ANTERIOR CRUCIATE LIGAMENT INJURY PREVENTION

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Femoral Attachment:
post-med corner of medial side of lateral femoral condyle

Tibial Attachment:
in a fossa, anterior medial tibia

- Length of 38mm (range 25-41)
- Width of 10mm (range 7-12)
- Multiple collagen fascicles
- Innervated by tibial nerve
- Middle genicular artery
Anterior and Posterior Bundles

- **Small anteromedial (AM) band**
  - Flexion -> tight
  - Responsible for anterolateral stability

- **Larger bulky posterolateral (PL) band**
  - Extension -> tight
  - Limits anterior translation, hyperextension, and rotation
Functional Role

• Predominant restraint to anterior tibial displacement
  • Posterior horn of medial meniscus is major secondary restraint (also, deep MCL)

• Role in gait:
  • Flexion -> extension, External Rotation of the tibia
  • ACL deficient knee -> lack of normal internal rotation of femur during terminal swing phase
ACL injuries

• Most common injured ligament in the body
• Estimated 200,000 repairs annually in United States
• Highest incidence in individuals 15-25yo who participate in pivoting sports
• Estimated $3 billion cost per year ($17,000 per procedure) in United States
• 70-80 % occur in noncontact situations
ACL injuries

• Overall seen more in **male** athletes
  – Absolute greater number of male participants in sports
  – NCAA stats show in those activities which both males and females both participate, (soccer, basketball, volleyball) likelihood of sustaining injury is 2-8x higher in females
ACL injury risk factors

• Environmental
• Anatomic
• Hormonal
Environmental Risk Factors

• Uneven playing surfaces
• Shoe-Surface interaction
  • A high-level of friction b/w shoes and playing surfaces is a major risk factor for non-contact ACL injuries.
    – Injuries occur most frequently on dry playing surfaces (basketball, volleyball)
• Playing style: jump analysis, erect position → increase load transmission (amplifies ground reaction forces that increase the load on ACL)
Anatomic Risk Factors

• Musculotendinous flexibility
  • Exercise induced
  • Increased laxity in AP plane after 30 min of exercise, returns to baseline after 60 min.

• Joint hypermobility
  • Genetically inherited

• Although intriguing and initially thought to be associated, no evidence to prove this.
The “X Factor”

• Female Athlete Risks
• Female athletes are at 3.5 times risk of non-contact ACL injury compared to males.
  – Wider pelvis and greater average Q-angle.
  – Greater hip IR and tibia ER, knee valgus.
  – Above-average hamstring flexibility.
    • exert a posterior force on the proximal tibia that protects the ACL.
    • Greater quadriceps than hamstring activation.
Hormonal Risk Factors

• May be an increased risk during preovulatory phase when estrogen levels peak.
  • Estrogen proposed to decrease ACL strength by reducing tensile properties of the ligament.
  • Estrogen has been shown to affect the CNS possibly decreasing motor skills in premenstrual phase.
ACL Injury Prevention Programs

1. Balance and proprioceptive training programs.
2. Landing patterns and neuromuscular adaptation programs.
Balance and Proprioceptive Training

Caraffa et al, 1996
- Italian semi-professional and amateur soccer players
- 20 control and 20 intervention
- Balance on one leg using a balance board
- 3 x week (20 min)
- 70 ACL in control vs 10 in intervention (p<0.001).

Soderman et al, 2000
- Swedish female soccer players
- 121 to balance board and 100 to regular training
- 3 x week (10-15 min)
- Not supervised
- No statistical differences in injury rates
Landing patterns & neuromuscular adaptation

LaBella et al, 2011

- High school female athletes in Chicago public schools
- 90 coaches, 110 teams, 1492 athletes
- Control coaches learned how to complete warm up
- Plyometric, balance, progressive strengthening and agility exercise.
- 80% of intervention coaches reported compliance
- 3x week for 13 weeks
- 6 total ACL injuries in control vs 2 in intervention (p=0.04)
ACL Prevention Programs

• Challenges:

1. Initiate at or prior to puberty to prevent maladaptive biomechanical patterns
2. Initiate prior to start of season (ideally 6 wks) and cont at a lower freq.
3. Needs to include both balancing, landing, and neuromuscular adaptations
4. Hamstring strengthening and plyometric focusing on quick explosive movements
5. Needs to include feedback (partner athlete or trainer)
6. Programs need to be easy to incorporate and challenging in order to motivate athletes (20 min sessions)
How Much?

Prevention and Screening Programs for Anterior Cruciate Ligament Injuries in Young Athletes

A Cost-Effectiveness Analysis

Eric Swart, MD, Lauren Redler, MD, Peter D. Fabricant, MD, MPH, Bert R. Mandelbaum, MD, Christopher S. Ahmad, MD, and Y. Claire Wang, MD, ScD

Investigation performed at Columbia University Medical Center, New York, NY
How Much?

• **Background:**
The purpose of the study is to evaluate the cost-effectiveness of ACL injury prevention programs and screening strategies for preventing ACL injuries.

• **Methods:**
A decision-model analysis was created to evaluate three strategies for a population of young athletes:
1. No training OR screening
2. Universal neuromuscular training
3. Universal screening with neuromuscular training for high risk athletes ONLY.
How Much?

- Cost of ACL Reconstruction; **$5,000-$17,000**.
- Cost of training, including coach training and up to 18 pre-season sessions (20 min each): **$25.00 per player per season**.
- Dedicated screening center w/ two cameras, one computer, and full-time staff: **$2.00-$3.00 per player** (up to $15.00 per player if coaches and athletic trainers involved)
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<tr>
<th>Description</th>
<th>Value</th>
<th>Studies</th>
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<tr>
<td></td>
<td>Base Case</td>
<td>Low</td>
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<td>Surgical costs</td>
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<tr>
<td>ACL reconstruction ($)</td>
<td>8000</td>
<td>5000</td>
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<tr>
<td>Risk of ACL injury</td>
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<td>Baseline incidence of ACL rupture (per season)</td>
<td>0.03</td>
<td>0.02</td>
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<tr>
<td>Prevention program</td>
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<tr>
<td>Cost of prevention program ($/player/yr)</td>
<td>1.25</td>
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<td>Risk ratio of prevention program</td>
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<td>Cost of screening test ($/player)</td>
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<td>Sensitivity of screening test</td>
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<td>Quality of life (utility value)</td>
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<td>After ACL reconstruction</td>
<td>0.78</td>
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\(^*\)ACL = anterior cruciate ligament.
How Much?

Results:

- Universal training was estimated to reduce the incidence of ACL injury by an average of 63% (3% to 1.1% per season).
- Screening program reduced incidence by an average of 40% (3% to 1.8% per season).
How Much?

Results:

• On a per case basis, the average cost of universal training program was $100 lower than no training and $25 lower than screening.

• Universal training also results in a net gain of 0.05 QALY compared to no training and an average gain of 0.03 QALY compared with screening.

• Universal training, therefore, resulted in lower costs overall as well as improved health outcomes.
References