab, graft type, and severity of the initial injury.
- General Function
  - 8-12 weeks
- Running
  - 12-16 weeks
- Return to Sport
  - 16 weeks up to 1 year.
- OA
- Contracture
- Re-Repture

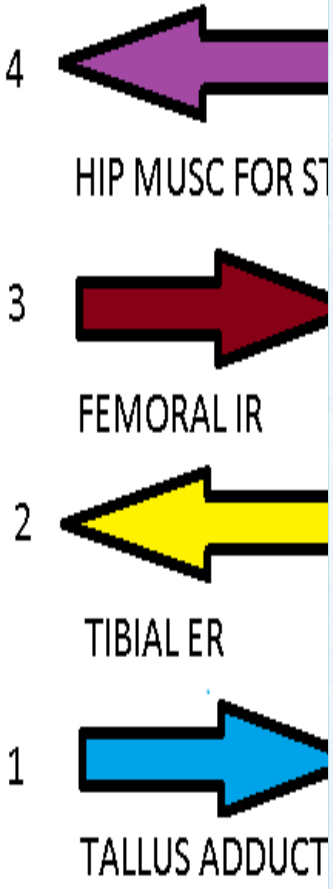
Test/Re-Test withDynamic Valgus

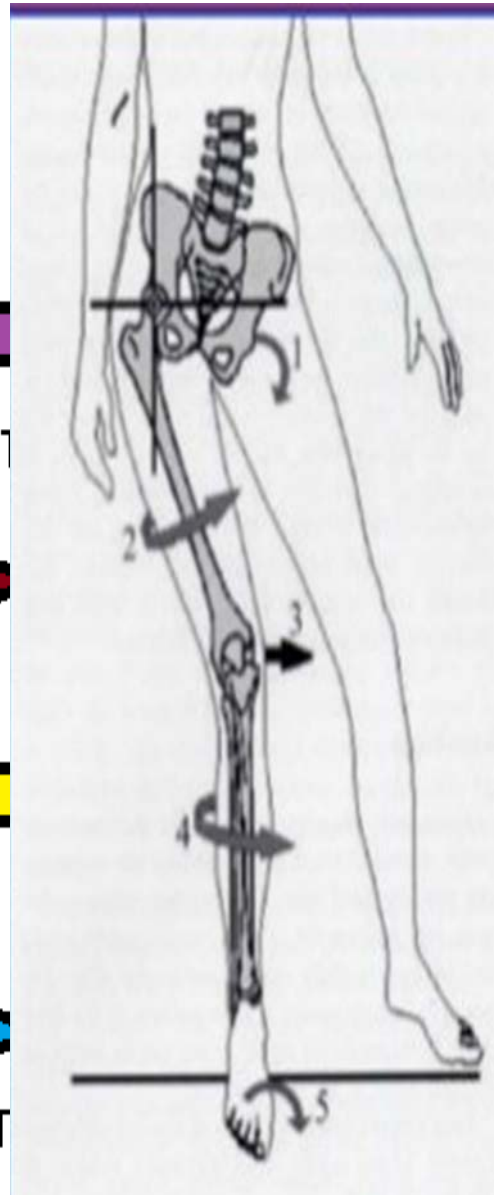




GRforce

Arch Sup
Tape
Contr
Vecto





KT to Enhance Vector 4

Lower Chain Assessment - Correction

Baseline

W/ Arch Support

W/ Arch Support + KT

Rehabilitation Goals

Conservative Management of the Rotator Cuff

Educating your patient Non-Operative

Group 1	Group 2	Group 3
Chronic Full Thickness Tear	Acute Mild Tears Chronic Full thickness Tears	Chronic Mild Tears Tendonopathy
Age >60 Irreparable tears	Age<60	Not Age Dependent
Begin with Conservative Care	Early Surgical Repair	Prolonged non operative care

Treatment Goals for Conservative Care

- Avoidance of Surgery
- Normalization of upper extremity motion at all joints.
  - Scapulohumeral
  - Scapulothoracic
  - Acromioclavicular
  - Cervical Spine
  - Thoracic Spine

Intervention Goals

- Treating Scapular Dyskinesis
- Normalization of Movement
  - SH Rhythm
    - What is tight
    - What is weak

Review of Shoulder Biomechanics

- 2:1 Ratio of GH:Scapula
- Force Couple
- SH Rhythm

Conservative Shoulder Care Treatment

What is Tight?

- Pec Minor
- Subscapularis
- Lat. Dorsi
- Bicep
- Upper Trap
- _____

What is Weak?

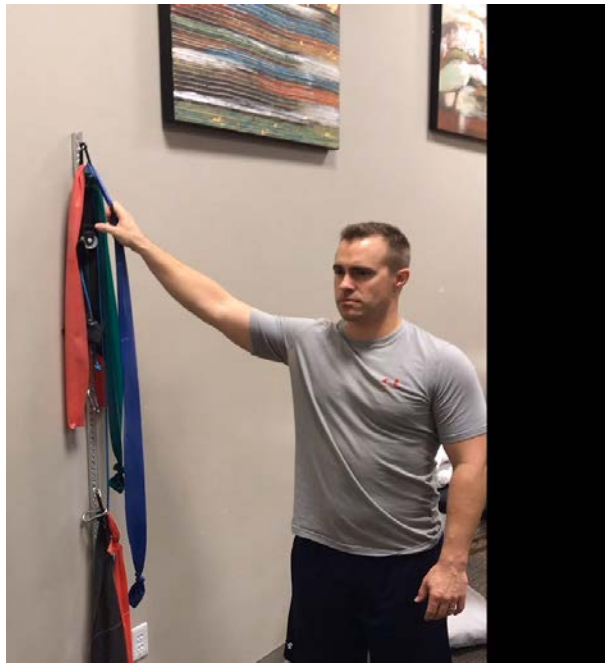
- Rotator Cuff/ER
- Serratus Anterior
- Low Trap
- Mid Trap
- _____

Stretching Tight Muscles (Pec Minor)

Manual

- In Sitting
- Use Theraband if needed.
- DEMO

Exercise



Stretching Tight Muscles (Latissimus Dorsi)

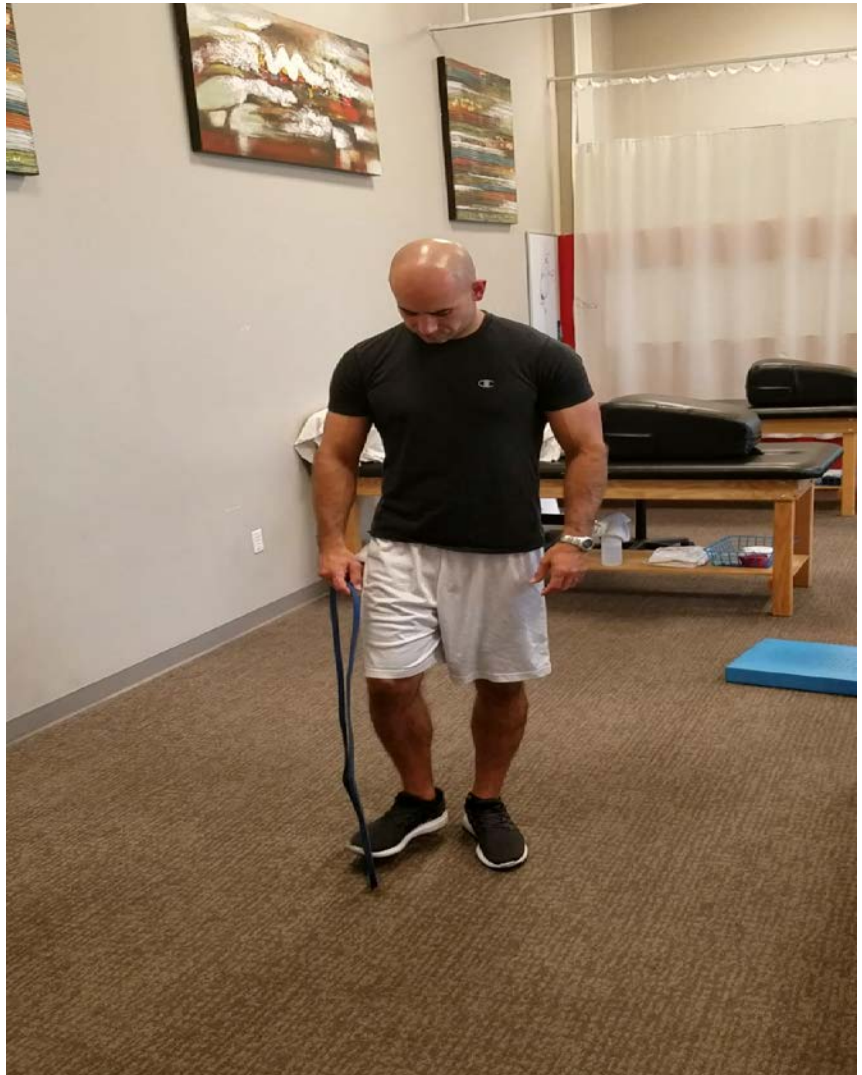
Manual

Stretching Tight Muscles (Sleeper Stretch)

Exercise

Stretching Tight Muscles (Upper Trap)

Manual



Strengthening Weak Muscles (Rotator Cuff)

Manual

Exercise

Strengthening Weak Muscles (Serratus Anterior)

Exercise

Rehabilitation Goals

Advanced Understanding of Rotator Cuff Repair

Common Surgical Techniques

- Arthroscopic, Open, or Combination
- Subacromial Decompression (SAD)
- Distal Clavicle Excision (DCE)
- General Debridement
- Definition of Terms
  - Split
  - Retracted
  - Full thickness Tear
  - Partial Thickness Tear

Histological Implications *(Nikolaidou et al 2016)*

- Acute Phase
  - Inflammatory cells along with platelets and fibroblasts migrate into the repair site during the first week and proliferate over the next 2-3 weeks

- Subacute Phase
  - Initiate Scar Tissue Formation
  - Ehe initial type III collagen formation is slowly replaced by collagen type I, until mature scar tissue is formed. This remodeling process does not reach maximal tensile strength for a minimum of 12-16 weeks post repair.
- Final Phase
  - RC tendon heals to the greater tuberosity *via* fibrocartilage /scar tissue.
    - Normal Histology - the rotator cuff inserts onto the bone through four distinct transition zones: tendon, unmineralized fibrocartilage, mineralized fibrocartilage and bone.
  - After repair, the tendon heals on to the bone with an interposed layer of fibrovascular scar tissue. The mechanical properties of this fibrous tissue are weaker than the native insertion site and may render repairs prone to failure

Aggressive vs Non-aggressive Rehab *(Nikolaidou et al 2016)*

- Aggressive
  - Defined by ROM limitations and plane of movement limitations.
  - Discontinued Sling Sooner
  - Use of CPM in some studies
- Findings
  - No evidence to suggest that aggressive rehabilitation was associated with failure.
  - No evidence to suggest that non-aggressive rehabilitation was associated with adhesion/ROM restriction in long term follow up (up to 9 months)
- Clinical Implications
  - High communication with the surgeon and patient
  - Pain is an indication to stop with ROM activity.

Acute Phase – 0-4 weeks

- PROM only
- Decrease pain
- Protect repair
- Educate patient regarding rotator cuff repair precautions
- Independent with home exercises
- Initiate scapular awareness exercises

Manual Therapy

- ROM
  - Passive Motion beyond patient's internal ability to perform.
  - GH Joint
    - Gentle Oscillation and Distraction (Grade I and II)
  - ST Joint
    - Tilting
    - Caudal and Cephal Glides
  - Thoracic Spine
    - P/A Mobilization Grade III and IV as tolerated
- Soft Tissue
  - Avoid healing incisions unless inspecting the incision site or re-dressing.
- Edema Control
  - Effleurage and lymphatic draining techniques

Therapeutic Exercise – With Skilled Emphasis

- Increase Passive Range of Motion in all planes
  - Isolate and identify points of restriction above and below the shoulder.
    - Common Adjacent Deficits
      - Loss of Thoracic Spine Extension
      - Scapulothoracic retraction and glide
      - Cervical spine with UT overuse
      - Epicondylitis (lateral and medial)
  - Prescribe exercise while taking into account:
    - Gravitational assistance
    - Ease of Reproduction
    - Dual Purpose Activity
      - i.e. core and PROM at the same time
    - Match the patient's goals and PLOF-providing provisions to the most mundane activities.

OVERSIMPLIFICATION SLIDE

- Improve Posture via Core
- Improve Scapular Awareness via multi-positional manual therapy and therex.
  - Per previous videos

Sub Acute Phase (2-8 weeks)

- Goals
  - Obtain full pain free PROM
  - Initiate strength training via isometrics and AAROM
  - Progress exercise and manual therapy to adjacent structures consistent with the patient's goals.
  - Awareness of upper trapezius substitution pattern
  - Avoid abnormal scapular substitution patterns with initiation of active motion
    - Scaption vs Sagital Plane vs Supine

Manual Therapy

- Scar mobilization once the most superficial healing occurs.
  - Avoid cross friction initially, move in parallel to the incision
  - HEP to desensitize and self mobilize.
    - Use cryotherapy to assist
- GH Mobility
  - Inferior and posterior glide to the tibia in scaption/open pack position
- ST Mobility
  - Assertive mobilization of the Scapula inferior, superior and into retraction.
- Symptom Management –local and global
  - DDN, KT, Soft tissue mobilization, scraping (“A-stym”), MF decompression (cupping)

OVERSIMPLIFICATION SLIDE

- Quality of Movement and NM – Re-education is essential
- Adjacent structures require as much attention as the shoulder joint

Scapulo-Thoracic Range of Motion

8-16 Weeks (Progressive Resisted Exercises)

- Goals
  - Full active range of motion in all planes
  - PREs all planes.
  - Minimal to no shoulder pain with normal functional tasks.
  - Improved rotator cuff and scapulothoracic strength.
  - Normal scapulohumeral rhythm with active motions.
  - Functional Tests and Predictive Variables.

Manual Therapy

- Restore or facilitate appropriate movement.
- In order to communicate and progress care at the highest level, manual therapy must occur at each appointment.
  - Identify areas of motion deficiency
    - DDN to Trigger Points (TPs)
    - Scraping, Deep Tissue Massage and MF decompression to areas of fibrosis
    - End Range Passive Motion.
  - Identify areas of strength deficiency
    - KT – To Scapula, Deltoid, Cervical Spine, Elbow
    - DDN to TPs
    - Manual Resistive Exercise (MRE) or Proprioceptive Neuromuscular Facilitation (PNF)

Joint Mobilization

Prognosis and Comorbidities

- Surgical Pain
  - Typically 6-8 weeks with full maturation of the bone tunnels.
- Pain
  - Dependent on success with early phases of rehab, chronic or acute injury, and severity of the initial injury.
- General Function
  - 8-12 weeks
- Pain Free Exercise
  - 12-16 weeks
- Return to Sport
  - 16 weeks up to 1 year.
- OA
- Contracture/Frozen Shoulder
- Re-Occurrence

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