ACL Injury Prevention

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"An Ounce of Prevention is Worth a Pound of Cure"
- Benjamin Franklin

Some ACL Injuries Are Not Preventable

Some ACL Injuries May Be Preventable

Epidemiology

- About 100,000-250,000 ACL Injuries in the U.S. Annually
- 1/3000 overall incidence (1/1750 in prime age)
- Annual cost of $2 billion for reconstruction

Epidemiology

- "High Risk" Sports
  - Football
  - Basketball
  - Volleyball
  - Soccer
  - Skiing
  - Team Handball
**Epidemiology-Mechanism**

- Over 70% Non-Contact Injuries
  - Quick Deceleration
  - Jumping & Landing
  - Running & Cutting
  - Twisting
  - Closed Chain

**Epidemiology**

- Greater Risk in Female Athletes
  - Chandy (HS sports) 4.6:1
  - Arendt (coll. sports) 4:1
  - Malone (basketball) 8:1
  - Lindenfield (soccer) 6:1
  - Ferratti (volleyball) 4:1
  - McFarland (USNA) 10:1
  - Viola (skiing) 1.4:1

**Female Risk-Anatomy**

- Compared to Men, Women have:
  - Wider pelvis, greater hip varus, femoral anteverision, knee varus, increased Q-angle, foot pronation,
  - Hypoplastic VMO, weak hip ERs
  - Increased ligamentous laxity
  - Smaller ACL size & Intercondylar notch
    - ? Increase risk for injury
  - More body fat, less lean body mass

**Female Risk-Hormonal**

- Hormones fluctuate in cycle, increase ligament laxity and decrease neuromuscular performance. Estrogen and progesterone receptor sites on human ACL. Estradiol decreases ACL fibroblasts proliferation and collagen synthesis. (Faryniarz 2006)
- No link b/t specific phase of cycle and laxity (Van Lunen 2003, Karageanes 2000)
- Need more studies to determine hormonal influences

**Female Risk-Biomechanical Differences**

- Land/cut with more erect hip-trunk posture, knee valgus, less knee flexion, weak gluteus musculature
  - (McLean 2005)
- Females rely on quads, while males rely on hamstrings to stabilize the knee
  - (Chappell 2006)
So How Do We Stop This???

Prevention-Bracing

- Studies on ACL prevention with prophylactic bracing have shown no benefit
  - Hewson 1986
  - Sitler et al 1990
  - Albright et al 1994
  - Lam 2002

Prevention-Environment

- Synthetic Fields generally have more injuries per exposure compared to natural grass fields
  - Not necessarily increased incidence of ACL injuries
  - Conflicting NFL studies on risk of ACL injury due to artificial turf vs. grass
    - Powell 1992, Nicholas 1988
    - Relative risk (1.8x) of injury on artificial turf in U.S. collegiate intramural sports
      - Stevenson 1981
- Dry, even athletic fields provide most stability

Prevention-Footwear

- Longer cleats at edge of sole with fewer, smaller cleats in the middle of the sole may be riskier
  - Increases torsional resistance (Lambson 1996 AJSM)

- Shoes with lower ACL injury risk:
  - Cleats flat, all the same size on forefoot
  - Screw in cleats with 0.5 in ht/diameter cleats
  - Pivot disk: 10-cm circular edge on sole of forefoot

- Optimal shoe-surface combination: minimizes rotational friction (↓ injury risk) while keeping translational friction high enough to optimize athletic performance

Prevention-Hormones

- No differences in ACL injury incidence with OCP use (Agel 2006)
- Inconclusive
ACL Prevention Programs

- NCAA Division I Women’s Basketball Study 1989, Henning/Griffis
  - Training emphasized knee flexion, change in technique:
    - plant and cut → accelerated rounded turn
    - straight knee landing → bent-knee landing
    - one-step stop → three-stop stop with bent knees
- ACL injuries reduced from 5.5/year to .58/year (89%) in 2 NCAA Div. I basketball teams

ACL Prevention Programs

- Cincinnati Study-1999; Hewitt, Noyes et al, Sportsmetrics Program
  - 6 weeks preseason
  - Stretching, Plyometrics (jump training), Weight Training
  - 1263 HS Athletes (Volleyball, Soccer, Basketball)
    - 3 groups: male controls, female trained, female untrained
- Knee injury incidence per 1000 athlete-exposures:
  - Untrained female athletes 0.43 *
  - Trained female athletes 0.12
  - Male athlete controls 0.09

ACL Prevention Programs

  - Neuromuscular and Proprioceptive Sport-Specific Training Program instituted during 12 week soccer season
  - Female soccer players
    - Untrained female athletes 32/1905 = 1.7%
    - Trained female athletes 2/1041 = 0.2%
  - Overall ACL injury reduction of 88% year 1
    - 74% reduction in ACL injuries year 2

ACL Prevention Programs

- Programs work on proper jumping/landing, proprioception/balance, quad strengthening, flexibility
- PEP Program example
  - 20 minute warmup at least 3x/week
  - No special equipment

ACL Prevention Programs

- PEP Program, NCAA women’s soccer, 2002
- NCAA Division I female soccer players
  - 2 groups (61 teams)
    - untrained female athletes 19/833= 2.3%
    - trained female athletes 7/561 = 1.5%
- Overall ACL injury reduction of 66%

ACL Prevention Programs

- Meta-analysis of 6 studies demonstrates statistically significant effect of neuromuscular training programs on ACL injury incidence in female athletes (Hewett 2006)
- Agility exercises improved rt time to anterior tibial translation (Wojtys AJSM 2003)
PEP Program

Warmup
- 1: Avoidance Jogging
- 2: Avoidance Shuttle Run
- 3: Avoidance Running

Stretching
- 4: Flexibility Core
- 5: Flexibility Hip
- 6: Flexibility Leg
- 7: Flexibility Hip
- 8: Flexibility Hip

Future Direction
- Emory Sports Medicine will be setting up a new program on our website where people can input their features and get their own biomechanical analysis. Hopefully this can be used to identify those that are at risk and institute a training program.

Conclusions
- ACL Injuries are a serious problem that may be preventable
- Females are much more likely than males to sustain ACL injuries due to several factors
- Neuromuscular training programs have shown the most promise in preventing ACL injuries

Thank You
- References:

- Charlie Weis