ACL Injury: What are the Risk Factors?

Kenneth G. Swan, Jr., M.D.
June 2, 2015
• I have no disclosures
• ACL injuries (ACLIs) are 3-6x more common in females than males......But there’s more to it than that.

• What does the Evidence say about ACL injury Risk Factors?
ACL Injury Risk Factors?

- Non-modifiable
  - Genetics
  - Female Gender
  - Notch width
  - Posterior tibial slope
  - ACL size
  - Ligamentous laxity

- Modifiable
  - High BMI
  - Jump landing mechanics
  - Hormonal
  - Playing surface
Non-modifiable Risk Factors
ACLI and Genetics

• Many anecdotal reports of ACL injuries running in families
• Two case-control studies support this theory
• However, overall Evidence is poor, level III at best
• Genetic studies exist, but few
• Cannot make definitive conclusions or practice recommendations….yet
Does the size of the intercondylar notch effect the risk of ACLI?
ACL Injury Risk Factors: Intercondylar Notch Width

- Notch Width Index (NWI) = width of intercondylar notch/width of distal femur at level of popliteal groove
  - as seen on tunnel view radiographs

Souryal, *AJSM*, 1988
Notch Width

• Several* prospective level II evidence cohort studies have shown:
  a) Females have smaller NWIs than males
  b) Male and female athletes with ACLIs have significantly more notch stenosis than athletes without ACLIs

* Souryal, AJSM, 1993; LaPrade, AJSM, 1994; Uhorchak, AJSM, 2003
++ Zeng, Knee Surg Sports Traumatol Arthrosc, 2013  Meta-analysis (III)
Does the geometry of the tibial slope play a role in ACLI?
Bony geometry of tibial plateau and ACLI

- Both the concavity depth of the medial plateau and the degree of posterior-inferior tibial slope have been studied.
- Studies suggest that increased posterior tibial slope places athletes at higher risk for non-contact ACLIs.
Posterior Tibial Slope: What’s the Evidence?

- Best evidence implicating increased posterior tibial slope as a risk factor for ACLIs is **LEVEL III**
- Radiograph-based, case control studies
- A recent Level III study suggests it is a combination of increased posterior slope and tight intercondylar notch that places female athletes at risk*

  — *Sturnick, AJSM* 2015
ACL size: Does size matter?

- Females suffer higher rates of ACL injuries than men
- ACL in females is smaller than male counterparts
  - Chandrashekar, *AJSM* 2005
- Smaller ACL (MRI) found in c/l knee of ACLI patients vs controls
  - Chaudhari, *AJSM* 2009
- Smaller ACL (U/S) diameter is a predictor of ACL injury
- Evidence: poor, few studies, two Level III
Ligamentous Laxity

• Is generalized or focal pre-injury laxity a risk factor for ACLI?
Ligamentous Laxity

- Generalized ligamentous laxity, as measured by 5th MCP hyperextension, thumb-to-forearm test, and elbow hyperextension has been suggested as a RF for ACL tear.
- Healthy females have greater ligamentous laxity about the knee and ankle compared to males (Beynnon, *AJSM* 2005 Level II)
- Knee laxity alone (passive hyperextension or via KT-1000) or as part of systemic laxity, has also been associated with ACLI in several studies
Ligamentous Laxity and ACLI: What’s the Evidence?

- Level of Evidence II
- Uhorchak, *AJSM*, 2003
  - Prospective cohort of 859 West Point cadets followed over 4 years
  - Male RFs: small notch and generalized laxity
  - Female RFs: small notch, generalized laxity, and high BMI and KT-2000
- Vauhnik, *KSSTA* 2008
  - Prospective cohort of Slovenian female athletes
  - Passive knee hyperextension and anterior laxity preseason a significant RF for ACL injury
Non-modifiable Risk Factors

- Genetics/Family history
- Female Gender
- Small Notch size
- Increased posterior tibial slope
- Small ACL size
- Ligamentous laxity
Non-modifiable Risk Factors

- Genetics/Family history
- Female Gender
- Small Notch size
- Increased posterior tibial slope
- Small ACL size
- Ligamentous laxity

ACL Prevention Program
ACL Injury: Modifiable Risk Factors
Does BMI play a role in ACLI?

- Higher than avg. BMI found to significantly increase risk of ACL injury in female (but not male) military cadets
  - Uhorchak, *AJSM* 2003
  - Single study, level II
Neuromuscular Control

• Several studies have implicated female jump landing and pivoting techniques as different than males and a risk factor for ACL injury
• Basis for several successful ACL prevention programs
  – PEP, SportsMetrics
• Hewett, AJSM 1999, 2005
  – Prospective cohort studies, level II
  – Adolescent females who participated in a pre-season plyometrics program had lower rates of ACL injuries
  – Adolescent female basketball players who jump land with increased knee abduction (valgus knee) had higher rate of ACL injuries
At Risk Jump-Landing technique
Jump Landing Technique
Do hormonal factors play a role in ACLI?

- Higher incidence of ACLI in females
  - this difference is not seen until ~puberty
- Ligamentous laxity
- Relaxin
- Hormone receptors found on ACL
- Highest incidence of ACLI during follicular, pre-ovulatory phase?
- What about oral contraceptives?
Ovarian Cycle
Hormones and ACLI: The Evidence

• Very little evidence
• Conflicting data from level III and IV studies
• OCPs have not been proven to have a protective or deleterious effect on the ACL.....
Extrinsic Risk Factors

- **Cleat type**
  - Higher torsion, higher risk

- **Weather conditions**
  - Hot, dry worse than moist

- **Field surface**
  - Bermuda grass >> Rye grass
  - FieldTurf >> Grass
    - Hershman, *AJSM* 2009
    - 67% higher risk of ACL injury on FieldTurf!

www.UOANJ.com
Extrinsic Factors: What’s the Evidence

- Too few studies to make conclusions regarding cleat type, field condition and turf type
Summary: What does the evidence say about ACL injury risk factors?
ACL Injury Risk Factors?

- **Modifiable**
  - High BMI
  - Jump landing mechanics
  - Hormonal?
  - Playing surface?

- **Non-modifiable**
  - Female Gender
  - Genetics?
  - Notch width
  - ACL size?
  - Tibial slope?
  - Ligamentous laxity
“Screening programs designed to identify those athletes who will best benefit from ACL prevention programs are desirable”

“Those [female] athletes with a prior ACL injury, poor jump landing mechanics, ligamentous laxity, and perhaps a family history are good candidates for such a program”

“Identifying those with anatomic risk factors (small ACL and tight intercondylar notch) may be in our future”
• “Screening programs designed to identify those athletes who will best benefit from ACL prevention programs are desirable”

• RECOMMENDATION: “Those [female] athletes with a prior ACL injury, poor jump landing mechanics, ligamentous laxity, and perhaps a family history are good candidates for such a program”

• “Identifying those with anatomic risk factors (small ACL and tight intercondylar notch) may be in our future”
Evidence Based References

• (Level II or higher)
Modifiable Risk Factors


Non-modifiable risk factors

THANK YOU