STRESS

INTRODUCTION

- What this presentation is not!
  - Will not provide all of the answers
  - Not intended to provide the “best” way
  - Does not advocate one philosophy over the other.
  - Does not “promise” results

So what is the purpose of this presentation?

- Provides information so you can decide
- Stimulates interest for further investigation
- Clarifies misconceptions
Outline of Topics
I. General anatomy of the knee
II. Mechanism of injury of the ACL
III. Repair options currently in use
IV. Surgical procedures
V. Rehabilitation of the reconstructed ACL
VI. Post rehab considerations
VII. Injury prevention strategies

ANATOMY OF THE KNEE

POSTERIOR MUSCULATURE
- Hamstrings
- Gastrocs
ANTERIOR MUSCULATURE
- Quads

LIGAMENTS
- B. Lateral Collateral
- C. Medial Collateral
- D. ACL
- E. PCL

MENISCUS
- A. Medial Meniscus
- B. Lateral Meniscus
A Closer Look at the ACL

- Originates on the anterior medial intercondylar tubercle of the tibia
- Inserts on the medial side of the lateral femoral condyle
- Consist of 2 bundles
  - Anteromedial and posterolateral
- Contains several types mechanoreceptors

ACL FUNCTION

- [Image of person bending over]
**ACL FUNCTION**

- Primary passive restraint to anterior translation of the tibia on the femur
  - This may be as high as 85% (Butler et al., J Bone Joint Surg, 1980)
- Stabilizes against internal and external rotation of the tibia on the femur
- Prevents hyperextension of the knee
- May act as a dynamic restraint to anterior tibial translation.
  - Strain on the ACL elicits a sensory response that creates a reflex contraction of the hamstrings (Solomonow et al., Am J Sports Med, 1987)

**Deficient ACL**

- Produces abnormal arthrokinematics of the tibiofemoral joint.
  - Tibia sublux
    - Presents clinically as episodes of “giving way”
  - Chronic instability
    - Stretching of secondary restraints
    - Injury to menisci
    - Deterioration of the joint surface
    - Recurrent pain

**Who are most vulnerable to ACL injury?**

- Estimated 80,000 tears/year
- 56,000 occur during sports
- Sports involving quick decelerations with rapid change in directions.
- Women are 2-8 times more likely to tear ACL
ACL Injuries in Women
What’s going on?

- The passage of Title IX of the Education Assistance Act, 1972.
- 1972 – 300,000 girls in high school sports
- Now – over 2 million

Have women received equal attention?

THEORIES

- Hormonal
- Anatomical
- Biomechanical
- Environmental

- No conclusive evidence linking hormonal, anatomical or environmental factors to increased ACL injuries. (Griffin et al, J Amer Acad Orthop Surg, 2000)

HORMONAL

- ACL tears have been reported to occur just before or after a menstrual period.
- Estrogen inhibits collagen synthesis and may cause a weakening of ligaments. (Lee et al, Abstract AORM, 1998; Aruna Seneviratne et al., American Journal of Sports Medicine, October 2004, Volume 32, pages 1613-1618)
- Conflicting results with research
Anatomical Differences

- **Females**
  - Wide pelvis
  - Less quad/VMO
  - Increased hyperextension
  - Larger Q-angle
  - Genu valgum
  - Narrow intercondylar notch
  - External tibial torsion

- **Males**
  - Narrow pelvis
  - More quad/VMO
  - Less flexibility
  - Smaller Q-angle
  - Genu varum
  - Wide intercondylar notch
  - Neutral tibial torsion

BIOMECHANICAL

- Alignment problems around the knee and foot
- Hyperextension can impinge the ACL in the notch (Loudon et al.; J. Sports Phys. Ther.; 1996)
- Weak quads lead to decreased ability to decelerate during landings

Mechanism of Injury

- **Direct Contact**
  - Least common
  - Direct blow to anterior of leg

- **Non-Contact**
  - Most common
  - Sudden change in direction
  - Deceleration force crossing the knee
  - “Point of no return”

*ACL injuries occur when bones of the leg twist in opposite directions under full body weight*
Signs/Symptoms of Tear

- Most patients recall hearing a “popping” sound or feel a “tearing” sensation
- Usually has significant pain at time of injury
- Rapid onset of swelling within 3 hours
- Positive Anterior Drawer and Lachman’s

Treatment Options for ACL Ruptures

- Non-operative management
  - Best with isolated ACL injury
  - Patient may have to modify lifestyle
- Surgical repair of torn ligament
  - Poor results to date
  - New technique may have some limited success
- Reconstruction of new ACL
  - Best choice for athletes and those needing a stable knee to carry out job duties
  - No differences in post-op outcomes between females and males (Barber-Westin et al., 1996)

Graft Choices for ACL Reconstruction

- Autografts
  - Patellar Tendon
  - Hamstring/Gracillis
  - Quadriceps Tendon
- Allograft
  - Same tissues as Autografts
- Synthetic
  - Gore-Tex cable
  - Dacron
  - Carbon fiber
Graft Choices Continued…

- Xenograft
  - Bovine
  - Porcine
- Bioengineering and Gene Therapy

**PATELLAR TENDON GRAFT**

Considered “Gold Standard” graft choice since 1980’s

A recent survey indicated that 70% of respondents used BPTB graft (Campbell; ACL Study Group Meeting, 2004)

90%-95% success rate in returning to pre-injury levels

**Advantages**
- Close match in size to original ACL
- High tensile strength
- Near normal stiffness (Steiner et al; Am J Sports Med, 1994)
- Bone plugs make for strong attachment due to “bone to bone” healing
- “Bone-Bone” generally heals quicker than “soft tissue-bone” fixations
- Donor site re-growth

**Disadvantages**
- Risk of patellar fracture or PT rupture in first 6-8 weeks
- Increased incidence of patellar tendinitis/bursitis (Freedman, 2003)
- Pain may result in greater initial quad atrophy
- Larger incision with loss of sensation lateral to incision

Patellar Tendon Graft
Patellar Tendon Graft

- Non-candidates
  - Petite individuals with narrow patellar tendons
  - Patient’s with histories of:
    - Patellar tendonitis
    - Patellofemoral pain
    - Arthritis of patellofemoral joint
    - Osgoods Schlatter’s disease
  - People who must kneel often

HAMSTRING TENDON GRAFT

- Increased usage in recent years
- Better choice for younger patients with open growth plates

HAMSTRING TENDON

Advantages
- Less post op anterior knee pain
- Smaller incision, less pain overall post-operatively
- Kneeling is comfortable
- Less initial quad atrophy

Disadvantages
- Longer healing period necessary for fixation of graft
- Longer protection time during rehab
- Higher surgical demand in harvesting graft and tensioning once in position.
- Donor site unlikely to grow back
- Reduced stiffness
- Higher incidence of “tunnel widening” (Hantes et al.; Arthroscopy, 2004)
- Possible permanent loss of hamstring strength at donor site (Nyland et al.; 4th World Congress on Sport Trauma, 2004)
HAMSTRING TENDON GRAFT

- Non-candidates
  - Patients with multi-ligamentous laxity
  - Patient’s with a history of recurrent hamstring tears
  - Patients that participate in hamstring specific sport functions. (ie. Backwards running demands)

Quad Tendon Graft

- Advantages:
  - Decreased quad strength up to 1 year (Fleisch, 1993)
  - Harvesting is technically difficult and results in large scar
  - Not many surgeons familiar with its use

Quad Tendon Graft

- Non-candidates
  - Similar to Patellar Tendon graft
Allografts

- Advantages:
  - No risks, pain or scars at donor site
  - Surgical time is quicker
  - Less post-op pain results in less joint stiffness and less quad atrophy

- Disadvantages:
  - Risk of contracting serious infection
  - Increased incidence of tunnel widening
  - May take longer for graft to heal
  - May have increased laxity long term
  - Cost and availability

Synthetic Grafts

- Rarely used
- Poor long term follow-up results
- Overly stiff with poor elastic properties
- Cause foreign body reactions

Xenografts

- Poor tissue incorporation in the human host resulting in immune rejection
- Increased intraarticular wear and synovitis (Clin Orthop, 1988)
Bioengineered grafts
- Seeding of human ACL cells onto synthetic polymer fiber scaffolds such as silk

ACL Reconstruction

ACL REHAB
Then and Now

THEN
- Time constraints for healing
- Avoidance of forces that may interfere with healing
- Return to full activity in 9-12 months

NOW
- Early restoration of full knee extension
- Immediate full weight bearing
- Use of closed chain exercises
- Return to full activity in 4-6 months
Traditional vs. Accelerated

**TRADITIONAL:**
- 2-3 days
  - casted at 30 degree flexion
  - Ext/ABD/ADD SLR
  - Glut sets
  - NWB ambulation
- 6-7 days
  - Discharged from hospital
- 2-4 weeks
  - Cast removed, hinge brace
  - Passive ROM
  - Ham curls
  - Ext/ABD/ADD SLR
  - Toe-touch weight bearing

**ACCELERATED:**
- 2-3 days
  - CPM with cryo cuff
  - Passive ROM
  - WRAT
- 4 days
  - Discharged from hospital
- 3-5 days
  - ROM, terminal ext to 90
  - Wall slides, heel slides
  - step ups, heel raises, leg press, quarter squats
  - Recycling and swimming
- 5-6 weeks
  - ROM, terminal ext to 130
  - Isokinetic evaluation, 180, 240
  - Lateral shuffles, carties, jump rope
  - Weight room activities
  - Recycling and swimming

**Protocol comparison continued**
- 4 weeks
  - ROM from 20-70 degrees
- 5-10 weeks
  - WRAT
  - ROM from 10-90 degrees
  - Passive-stretching
  - SLR with weights
  - Eccentric knee extensions
  - Hamstring curls
  - Recycling and swimming
- 12-14 weeks
  - ROM 0-110 and FWB
  - Continue exercises add step ups and heel raises

- 10 weeks
  - Full rom
  - Isokinetic eval 60, 180, 240
  - Ligament stability tests
  - Increased agility workout
- 16-24 weeks
  - Isokinetic eval
  - Return to sports if strength is 80% of uninvolved and no difficulties with exercises

**Protocol comparison continued**
- 4 months
  - ROM 0-120
  - Discontinue brace for ADL
  - Increase intensity of exercises
- 6 months
  - Isokinetic eval 180, 240
  - Ligament stability test
  - Jump rope, lateral shuffles
  - Walking up to 2 miles
  - Squats
- 7 months
  - ¼ mile walk/jog progression
- 8 months
  - Agility drills
  - Isokinetic strengthening
- 9-12 months
  - Return to normal activities if full ROM, no pain or swelling, strength greater than 80% uninvolved.
Findings from Shelbourne & Nitz Research

- Earlier and more complete achievement of ROM
- Earlier return of strength as tested on Cybex, no difference at 1 year.
- KT-1000 results were equal or better
- Subjective satisfaction questionnaire; stability scores, 98% scored 20/20 vs 95%
- Fewer problems with patellofemoral joint symptoms
- Fewer procedures required to obtain full knee extensions (scar resections)
- Overall better patient compliance and satisfaction

Interesting Research
Home Based Programs

- Several studies have reported home based ACL programs to as effective as Physical Therapy supervised programs. (Grant et al, Am J Sports Med, 2005; Fischer et al, Clinical Orthopedics, 1998; Treacy et al, Am J Ortho, 1997; Schenck et al, Arthroscopy, 1997)
- Study Outcome measures
  - ROM
  - Ligament laxity/KT-1000
  - Lysholm knee rating scores
  - Hop test
  - Isokinetic strength
- Number of visits
  - PT supervised – 14-24 visits
  - Home Based – 3-6 visits

Prevention is the Key

- Goals of prevention programs:
  - Enhance balance
  - Improve body/joint awareness
  - Teach movement technique
  - Increase muscle strength
Basic prevention program design

- Dynamic Warm-Ups
- Stretching
- Strengthening exercises
- Progressive Plyometrics
  - Focus on proper technique must be taught
    - Land on balls of feet, knees flexed, chest over knees
    - Avoid valgus movement of knee
- Sport specific agilities


Post Rehab Considerations

- Continue to focus on developing functional LE strength.
- Training should include proprioception and balance activities to enhance the knee’s response to stress
- Sport specific agility activities should be encouraged during practice/training
- Coach should enforce proper techniques

THANK YOU!!!!!!
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**MORE READING**

- [http://factotem.com](http://factotem.com)
- **Knee Library**


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