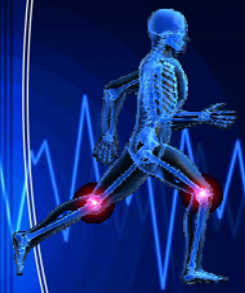
ACL Injury Prevention

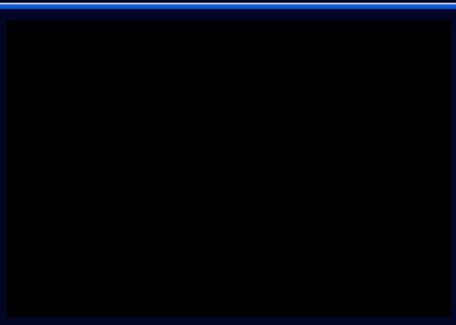


Jeff Webb, M.D.

- "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

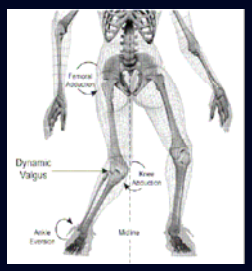
- About 100,000-250,000 ACL Injuries in the U.S. Annually
- 1/3000 overall incidence (1/1750 in prime age)
- Annual cost of $2 billion for reconstruction

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



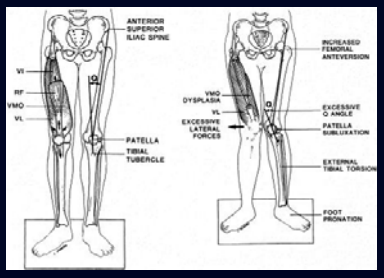
Epidemiology

- 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 anteversion, knee valgus, 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-Anatomy



Male *Female*

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)
- Studies noted more laxity/injuries in ovulatory phase (Zazulak 2006, Wojtys 2002, Heitz 1999)
- 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)

Male ***Female***

Prevention

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

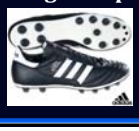
- Synthetic Fields generally have more injuries per exposure compared to natural grass fields
  - Not necessarily increased incidence of ACL injuries
  - Conflicting NFL studies on risk of ACL injury due to artificial turf vs. grass
    Powell 1992, Nicholas 1988
  - ⇧ relative risk (1.8x) of injury 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)

Prevention-Footwear

- Shoes with lower ACL injury risk:
  - Cleats flat, all the same size on forefoot
  - Screw in cleats with 0.5in 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

- Lower ACL injury incidence in athletes taking oral contraceptives (Wojtys AJSM 1997,2002)
- 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

- Cincinatti 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

- PEP (Prevent Injury and Enhance Performance) Program, Southern CA, Mandelbaum, et al AJSM 2005
  - 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= .2%
- Overall ACL injury reduction of 88% year 1
  - 74% reduction in ACL injuries year 2

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= 2.8%
    - trained female athletes 7/561 = 1.5%
- Overall ACL injury reduction of 66%

ACL Prevention Programs

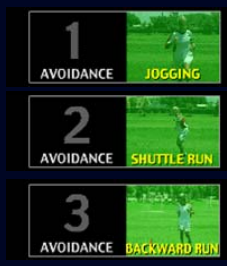
- Meta-analysis of 6 studies demonstrates statistically significant effect of neuromuscular training programs on ACL injury incidence in female athletes (Hewett 2006)
- Agility exercises improved rxn time to anterior tibial translation (Wojtys AJSM 2003)

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

PEP Program

Warmup



Stretching

PEP Program

Strengthening

Plyometrics

PEP Program

Agilities

Cooldown

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

- Barber-Westin SD et al. Jump-Land Characteristics and muscle strength development in young athletes. Amer J Sports Med. 2006: 34(3)1-10
- Boden BP et al. Etiology and prevention of noncontact ACL injury. PhysSportsMed. 2000: 29(4)
- Caraffa A et al. Prevention of anterior cruciate ligament injuries in soccer: a prospective controlled study of proprioceptive training. KneeSurgSportsTraumatolArthrosc. 1996:4:19-36
- Heidt RS et al. Avoidance of soccer injuries with preseason conditioning. AmJSportsMed. 2000: 28(5)659-62
- Hewett TE et al. The effect of neuromuscular training on the incidence of knee injury in female athletes: a prospective study. Amer J Sports Med 1999. 27(6) 699-706
- Lambson RB et al. Football cleat design and its effect on anterior cruciate ligament injuries: a 3-yr prospective study. AmJSportsMed.1996:24(2)155-9
- Mandelbaum BR, Silvers HJ, Watanabe DS. Effectiveness of a neuromusclular and proprioceptive training program in preventing anterior cruciate ligament injuries in female athletes: a 2-year follow-up. Amer J Sports Med. 2005: 33(7) 1003-9
- Noyes et al. The Drop-Jump Screening Test. Amer J Sports Med. 2005: 33(2)197-207

- Charlie Weis