

Proprioception and Strength: Knee Injury Prevention Strategies

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Knee Injury

- Knee injuries in active individuals are commonly ACL, meniscus, or patellar tendon
- In 2003, 19.4 million people saw a physician for knee related pain
- 1 in every 50 high school athletes will experience an ACL injury every year

- The health care industry makes \$625Million per year on ACL and meniscus related expenses (rehabilitation, surgery, braces)
- The average cost of ACL injury in an adult with surgical treatment is \$18-25,000, including surgery, anesthesia, hospital bills, MD visits, physical therapy, time off work, loss in productivity

The Female Factor

- Women are 4 to 8 times more likely to suffer an ACL injury than male counterparts
- 1 in every 10 of those athletes will have knee pain or ACL injury that will result in over 50% off of season
- Females who are experiencing all or part of the Female Athlete Triad have 27-32% higher chance of ACL injury

Female Factor– Possible Causes

- Female Triad– 3 risk factors
 - Disordered eating
 - Amenorrhea
 - Osteoporosis
- Hormonal– joint laxity
- Q-angle
- Muscular and neuromuscular learning and strength

Training Causes

- Poor quad to hams strength ratio
 - Hamstrings should be $\geq 75\%$ of quadriceps
- Core weakness
- Not performing sport specific drills
- Overbracing
- Lack of proprioception
 - Decreased fall anticipation
 - Decreased outside force anticipation

Research review

Study (year)	Sport	Subjects	Balance test	Study Duration	Injury	Significant findings
Hrysomallis et al (2007)	Australian football	210 male adults	Mat on force plate	1 season	Ankle	Low balance ↑ risk of injury
Williams et al (2005)	Phys ed students	241 male students	Flamingo	1-3 years	Ankle	Low balance ↑ risk of injury
Williams et al (2005)	Phys Ed students	159 female students	Flamingo	1-3 years	Ankle	No association

Research Review

Study (year)	Sport	Subjects	Multifaceted intervention	Balance program	Study duration	Effectiveness of intervention
Mykleburst et al (2003)	Team Handball	>850 female adults	Floor exercises focusing on control of knee position, balance	Wobble board squatting, throwing and pushing 15 min 3x/wk for 5-7 wks, then 1 wk in-season	3 season	↓ in non-contact ACL injuries ↓ in all ACL injuries
Olsen et al (2005)	Team handball	879 control 958 interventions youth	Warm-up running, technique, balance, strength, and power	Wobble board passing ball, squats, bounding, and pushing 5 min each training session x 15 weeks; 1x/wk during season	1 season	46% decrease in knee and ankle injuries

Research Review

Study (year)	Sport	Subjects	Balance program	Study Duration	Results
Caraffa et al (1996)	Soccer (semi-professional and amateur)	300 control, 300 intervention male	5 phases of increasing difficulty using tilt and wobble boards, each phase with stepping exercises daily for >30 days >20 min/day pre-season then 3x/week in-season	3 seasons	86% ↓ in ACL ruptures
Emery et al (2005)	Physical ed students (H.S.)	60 youth control (30m, 30f) with 60 intervention	Home-based wobble board bilateral stance, single-limb stance, eyes closed, inclusion of abdominal and gluteal muscles	6 months	82% ↓ in sports related injuries

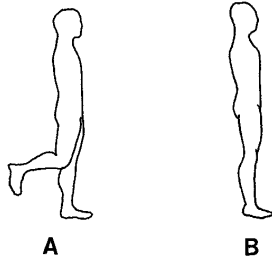
The Knee

Joint Structure and Motions

- Appears simple BUT is very complex
 - Supported and maintained by muscles and ligaments
 - Lacks bony stability
 - Exposed to severe stresses and strains
- One of the most frequently injured joints in the body

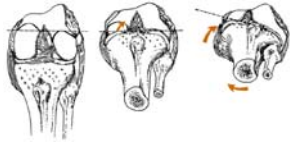
Joint Structure and Motions (cont'd)

- Largest joint in the body
- Synovial hinge joint
 - Not a true hinge
 - Has a rotational component
 - Accompanies other motions
- Motions
 - A. Flexion - 120-135°
 - B. Extension - 0°



Screw-Home Mechanism

- Medial femoral condyle longer than lateral condyle
 - As extension occurs, the articular surface of lateral condyle is used up while ~1/2" remains medially
 - therefore the medial condyle must glide posteriorly to use all of its articular surface
- With knee extension in NWB get ER of tibia



Patellofemoral Joint

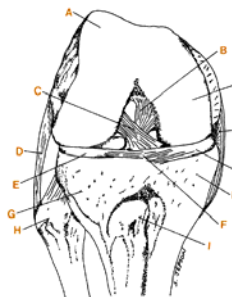
- Articulation between the femur and patella
- Patella's functions:
 - Increase mechanical advantage of quadriceps muscle
 - Protect knee joint



(Adapted from Smith, LK, Weiss, EL and Lehmkühnl, LD: Brunstrom's Clinical Kinesiology, ed 5, FA Davis, Philadelphia, 1996, p 13, with permission.)

Ligaments & Other Structures Anterior Cruciate Ligament (C)

- Runs from anterior tibia to posterior femur
 - Attaches to the anterior surface of the tibia in the intercondylar area just medial to the medial meniscus
 - Runs superior and posterior
 - Attaches posteriorly on the lateral condyle of the femur
- Prevents anterior tibial displacement
 - Tight during extension



Muscles of the Knee

- **Anteriorly**

- One-Joint Muscles
 - Vastus lateralis
 - Vastus medialis
 - Vastus intermedialis
- Two-Joint Muscles
 - Rectus Femoris

- **Laterally**

- Two-Joint Muscles
 - Tensor fascia latae

- **Posteriorly**

- One-Joint Muscles
 - Biceps femoris (short head)
 - Popliteus
- Two-Joint Muscles
 - Biceps femoris (long head)
 - Semimembranosus
 - Semitendinosus
 - Sartorius
 - Gracilis
 - Gastrocnemius

Muscles of the Knee

Rectus Femoris

- Part of the quadriceps
- Two-joint muscle crosses hip and knee

O: Anterior inferior iliac spine

I: Tibial tuberosity

A: Hip flexion
Knee extension

N: Femoral Nerve (L2, L3, L4)



Muscles of the Knee

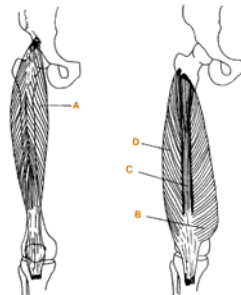
Vastus Lateralis (D)

O: Linea aspera

I: Tibial tuberosity via patellar tendon

A: Knee extension

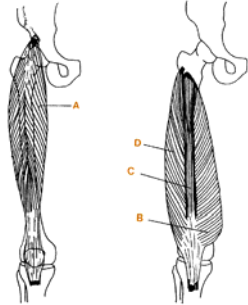
N: Femoral nerve
(L2, L3, L4)



Muscles of the Knee

Vastus Medialis (B)

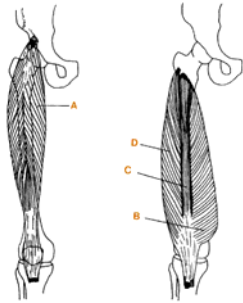
- O: Linea aspera
- I: Tibial tuberosity via patellar tendon
- A: Knee extension
- N: Femoral nerve (L2, L3, L4)



Muscles of the Knee

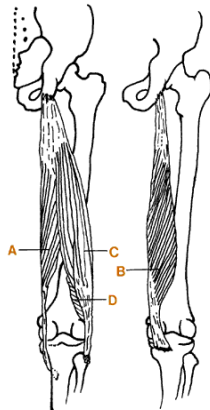
Vastus Intermedialis (C)

- O: Anterior femur
- I: Tibial tuberosity via patellar tendon
- A: Knee extension
- N: Femoral nerve (L2, L3, L4)



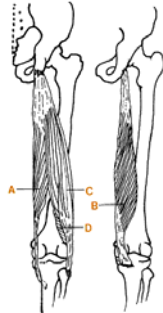
Hamstrings

- Posterior thigh muscles
- A. Semitendinosus
- B. Biceps femoris
- C. Semimembranosus
- Common origin
 - Ischial tuberosity



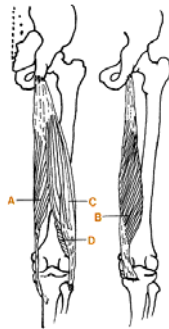
Hamstrings Semitendinosus (A)

- O: Ischial tuberosity
- I: Anteromedial surface of proximal tibia
- A: Extend hip, flex knee
- N: Sciatic nerve (L5, S1, S2)



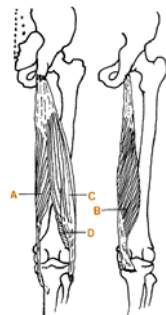
Hamstrings Biceps Femoris (B)

- O: Long head: Ischial tuberosity
Short head: lateral lip of linea aspera
- I: Fibular head
- A: Long head: Extend hip, flex knee
Short head: Flex knee
- N: Long head: Sciatic nerve (L5, S1, S2)
Short head: Common peroneal nerve (L5, S1, S2)



Hamstrings Semimembranosus (C)

- O: Ischial tuberosity
- I: Posterior surface of medial condyle of tibia
- A: Extend hip, flex knee
- N: Sciatic nerve (L5, S1, S2)



Popliteus

- Deep to two heads of the gastrocnemius
- “Unlocking” the knee

O: Lateral condyle of femur
 I: Posteriorly on medial condyle of tibia
 A: Initiates knee flexion
 N: Tibial nerve (L4, L5, S1)



Gastrocnemius

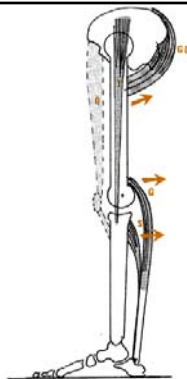
- Two-joint muscle, crosses knee and ankle
- Strong ankle plantar flexor

O: Medial and lateral condyles of femur
 I: Posterior calcaneus
 A: Knee flexion, ankle plantar flexor
 N: Tibial nerve (S1, S2)



Gastrocnemius (cont'd)

- The gastrocnemius as knee extensor
- With nonfunctioning quadriceps, stance is possible by gluteus maximus and gastrocnemius action
- In weight-bearing position, the two muscle contract, pulling the knee into extension
- Soleus may assist the gastrocnemius
 - Q Quadriceps
 - T Tensor fascia latae
 - GL Gluteus maximus
 - G Gastrocnemius
 - S Soleus



(Adapted from Calliet, R: Knee Pain and Disability. FA Davis, Philadelphia, 1973, p 30, with permission.)

Other muscles

- Gracilis, sartorius, and tensor fascia latae span knee posteriorly
 - Provide stability to the knee
 - Do not have a prime-mover function
 - Size
 - Angle of pull
- Tensor fascia latae
 - Contributes to lateral stability
- Gracilis and sartorius
 - Contribute to medial stability
- Gastrocnemius and hamstrings
 - Medial and lateral stability
- Quadriceps
 - Anterior stabilizer

Proprioception Program

- Hypothesis: increasing proprioceptive input increases strength by increased co-contractions
- Utilizing BOSU or wobble board, engage dynamic activity

Patient Screening

- Valgus passive deformity- also at Q-angle
- Single leg squat – should be able to squat to 90 degrees and back up without wobble or valgus deformity, watch foot position as well as hip closed chain adduction (weak abductors)
- Check hamstring strength versus quad strength
- Vertical Jump height
- Dynamic balance on various surfaces

The Basics

- There are six components of the training program:
 1. Training Time
 2. Training Frequency
 3. Training Volume
 4. Training Intensity
 5. Type of Exercise
 6. Quality of Exercise– speed, breaks, etc

Strength Goals

- Leg Press– 2.5x bodyweight
- Calculate hamstring to quad ratio hams at least 75% of quads
 - Measure 1RM hamstring curl vs quad extension
 - See table
- Squats
 - Males \geq 2x bodyweight
 - Females \geq 1.5x bodyweight

Target Population Cases

- Preventative– for those involved in any sports or activities that are high risk for knee injury
- Post-injury rehab– meniscal, ACL, PCL, MCL, LCL, patellar tendon

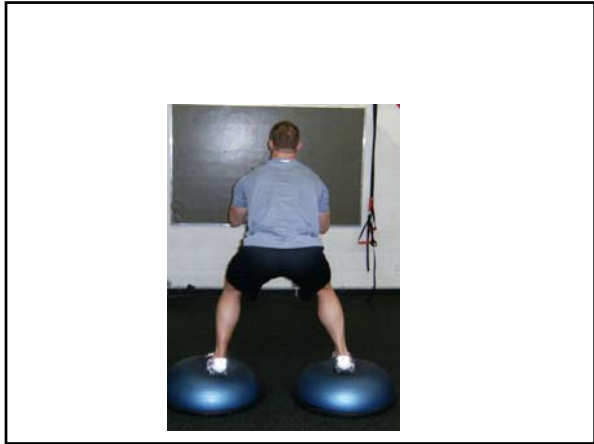
Single BOSU- Med ball toss



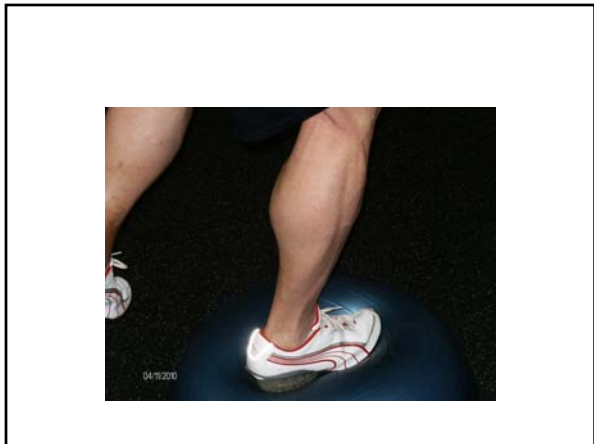


Double BOSU- Med ball toss

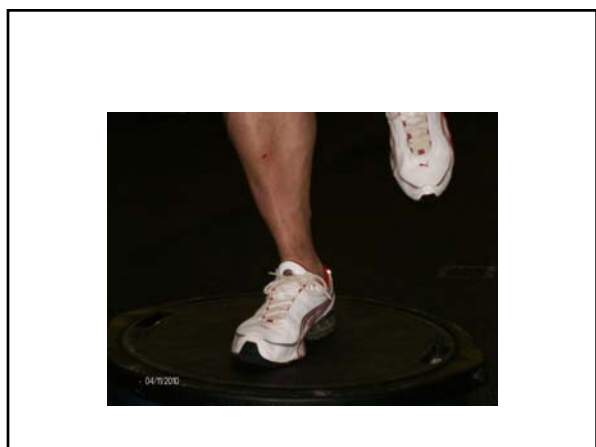












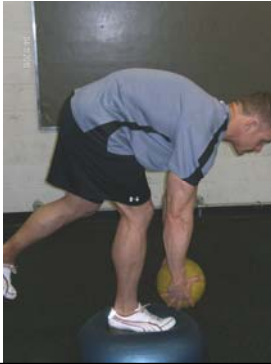
BOSU—Surfboard w/ Med Ball



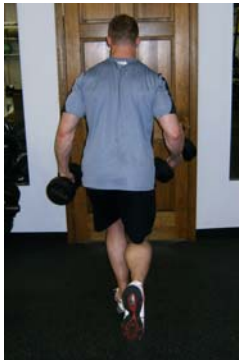
BOSU Wide Base Squat w/ Med Ball



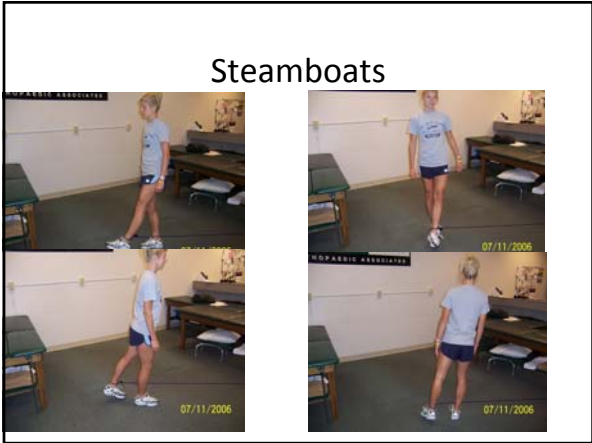
BOSU- Golfer's Deadlift w/ Med Ball

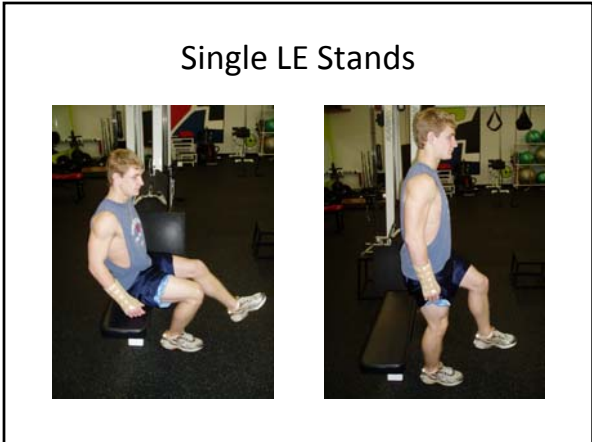


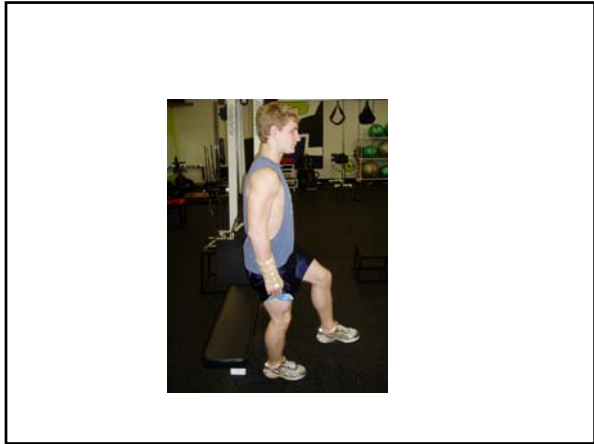
Rear View- Single Leg Stance















Billing

- Self pay options
- Neuromuscular re-ed 97112
- Outcomes
 - Client feedback
 - Oxford study

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