ACL Injuries in Female Athletes: Theoretical Causes and Prevention

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ACL: Anterior Cruciate Ligament

- Primary stabilizer of the knee
- Limits rotation and anterior translation of the tibia
- Protects the menisci from shearing forces

Length
- 22-41mm
- Avg 32mm

Width
- 7-12mm

Cross-sectional diameter
- 36-49mm

PCL - Medial Femoral Condyle
ACL - Lateral Femoral Condyle
Lateral Meniscus
“No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance...”

- Title IX of the Educational Assistance Act (1972)

Early opponents of Title IX legislation were concerned that women were weaker and would have significantly higher injury rates than men, and therefore should not be allowed to compete.

This fear was largely unfounded... with one glaring exception.

ACL Injuries/Tears

- >70% of ACL injuries are sports-related
- Often associated with concurrent meniscal injury

Contact vs. Non-Contact

- >20% contact (football, rugby, ice hockey)
- ~80% non-contact (soccer, basketball, skiing, etc.)

Non-Contact – usually with landing, rapidly stopping, cutting or change in direction

- Altered biomechanical and neuromuscular patterns
ACL Injury Mechanisms

- Hip internally rotated, adducted
- Knee near full extension
- Tibia externally (or internally) rotated
- Foot everted and planted
- Body decelerating

Combo of above leads to "Dynamic Knee Valgus" (collapse of the knee)

Prevention of ACL Injuries

100,000 ACL tears every year
Majority in 15 to 25 year olds
Cost to society 1.5 Billion dollars a year
Short term, loss of participation and game time
Long term, higher chance of arthritis in future
ACL Injury: The Gender Gap

- Females
  - 4-8x more likely to tear the ACL than males in similar sports
  - More likely to have surgery for an ACL injury
  - Less likely to return to sports after ACL injury
  - ≈ 40,000 ACL tears in females/yr

High school anterior cruciate ligament (ACL) injury rates per 100,000 athlete exposures (AEs) by sport and sex. (An athlete exposure is 1 athlete participating in 1 practice or competition.)

Impact of an ACL Injury

- **Physical**
  - Surgery and/or 6-9 months of rehabilitation

- **Social/Academic**
  - Athletes miss whole seasons of play, possible loss of scholarship
  - Often limits future sports participation
  - Negative impact on academic performance

- **Financial**
  - Treatment is $17,000 - $25,000 per injury ($800 million/yr)

- **Long-term health**
  - Despite treatment, 10x ↑ rate of early-onset knee OA (15-20 years post injury)
Factors in Female ACL Injury Risk

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Balance of Power

- Recruitment Pattern
- Quadriceps muscles antagonist
  - stress ACL
- Hamstring muscles agonist
  - protect ACL
- Weak hamstrings and strong quadriceps puts ACL at risk
  - Female Quad dominant
  - Male Hamstring dominant
- Hamstrings 60% to 80% as strong as Quadriceps

Anatomic Factors

- Intercondylar Notch
- Small notch
- Small Ligament size

Intercondylar notch
Pantano et al. noted that pelvic width to femoral length measurements may be a more accurate structural predictor of knee valgus and subsequent ACL tension during dynamic activities. Larger Q-angle tends to place the lower leg into a valgus position resulting in a possible strain on the ACL. Females demonstrate a wider pelvis and a greater average Q-angle. Q-angle and pelvic width to femoral length ratio. Anatomic Factors: Limb Alignment.

Environmental Factors

- Fields
- Cleat Design
Hormonal Factors

- Estrogen and Relaxin
- Relax and soft tissues
- Does this predispose female athlete to ACL injury?
  - Increased incidence of ACL tears during ovulatory phase?

**Estrogen**

- receptors located on the ACL
- reduction of collagen synthesis and fibroblast production

**Estradiol and Progesterone**

- associated with increased knee and ankle laxity

ACL Injuries Prevention

- Biomechanical Factors critical
- **Neuromuscular/Proprioceptive** programs
- Plyometric/jump training and Balance drills
- Retrain mind on body position
Prevention Strategies

Neuromuscular training programs have been shown to decrease ACL injury rates

| 72% | 89% | 88% | 74% | 75% |

Greatest success if follow 3 principles:

- Plyometrics, balance and strengthening, core stability, biomechanical feedback
- >1x/week
- Minimum of 6 weeks

Neuromuscular training programs have been shown to decrease ACL injury rates by 72%, 89%, 88%, 74%, and 75%.

ACL Injury Prevention Program: Basic Components

- **Warm-Up (~2 min):** increase core temp, increase heart rate, and circulation throughout the musculature
- **Stretching (~2 min):** either dynamic or static
- **Strengthening (~4 min):** focus on the core, hip and thigh regions
- **Plyometrics (~4 min):** jumping, landing, ballistic movements
- **Agility (~4 min):** cutting, changing directions

ACL Prevention Program

**Goal:** ↓ the number of ACL tears

- Improve neuromuscular control and train proper movement patterns
- Gain biomechanical efficiency and accuracy of movement
- Enhance dynamic strength and muscle endurance of the trunk, hip and knee

**Completed PRIOR TO and DURING sport season**

- At least 2-3 times per week x 15 min each session
- Replaces the traditional warm-up of practice
- Education for players on strategies to avoid injury
MANY ACL Prevention Programs out there...

www.smsmf.org/smsf-programs/pep-program

www.aclprevent.com

www.sportsmetrics.net

References

References