The MedFit Classroom
Orthopedic Fitness Specialist Course

Module 5: The Knee

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Learning Objectives

Lesson 1

- Skeletal structures
- Non-contractile structures
- Muscles

Lesson 2

- Injuries, Aches & Pains
  - PFPS
    - Rafael Escamilla, Ph.D. Interview
  - PCL
  - ACL
    - Tim Hewett, Ph.D. Interview
  - Meniscus
  - Arthritis
- Pre- and Post-Rehab exercises

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Lesson 1: Skeletal Structures

Femur

- **Head, Neck, Shaft**
- **Greater & Lesser Trochanters**
- **Condyles - medial > lateral**
  - **Intercondylar notch/fossa**
  - **Posterior notch between condyles**
- **Patellar groove (anterior)**

aka intercondylar groove, patellar sulcus, patellofemoral groove, femoropatellar groove, femoral groove, femoral sulcus, trochlear groove of femur, trochlear sulcus of femur, trochlear surface of femur, or trochlea (of femur)

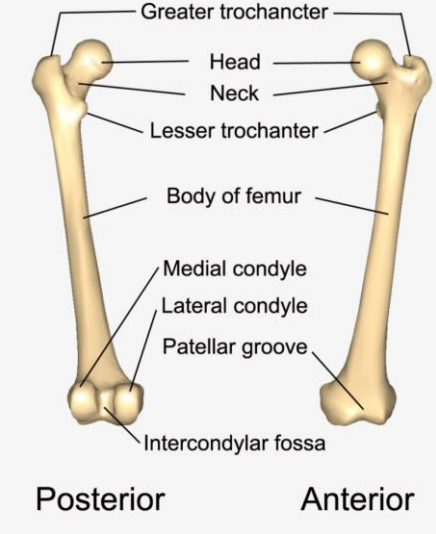

Image: NicePNG
Image: boneandspine.com

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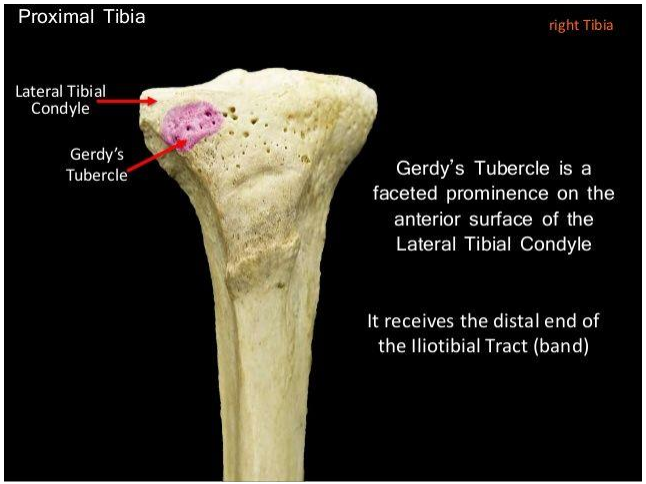
Skeletal Structures

Tibia

Tibial plateaus - medial > lateral

Tibial tuberosity - insertion of patellar tendon

Gerdy's tubercle - 2–3 cm lateral to the tibial tubercle on the proximal tibia



Fibula

Image: pinterest.co.uk

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The Patella

- Sesamoid
- Facets - lateral>medial
  - With increasing knee flexion, contact pressure moves proximally
- Medial patellofemoral ligament (MPFL)
  - Prevents lateral shift a la subluxation
- Slide, tilt, rotate, shift
  - With increasing flexion, patella slides distally
  - Tilt, rotation, and shift could be structural or functional

Patellofemoral Forces

Compressive, Shear (and Impulse, which takes time into account)

- Elliptical - 2.2 BW
- Walking - 2.5 - 3.5 BW
- Rowing - 0.8 BW
- Cycling - 0.4 - 1.3 BW

MO Ericson, R Nisell, Phys Ther. 1987 Sept;67(9):1365-1369

Kevin Wilk, from “Keeping Knee OA Patients Active”, LER/Run the World webinar Oct. 27, 2021

3 Mal-alignments

https://quizlet.com/327325011/knee-flash-cards/

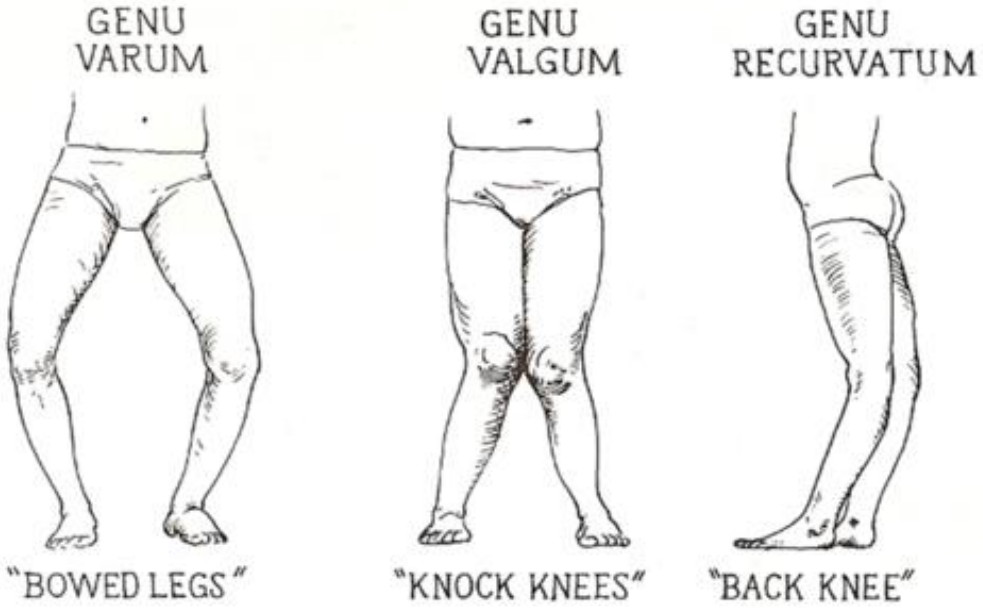

Fig. 2. Common types of knee deformity.

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Knee Alignment

- Genu recurvatum (hyperextended: anterior slope)
- Genu Valgum (knock-kneed: medial slope)
- Genu Varus (bow-legged: lateral slope)
- Windswept (one genu varus, the other genu valgum)

Leg Length Discrepancies (LLD)

- True vs Apparent or Functional
- > 1 cm MIGHT be worthy of consideration
- >3 cm worth treating with lift

K. Wilk, LER/Run the World Virtual, 2021

I Rubenstein, Ph.D. Dissertation, 1988

Non-Contractile Structures

Passive, support, motion-limiting, stabilizing, proprioceptive

Image: knee-pain-explained.com

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Retinaculum

Connective tissue wrapping entire knee

Supportive, proprioceptive, insertional

Pain-sensitive?

“… no pain with palpation of the patellofemoral joint, while probing of the anterior fat pad and anterior joint capsule was exquisitely painful.”

Christina Ward, M.D. HISTORY OF SELF-EXPERIMENTATION IN ORTHOPAEDICS. Iowa Orthop J. 2009; 29: 127–129.

Image: physio-pedia.com

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Meniscus (Menisci)

Cartilaginous ‘washers’ - deepening the concavity for the condyles, low-friction cushioning

- Thicker on perimeter, thinner toward center
- Laminated, can delaminate with age, movement
- Little to no vascularization after adolescent growth; poor healing qualities

Image: knee-pain-explained.com

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Ligaments

Thick connective tissues, provide passive restraint to excessive movement, provide proprioceptive feedback to the muscles as they reach terminus

Anterior cruciate (ACL)

Posterior cruciate (PCL)

Medial collateral (MCL)

Lateral collateral (LCL)

Image: stanfordhealthcare.org

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Contractile Structures: Quadriceps

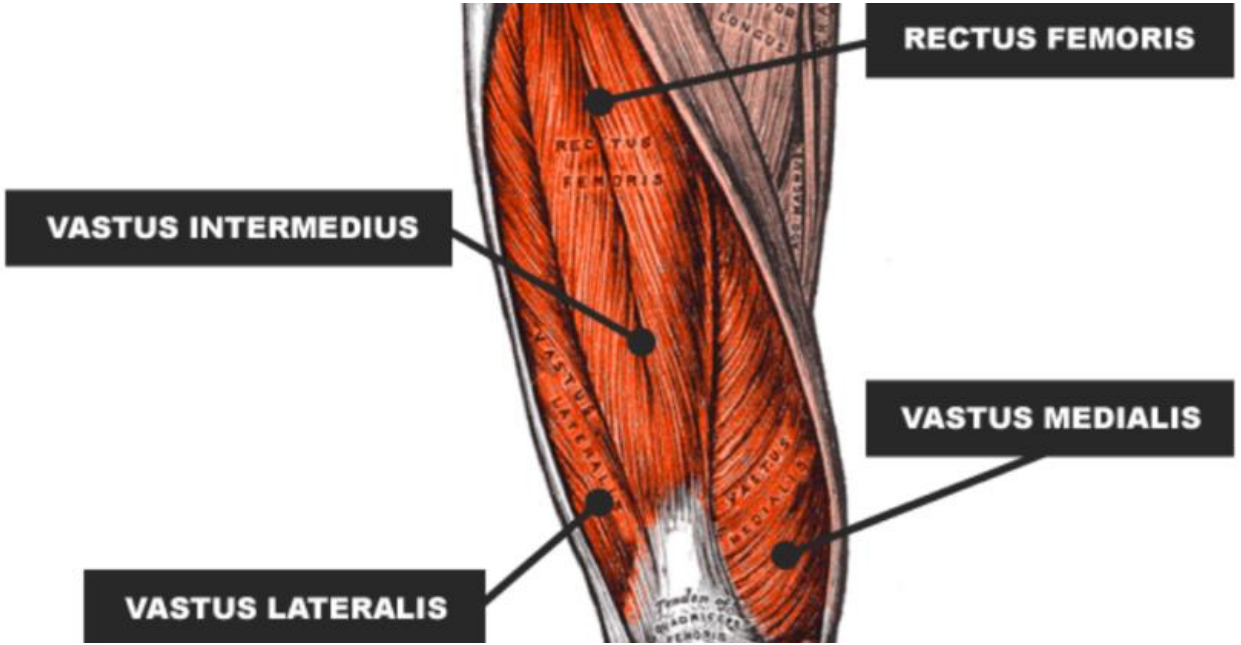

Image: buffscrolls.com

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Muscles of the Anterior Knee

Quadriceps

Rectus femoris

- Origin: Anterior Inferior Iliac Spine
- Insertion: Tibial tuberosity via the quadriceps tendon, past the patella, via patellar tendon
- Actions: Hip flexion, knee extension

Vastus intermedius

- Origin: anterior and lateral upper two-thirds of femur
- Insertion: deepest portion of quad tendon
- Action: knee extension

Vastus Medialis

- Two segments: longitudinal (medialis longus: VML) and oblique (VMO: ~ 55 degrees)
- VML extends the knee
- VMO medially-aligns the patella
- Firing latency thought to contribute to PFPS
- Historically, was thought to be trainable separately from the muscle as a whole or the other quadriceps muscles
  - Evidence is insufficient

Can You Isolate the VMO?

Lachlan, Webster, McClellan, and Cook (2015)

"Atrophy of all portions of the quadriceps muscles is present in the affected limb of people with unilateral PFP. There was no atrophy of the quadriceps in individuals with PFP compared to those without pathology. Selective atrophy of the VMO relative to the vastus lateralis was **not** identified in people with PFP."

Cheap, Lee, Jun, An, and Chang (2020)

"The thickness of the RF, VL, VM, and VMO muscles increased after OKCE, and the thickness of the VI muscle showed the greatest increase with a medium-large effect size… The thickness of the VI, VL, VM, and VMO muscles increased after CKCE, and the **VMO** muscle had the largest effect size."

Muscles of Antero-Lateral Knee

Vastus lateralis

Origin: upper part of the intertrochanteric line; the lower, anterior borders of the greater trochanter, to the outer border of the gluteal tuberosity, and the upper half of the outer border of the linea aspera (a posterior ridge of the femur, also the insertion of the deeper fibers of the gluteus maximus) (Wikipedia)

Insertion: lateral aspect of quad tendon, subsequently to patellar tendon

Actions: knee extension with a lateral pull of the patella

Ilio-Tibial Band

Origin: TFL

Insertions: 2-3 cm lateral to tibial tubercle (Gerdy's), lateral retinaculum

Actions: postural, flexes and extends at end ROMs

Muscles of Posterior Knee

Hamstrings

Biceps Femoris - lateral (2-joint muscles, laterally rotate femur)

Semitendinosis - medial (medial rotation moment)

Semimembranosis - medial

Gastrocnemius - 2 joint

Medial - rotates tibia medially, femur laterally

Lateral - rotates tibia laterally, femur medially

Muscles of the Deep Posterior Knee

Popliteus

- Medial rotator of tibia/lateral rotator of femur when fixed, acting eccentrically
- Unlocks knee from full extension

Plantaris (longest tendon?)

- Weak knee flexor, assists in ankle plantar flexion

Spotlight on Hip Abductors

- Gluteus medius, Gluteus minimus, Gluteus Maximus
- Patello-femoral alignment - ECCENTRICALLY
  - PFPS, ACL, Meniscus injury
- Gait - dynamic valgus
- Neuromotor synergy with quadriceps, especially VMO

Lesson 2: Injuries, Aches & Pains

Anterior Knee Pain/PFPS

- Chondromalacia
- Fat pad inflammation
- Runners knee
- Jumpers knee
- Synovial plica syndrome
- ITB syndrome

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PFPS Symptoms

- Anterior knee pain
- Clicking, clunking, popping sensation in loading activities such as squatting, going up steps
- Painful descending hills, steps
- Pain sitting for long periods - e.g. the Movie Sign
- Effusion around patella
- Tenderness to touch

PYF Lee et al. Sure J (NY). 2017

Managing PFPS

- Quad strengthening and stretching
- Hamstring stretching
- ITB stretching
- Gluteus medius activation, endurance, strength
- Gait mechanics
- Landing mechanics
- Avoid aggravating activities (cycle crank arm length)

Vicensino et al. *J Orthop Sports Phys Ther 2022;52(1):29–39. doi:10.2519/jospt.2022.10647*

Rick Schultz, A perfect bike fit starts with the correct crank arm length. LER Jan. 2022.

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Not All PFPS Is What It Seems

Conclusion: Femoral anteversion had highest correlation to swing-phase and early stance hip adduction in female runners

“gluteus medius activation was **not predictive** of stance phase hip adduction for both men and women combined… the correlation between gluteus medius activation and peak hip adduction during stance approached statistical significance in the female group (P = 0.06). It is possible that statistical significance could have been achieved with a larger sample size. Although the current results would appear to call into question the importance of gluteus medius activation in relation to hip adduction, a previous study has provided evidence that activation of the tensor fasciae latae may be contributory.”

Liu, Lewton, Colletti, Powers. Hip Adduction during Running: Influence of Sex, Hip Abductor Strength and

PFPS Focused Exercises

- 20 females with and without PFP
- 5 exercises for VMO, VL, Gmed, Gmax - single-leg squat (SLS), lateral step down (LSD), step-up, step-down, lunge
- PFP - SLS and step-ups with less glute activity; greater VMO for all others
- Similar quad activation but “greater discrepancies …in gluteal activation” for PFP
- LSD and step-ups work glutes best; SLS works all 4

Glaviano, NR and Saliba, S. Differences in gluteal and quadriceps muscle activation during weight-bearing exercises between female subjects with and without patellofemoral pain. *JSCR* 36(1): 55–62, 2022

To Lunge or Not to Lunge….

A study that quantified patellofemoral force and stress in a forward and side lunge, at floor- and 10 cm-levels, found greater PF force and stress at:

- Lower knee angles (0-30 deg) for forward lunge
- Higher knee angles (40-100 deg) for side lunge
- Mid-range knee angles (40-60 deg) at ground level vs with the main leg elevated 10 cm

Escamilla R, Zheng N, MacLeod TD, Imamura R, Will KE, Wang SC, Rubenstein I, Yamshiro K, Fleisig GS. Patellofemoral Joint Loading During the Performance of the Forward and Side Lunge with Step Height Variations. IJSPT. 2022;17(2):174-184.

Why the Deep Lunge Works

“Injury risk to the patellofemoral joint may not increase with knee angles between 70-100° or greater due to similar magnitudes in patellofemoral joint stress during these knee angles, with the benefit of increased quadriceps, hamstrings, and gastrocnemius activity when training at higher knee angles 70° - 100° or higher compared to lower knee angles between 0°-60°”

Escamilla R, Zheng N, MacLeod TD, Imamura R, Will KE, Wang SC, Rubenstein I, Yamshiro K, Fleisig GS. Patellofemoral Joint Loading During the Performance of the Forward and Side Lunge with Step Height Variations. IJSPT. 2022;17(2):174-184.

Gait Training for PFPS

- Shifting their initial ground contact forces toward the anterior foot, toward a forefoot strike pattern
- Shortening the stride length, increased step rate, more supination
- Reducing ground contact duration and loading, less pronation

“Verbally directed compliant running significantly decreased (17%) vertical ground reaction force impact peaks…”

Barefoot or Minimalist Shoes?

E Doyle, TLA Doyle, J Bonacci, JT Fuller. The Effectiveness of Gait Retraining on Running Kinematics, Kinetics, Performance, Pain, and Injury in Distance Runners: A Systematic Review With Meta-analysis. *JOSPT* Feb. 5, 2022. Pg. 1-44. https://www.jospt.org/doi/10.2519/jospt.2022.10585

Ó Catháin, CP, Richter, C, and Moran, K. Can directed compliant running reduce the magnitude of variables associated with the development of running injuries? J Strength Cond Res 36(3): 772–780, 2022

Rafael Escamilla, Ph.D. PT, CSCS, FACSM

- Ph.D. Degree in Biomechanics from Auburn University, 1995
- Professor of Physical Therapy and Director of the Biomechanics Laboratory at California State University, Sacramento
- Research Coordinator at Results Physical Therapy and Training Center, Sacramento
- served as Director of Research at the Andrews Institute in FL, Professor of Orthopaedic Surgery at Duke University Medical Center in Durham, NC, Director of the Michael W. Krzyzewski Human Performance Laboratory at Duke University
- taught in the Doctor of Physical Therapy program at Duke University
- published >200 peer reviewed scientific papers, abstracts, and book chapters in biomechanics, physical therapy, and sports medicine-related journals and textbooks.
- 2014-2015 - chosen the outstanding researcher for the College of Health and Human Services at California State University, Sacramento

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Interview with Dr. Escamilla

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Exercise Options for PFPS

Straight leg raises (SLR)
Squat, Lunge, Reverse Lunge, Step ups
Eccentric step downs
Resisted Reverse Walking (at high loads for quads)
Angled decline squat
Monster/Lateral Band walking
Bridges, 1-leg Bridges
Side-lying abduction
Clam shells - external, internal rotations

To Adduct or Not to Adduct?

YEA

H-T Peng,TW Kernozek, C-Y Song. Muscle activation of vastus medialis obliquus and vastus lateralis during a dynamic leg press exercise with and without isometric hip adduction. Phys Ther Sport. 2013 Feb;14(1):44-9. doi: 10.1016/j.ptsp.2012.02.006. Epub 2012 Jun 26.

KRR Coquiero, D Bevilaqua-Grossi, F Berzin, AB Soares, C Candolo, V Candolo, V Monteiro-Pedro. Analysis on the activation of the VMO and VLL muscles during semisquat exercises with and without hip adduction in individuals with patellofemoral pain syndrome. *J Electromyogr Kinesiol.* 2005 Dec;15(6):596-603. doi: 10.1016/j.jelekin.2005.03.001.

“Although there was no preferential VMO muscle activation, the association of hip adduction with squat exercise promoted a greater balance between the medial and lateral portions of the quadriceps femoris muscle and could be indicated for the conservatory treatment of PFPS patients.” Coquiero et al.

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To Adduct or Not to Adduct?

NAY

G M Karst, P D Jewett. Electromyographic analysis of exercises proposed for differential activation of medial and lateral quadriceps femoris muscle components. Phys Ther. 1993 May;73(5):286-95; discussion 295-9. doi: 10.1093/ptj/73.5.286.

J Laprade, Culham E, Brouwer B. Comparison of five isometric exercises in the recruitment of the vastus medialis oblique in persons with and without patellofemoral pain syndrome. Orthop Sports Phys Ther. 1998 Mar;27(3):197-204.

J Hertel, J E Earl, K K W Tsang, S J Miller. Combining isometric knee extension exercises with hip adduction or abduction does not increase quadriceps EMG activity. Br J Sports Med. 2004 Apr;38(2):210-3. doi: 10.1136/bjsm.2002.003277.

Boram Choi 1, Minhee Kim, Hye-Seon Jeon. The effects of an isometric knee extension with hip adduction (KEWHA) exercise on selective VMO muscle strengthening. J Electromyogr Kinesiol. 2011 Dec;21(6):1011-6. doi: 10.1016/j.jelekin.2011.08.008. Epub 2011 Sep 16. JElectromyogr Kinesiol. 2011 Dec;21(6):1011-6. doi: 10.1016/j.jelekin.2011.08.008. Epub 2011 Sep 16.

“Uniplanar knee extension exercises may be more appropriate than combining isometric knee extension exercises with hip adduction or abduction when eliciting maximal VMO and VL contractions.” Hertel et al.

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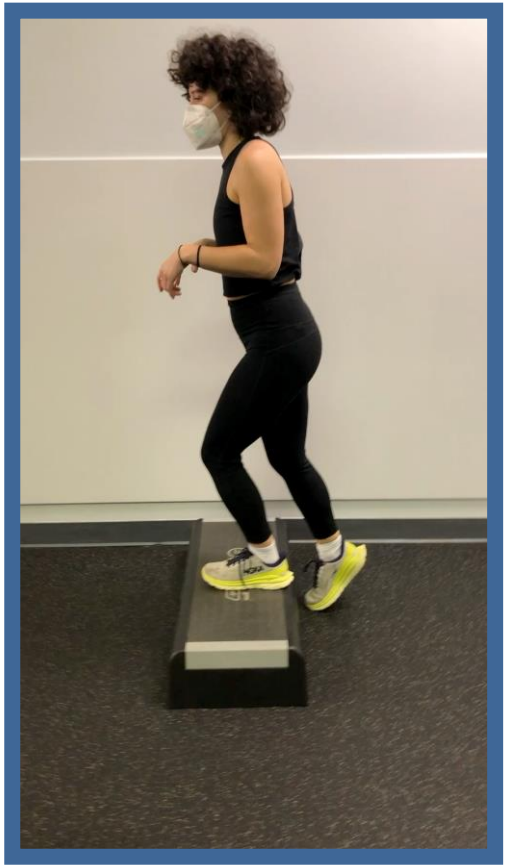
PFPS Exercise Videos

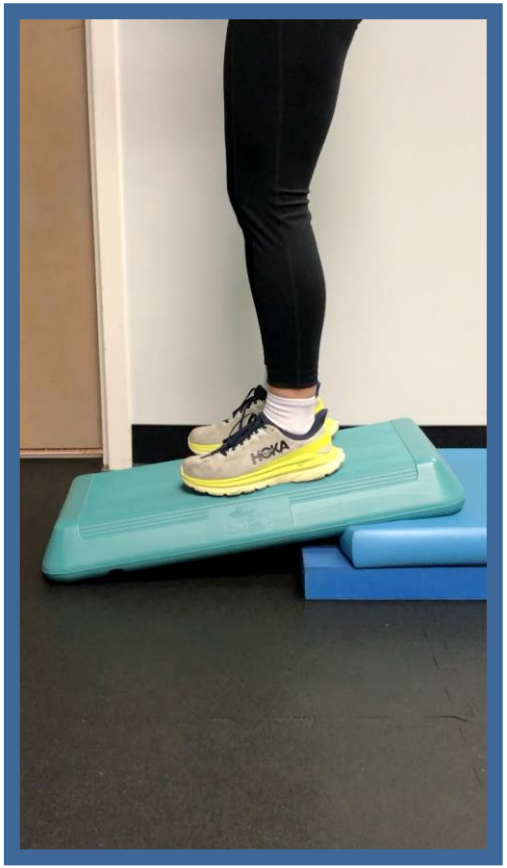
- Flexed-hip step up
- Eccentric step down
- 45 deg decline squat
- Flexed-hip Lunge, biased loading
- APT lateral walk/shuffle
- Internal rotation clams
- Capt. Morgans

Step Ups



Step Downs

Decline Squats



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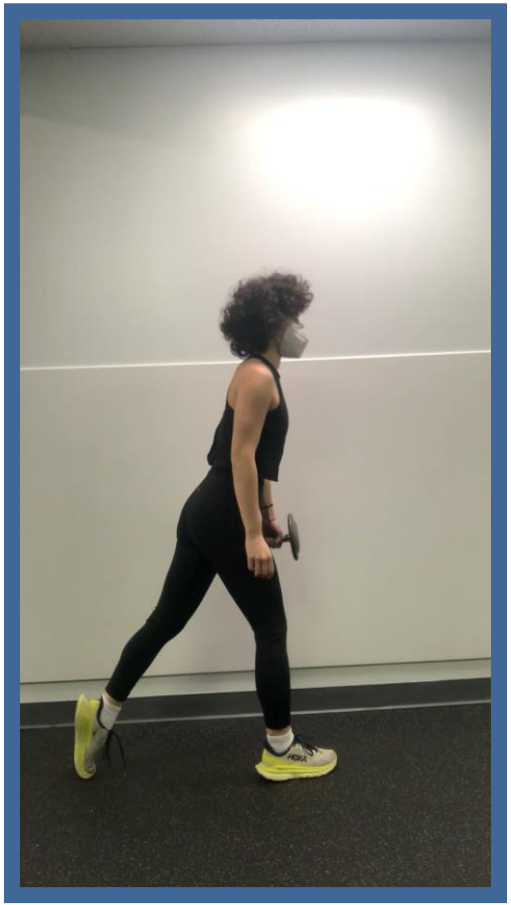
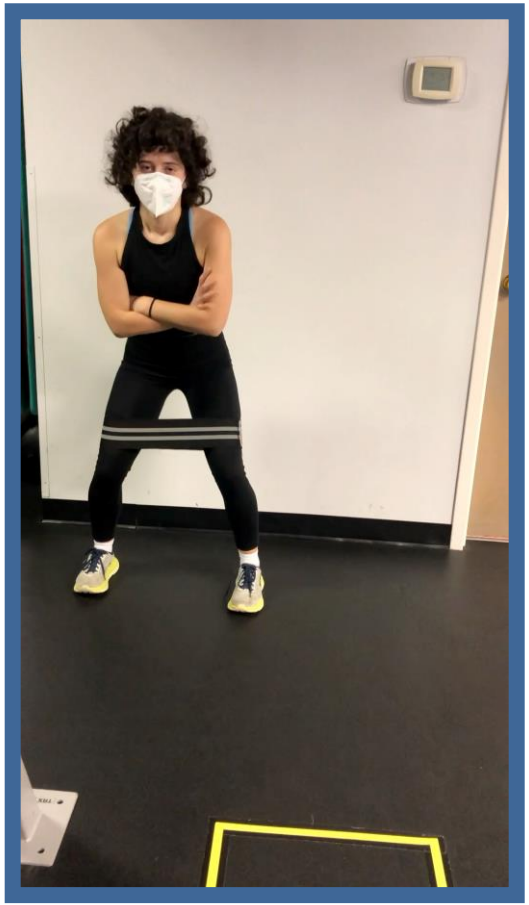
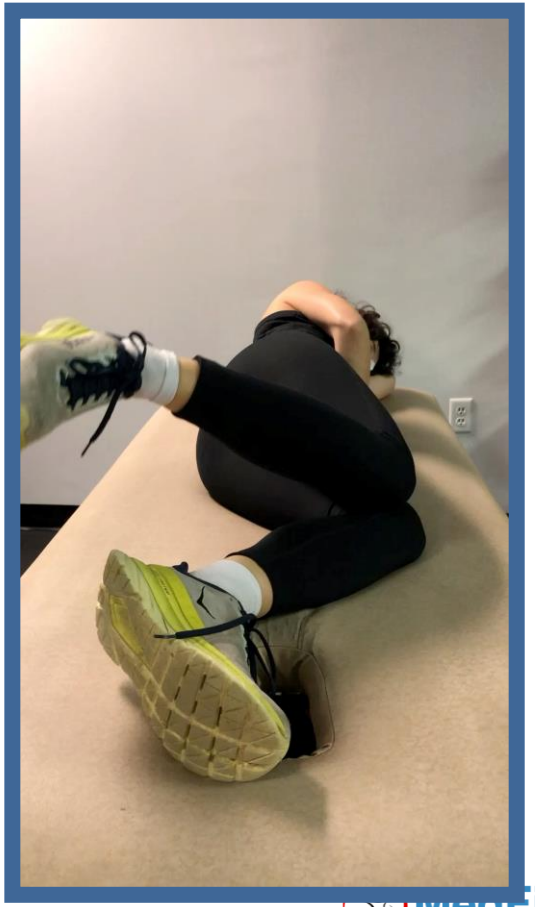
Unstable Lunge



Lateral Band Walk



Reverse Clam Shell



Capt. Morgans

Rotate against the wall to activate leg Gmed

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CKC vs OKC

- Knee extensions vs squats, lunges, step ups, leg presses
- OKC - patellar glide through the arc of motion creates shear toward extension, compression at the start
- CKC - engage the hamstrings in co-contraction with the quadriceps; engage the VMO at full extension; minimize patellofemoral forces through the arc of motion; engage core if upright

“…joint moment production among synergistic and antagonistic muscles remains constant as external load increases.”

Kipp, K, Kim, H, and Wolf, WI. Muscle-specific contributions to lower extremity net joint moments while squatting with different external loads. JSCR 2022; 36(2): 324–331

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BFR/Kaatsu

- Cuff at upper thigh
- 1.3 x resting systolic pressure
- Lower resistance, very high reps (30-15-15)
- Benefits match heavier loading for hypertrophy, not strength or power
- Excellent for deconditioned, post-injury, post-surgery (once wound is healed), muscle activation and endurance

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BFR Set Up

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PCL Injuries

Hyper-flexion events

- Dashboard impact
- Kneeling collisions - football, soccer, wrestling

Not necessarily as debilitating; quad strength can compensate

ACL Injuries

The Unhappy, or O'Donoghue's, Triad (ACL, MCL, Medial Meniscus)

Mechanisms of an ACL Injury

75% non-contact: Cut-and-Plant

Foot plant - changes of direction or deceleration

Knee goes into dynamic valgus, hip adducts, knee abducts, torso leans laterally away from landing foot

- Quadriceps dominance
- Internal hip rotation
- External tibial rotation
- Excessive posterior shear of femur on tibia

Horrific Videos of ACL Injuries

From Cincy SportsMed and Sportsmetrics, March 16, 2015.https://www.youtube.com/watch?v=mTN7ygT3-U8

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Tim Hewett, Ph.D.

- Received an Endowed Professorship from Mayo Clinic as a “pioneering researcher, expert team builder, and collaborative leader”
- Former Director of the Sports Medicine Research Center, the Biomechanics Laboratories and the Materials and Structural Testing Core at Mayo Clinic, the Sports Health & Performance Institute at Ohio State University
- Former Professor and Director of Sports Medicine Research at OSU
- Former Professor and Director of the Sports Medicine Biodynamics Center at Cincinnati Children's Hospital
- International lecturer, including Grand Rounds at Harvard, Stanford and Yale Universities
- Published over 400 peer- reviewed articles with 50,000+ citations
- Recipient of numerous awards for “Paper of the Year” of multiple journals.

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Interview with Tim Hewett, Ph.D.

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Return to Play?

- Jerry Rice, San Francisco 49ers receiver, tore ACL in week 1 of the 1997 season; had bone-patella tendon-bone repair; RTP in week 16 and fractured patella on a touchdown reception
- 3-7 x greater risk of re-injury if return before **9 months**; those who waited 12 (+/-4.8) months did not have a re-injury
- Most of those re-injured had not achieved symmetry (10% difference)
    - Range from 98% to 114% for healthy, uninjured
    - After 7 months, ACLR were comparable to healthy, uninjured

“No associations between sustaining a subsequent ACL injury and achieving symmetrical muscle function or quadriceps strength.”

S Beischer, L Gustavsson, EH Senorski, J Karlsson, C Thomee, K Samuelsson, R Thomee. Young athletes who return to sport before 9 months after anterior cruciate ligament reconstruction have a rate of new injury 7 times that of the those who delay return. JOSPT 2020. 50(2): 83-90

Pre-Hab and Post-Rehab ACL-Appropriate Exercises

CKC>OKC for quads especially

- Gluteals (max and med, Flexed hip lunge)
- Hamstrings, high-load eccentrics (Nordic)
- Adductors (Copenhagen adductors)
- Core, especially lateral core
  - 40%-60% in standing vs machine CKC

Proprioception/Reaction drills

Gait, especially cutting, decelerating

Plyometrics

ACL Exercise Videos

- Squats/Unilateral Squats

"Considering the effectiveness of bilateral squats, a neuromotor learning strategy to facilitate quadriceps activation does not seem to be necessary."

- Nordic hamstring curls
- Rebound tosses on labile surface
- Decelerations

Jean, LMY, Gross, DP, and Chiu, LZF. Knee extensor strength in anterior cruciate ligament-deficient individuals following normal and modified squats: a randomized controlled trial. *JSCR* 36(1): 47–54, 2022

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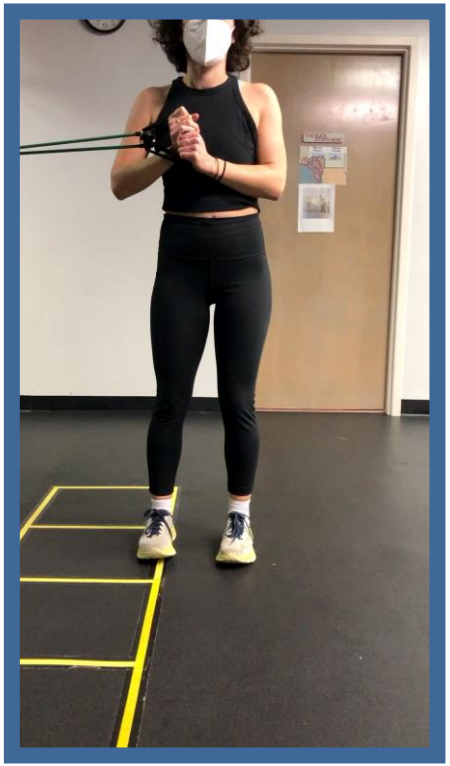
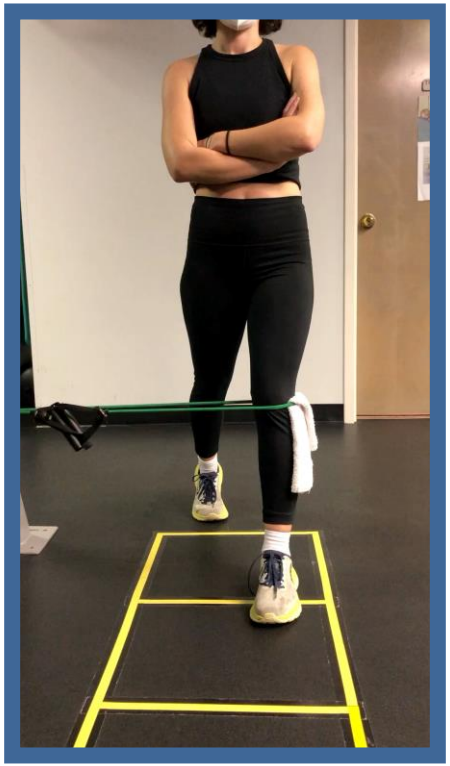
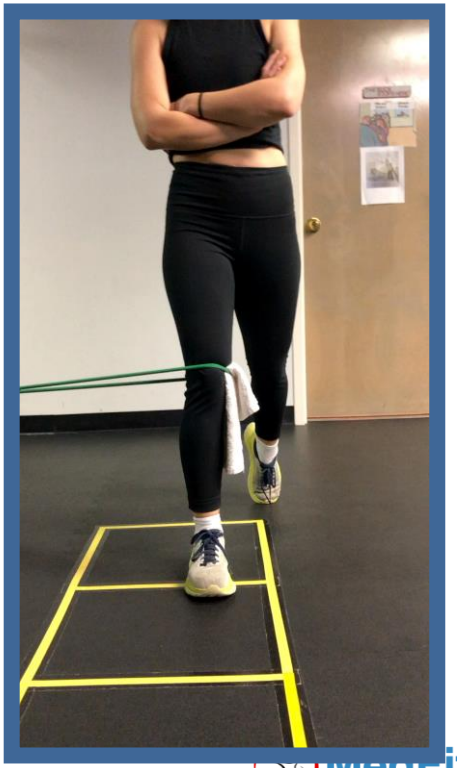
Flexed-Hip Lunge, Biased Loading

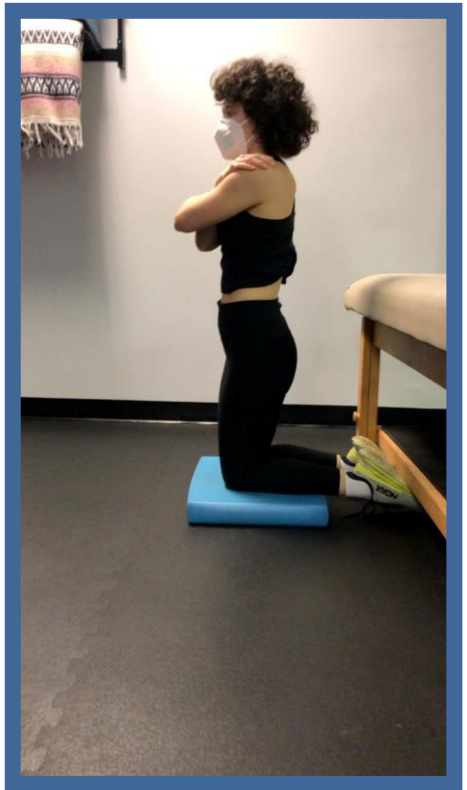






ACL Pre-Hab Exercises

Nordic Hamstring



Copenhagen Adduction

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Step-Ups: Traditional vs Flexed Hip

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Static Standing Proprioception

Active Standing Proprioception

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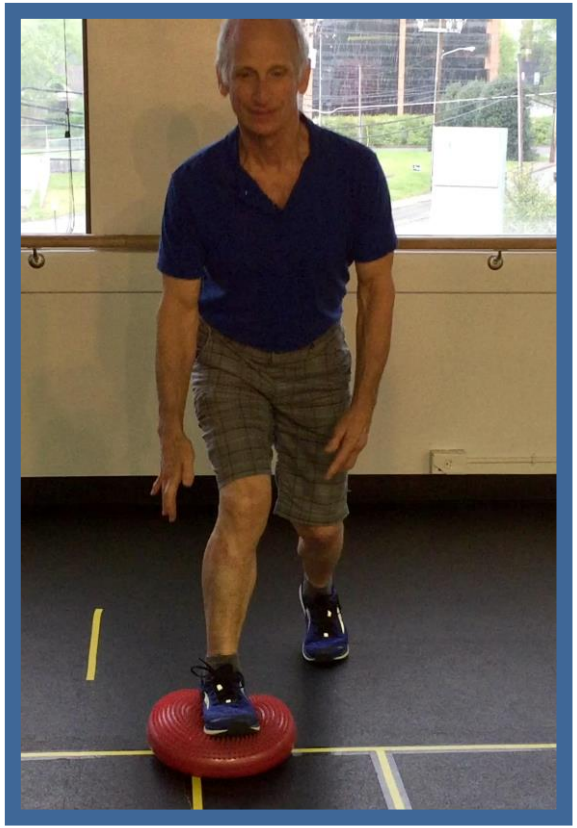
Unstable Split Squat



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The Single-leg Squat

Vertical Spine vs Flexed-Hip

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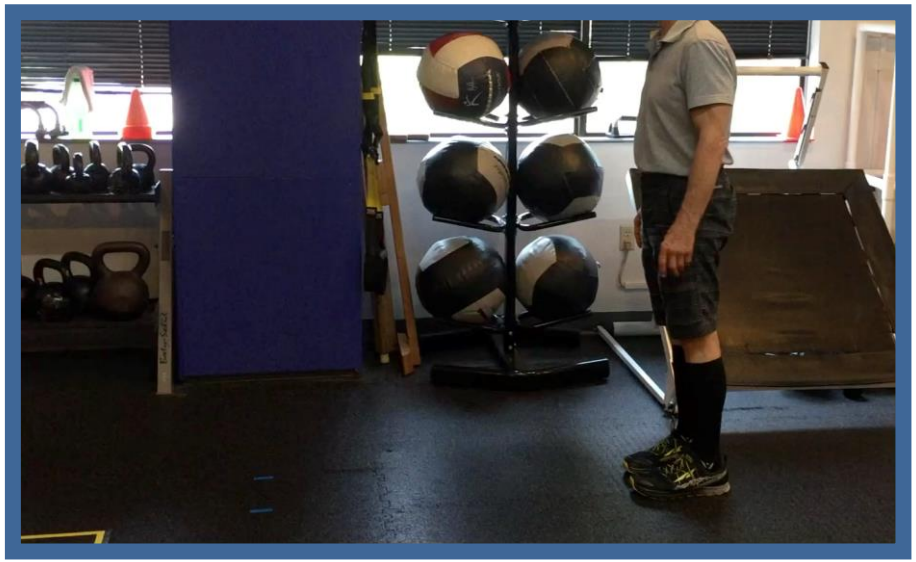
Deceleration Exercises

Walking Lunge



Multi-Directional Clock Lunge

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Deceleration + Balance

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Meniscus Tears

4 Main Types: bucket handle, flap, radial (vertical), degenerative

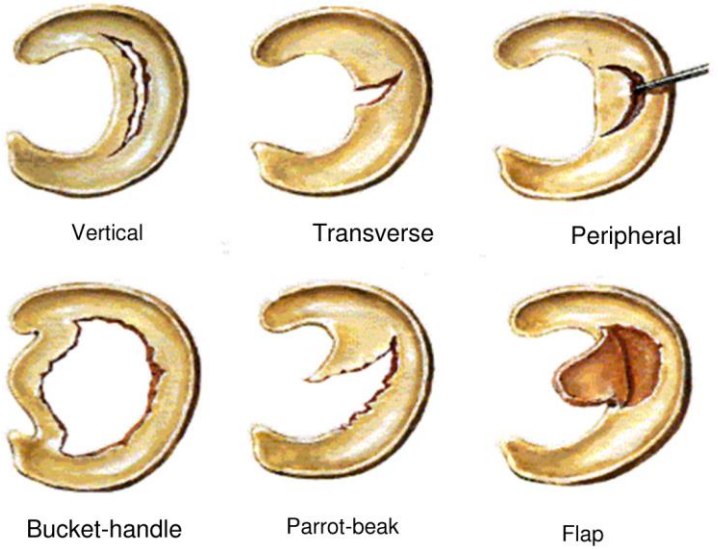

Image: Brisbane Knee and Shoulder Clinic

AAOS, Orthoinfo site: https://orthoinfo.aaos.org/en/diseases--conditions/meniscus-tears/

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Causes of Meniscal Injuries

- Grounded Flexion + Rotation
- Age-related degeneration
  - Less supple, more prone to slow-mo injuries
- Obesity
- Activity-related degeneration

Appropriate Exercises for Meniscus Injuries

- OKC>CKC early
  - SLR, ROM-limited knee extensions, isolated CKC- quadriceps/hamstrings, gluteals
- Body-weight/light-weight CKC (squats, lunges)
- Proprioception/Reaction drills
- Aquatics

Osteoarthritis Rheumatoid Arthritis

Osteoarthritis	Rheumatoid Arthritis
Degeneration by damage	Autoimmune assault
Wear-and-tear	Genetic, congenital, dietary

Contributing Factors

Use, disuse	Smoking, D-deficiency
Structural imbalances	Excess coffee, sodium, meat intake
Prior injury/surgery	
Excess body weight/High BMI*	

Minimizers

Muscle strength, balance	Statins, omega-3 fatty acids
Healthy ROM	Breastfeeding, maybe alcohol

HS Diamond, Fast Five Quiz, Medscape. Nov. 2021.

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Factors Contributing to OA

- 12-20 yrs post-ACL or meniscectomy - 7-14 OR
- Females - gymnastics and kung fu
- Track athletes 2.4 x more than non-athletes; football players had lower odd ratios
- Soccer, hockey and tennis do not unless injured
- Increased physical activity, even cumulatively, is protective; Low- to moderate PA not linked to OA
- Overweight (OR 1.8), Obese (OR 2.4), and Very Obese (OR 3.2)
- Occupation - cramped space, kneeling, carrying

Richmond, Fukuchi, Ezzat, Schneider, Schneider, Emery. Are Joint Injury, Sport Activity, Physical Activity, Obesity, or Occupational Activities Predictors for Osteoarthritis? A Systematic Review. JOSPT June 2013; 43(8):515-524.. Epub 11 June 2013. doi:10.2519/jospt.2013.4796

The Arthritic Knee

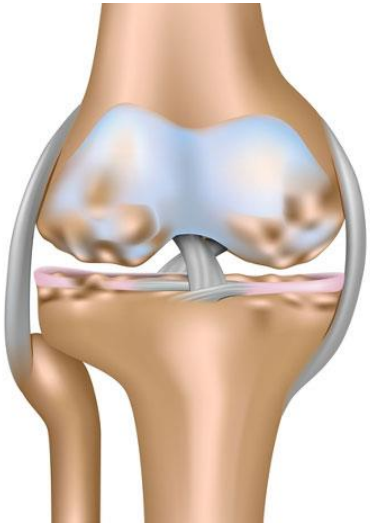

Image: Virtual Sports Injury Clinic

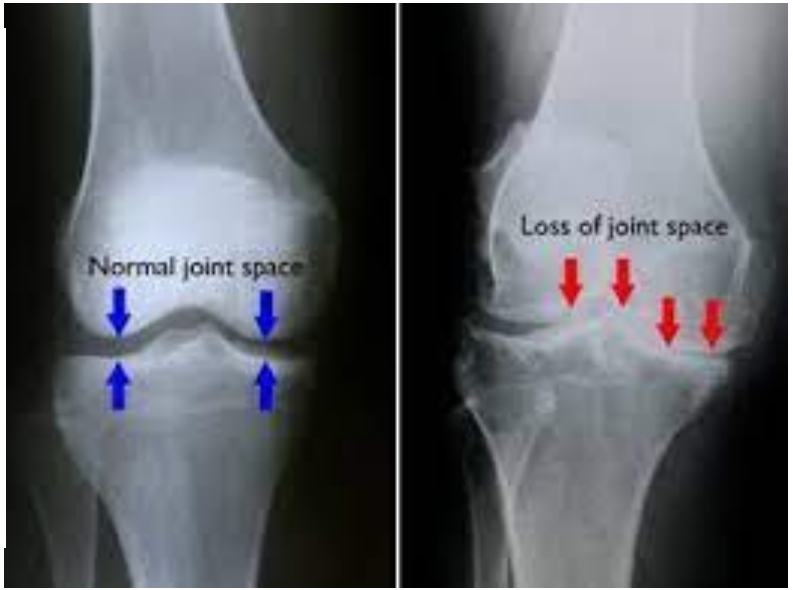

Image: OrthoInfo - AAOS

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Impact of Arthritis

Limiting ADLs, employment, and recreation

Articular deterioration

Constitutional symptoms (RA: fatigue, malaise, morning stiffness, weight loss, low-grade fever)

Tender and stiff muscles (that do not vary with the time of day with RA)

HS Diamond, Fast Five Quiz, Medscape. Nov. 2021.

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Quadriceps Dysfunction

- How to gage affected knee quad strength/function
- Atrophy and neuromuscular activation deficits precede surgical intervention
  - Persistant deficiency - >20% -

    for 1-2 yrs post-surgery
- ~40% of TKA patients have surgery for uninvolved limb within 10 yrs

Meier, Mizner, et al. JOSPT 2008;38(5):246-256. doi:10.2519/jospt.2008.2715

Informed Patient (Client)-Centered Decision-Making

When patients engage in “high-quality, informed, patient-centered (IPC) decisions” there were significant differences shortly after and at 6 month after arthroplasty for those who got TKA

Note: THA patients did NOT have greater satisfaction or less regrets when IPC decisions were made

KR Sepucha, H Vo, Y Chang, JM Dorrwachter, M Dwyer, AA Freiberg, CT Talmo, H Bedair. Shared decision-making is associate with better outcomes in patients with knee but not hip osteoarthritis. JBJS. Jan. 5, 2022. 104(1): 62. DOI 10.2106/JBJS.21.00064

TKA Components

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Shoe Thoughts?

- Barefoot/minimal shoes - possibly for prevention
- Thick-soled, sturdy shoes - better for managing
  - Annals of Internal Medicine (Jan. 2021): 82 older adults with OA assigned thick-soled, 82 assigned thin, more flexible shoe for 6 months
  - 58% of those in supportive shoes reported reduced pain vs 40% of those in flexible shoes
    - Also reported less ankle and foot pain

Harvard Health Letter May 2021

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Joint Replacement

- **Partial knee arthroplasty** (PKA) - usually medial condyle, medial tibial plateau, medial meniscus
- **Total knee arthroplasty** (TKA)
  - 4 components: femoral, tibial, patellar (button), meniscal
  - 10-yr implant survival rates are >95% for cemented and cementless; higher revision and re-operation rates for cementless
  - Customized implants yield better results and satisfaction

HR Mohammad, A Judge, DW Murray. JBJS Dec. 2021; 103(24):2270

L Schroeder, A Dunaway, D Dunaway. JBJS Feb. 2022; 10(2): e20.00182

Other Considerations

Co-Morbidities: osteoporosis, Vitamin D deficiency, diabetes

- Impact intraoperative complications
- Impact post-surgical complications, including integrity of the implants, rate and overall value of recovery, aseptic loosening, infection, revision/rehospitalization, pain, death
- D-deficiency <15 ng/mL: 3.7- to 4.0-fold risk of frailty; megadoses 60-100 days/pre-TKA improve outcomes

Team Approach: Preoperative Management of Metabolic Conditions in Total Joint Replacement. JBJS. Jan.29, 2022. https://jbjs.org/mreader.php?

High-Protein Supplementation Pre-TKA

- Double-blind, placebo-controlled, randomized trial
- N=19 had 20g essential amino acids or N=20 had placebo, 2/d for a week prior and 6 weeks after
- MRI measured quad and hamstrings volume
- "… EAA group had significantly less decrease in mean quadriceps muscle volume compared with the placebo group in the involved leg" : **~ 1/3 less atrophy**

Pre-Hab Exercises for TKA

- CKC, moderate - leg press allows <body wt
  - Wall squats, RDL, DL, mini-squats, CKC-TKE
    - Flexed hip lunge, step up
- OKC - BFR
- Abductors - OKC or CKC
- Hamstrings - OKC or CKC
- Functional core
- ROM

CKC Knee Extension

Seated External Hip Rotation

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Functional Core Exercises

Stability Ball Bridge/Ham Curl

Palof Press

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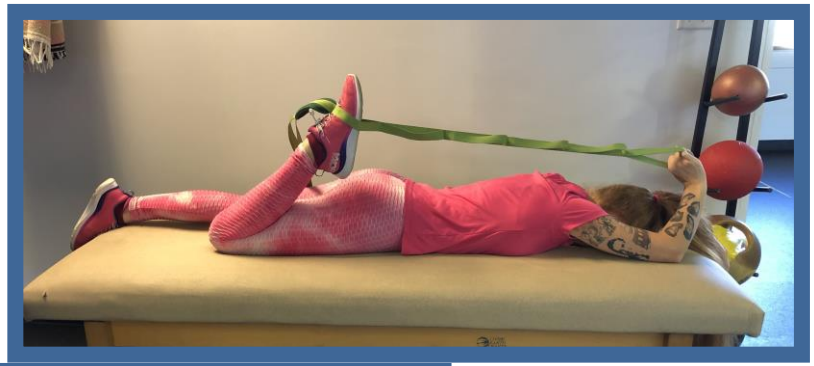
Quad Stretches



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Hamstring Stretches

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ITB Stretches

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Post-Rehab Exercises for TKA

- Cardio - cycle (in reverse), NuStep, Elliptical, Nordic Trac, Rowing
- Same as Pre-Hab but…
  - No BFR till blood clot risk abates
  - More CKC than OKC for quads
  - Cushion for kneeling
  - ROM - at least 120 deg flexion, full extension

Knee QUIZ

At this time, please complete and successfully pass the "Knee Quiz" before continuing to the next section.

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