Power As a Cost Effective and Practical Clinical Intervention to ACL Injury

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Purpose:

- Explore the research surrounding power as clinical Anterior Cruciate Ligament (ACL) injury identification and prevention strategy.
Learning Objectives

- **EVALUATE** the ease of existing intervention strategies for the four identified factor areas of ACL injury risk in their own practice settings.

- **APPRECIATE** the challenge of caring for a population at elevated ACL injury probability, while being unable to offer cost-effective risk identification or practical intervention strategies.

- **COMPARE** predictive value of power for ACL risk identification to other predictive strategies.

- **CONTRAST** the established guidelines to optimize force dissipation with landing to the tactical limitations in field- and court-based sport.

- **IDENTIFY** practical strategies to develop power for the Athletic Trainer in a high school or college setting.
Conflicts of Interest

- No financial conflicts of interest for this presentation.
Q: Why Are ACL Injuries *Still* A Problem?

O’Donoghue DH. 1964
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Q: Why Are ACL Injuries *Still* A Problem?

Anterior cruciate ligament (ACL) injuries are common, costly, and debilitating.

- Scope of the Challenge
  - Incidence / Prevalence
  - Sex Bias
  - Long-Term Effects
  - Costs
Q: Why Are ACL Injuries *Still* A Problem?

Anterior cruciate ligament (ACL) injuries are common, costly, and debilitating.

- Incidence: 80,000 – 250,000 / Year [Griffin, et al.]
  - Surgical rate 120,000 / Year [Kim, et al. Mall, et al.]

- Change in rate
  - 66-77% change [Hootman, et al.]
  - [Kim, et al, Mall, et al.]

- Highest rate for injury is adolescent to young adult athletic and active populations.
Q: Why Are ACL Injuries *Still* A Problem?

Anterior cruciate ligament (ACL) injuries are common, costly, and debilitating.

- **Sex Bias**
  - 2.29-4.14x as likely to tear
    - [Ireland, et al., Arendt, et al., Gwinn, et al.]
  - Reported as high as 4.75 to 9.74
    - [Gray, et al., Gwinn, et al.]
    - Higher estimates did not match complicating factors
  - Rate is increasing
    - [Hootman, et al.]
Q: Why Are ACL Injuries *Still* A Problem?

Anterior cruciate ligament (ACL) injuries are common, costly, and debilitating.

- **Long-Term Challenges**
  - PMHx ACL injury
    - Re-Injury, OR= 5.24
    - Contralateral Injury
    - Osteoarthritis, OR=3.17
  - [Swärd, et al.]
  - ([Shelbourne, et al., Ratzlaff, et al.]
  - Psychosocial Challenges
    - Depression
    - Anxiety
  - [Kvist, et al.]
Q: Why Are ACL Injuries *Still* A Problem?

Anterior cruciate ligament (ACL) injuries are common, costly, and debilitating.

- Health Care Costs
  - Operative / nonoperative
    - (Surg) $24,452 in 2011 US dollars / $28,305 in 2020
    - (NonSurg) $32,276 in 2011 dollars / $37,362 in 2020
  - Time lost
    - 6 to 12 month, or longer
  - Annual Total Cost $8-$18 Billion


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The Scope of the Challenge

- Prevent rather than treat.

- **Process:** [Van Mechlin, et al]
  - Identify causal factors
  - Implement an Intervention
  - Assess the Intervention
  - Reassess the Impact and Return to Step 1.
Don’t We Already Have ACL Prevention?

- Existing ACL Injury Prevention Programs
  - FIFA 11+
  - SportsMetrics
  - PEP
- Number Needed to Treat = 1
Don’t We Already Have ACL Prevention?

Number Needed to Treat [Sugimoto, et al.]

- NNT = 108 (1 non-contact injury)
- NNT = 120 (1 overall injury)

What is the Risk Reduction?

- Existing ACL Injury Prevention Programs
  - FIFA 11+
  - SportsMetrics
  - PEP

- Number Needed to Treat = 1
Learning Objective 1

- **APPRECIATE** the challenge of caring for a population at elevated ACL injury probability, while being unable to offer cost-effective risk identification or practical intervention strategies.
Learning Objective 2

- **EVALUATE** the ease of existing intervention strategies for the four identified factor areas of ACL injury risk in their own practice settings.
Risk Factor Identification

- Intrinsic Risk Factors
  - Anatomical
  - Hormonal

- Extrinsic Risk Factor
  - Environmental
  - Biomechanical
Risk Factor Identification

- Intrinsic Risk Factors
  - Anatomical
  - Hormonal

Intercondylar Architecture
- Notch Width
- Notch Shape
- Notch to ACL Width Ratio

Static Measures
- Pelvic Positioning
- Subtalar Positioning / Navicular Positioning
- Q-Angle

Stenosis more likely due to
- A Smaller Intercondylar Notch
- A more ‘A’ Shaped Intercondylar
- A smaller Notch-to-ACL size ratio
- All three are more common in females than in males.

- Each could offer greater tissue wear against wall, impingement, guillotine-ing.
- None of the three offer practical or cost-effective identification or intervention.
Risk Factor Identification

Intrinsic Risk Factors
- Anatomical
- Hormonal

Intercondylar Architecture
- Notch Width
- Notch Shape
- Notch to ACL Width Ratio

Static Measures
- Pelvic Positioning  [Shultz, et al.]

Anterior Pelvic Tilt + hip anteversion + navicular drop + knee positioning = predicts anterior knee laxity.
- Challenging to quantify pelvic tilt.
- Does not explain sex difference in equation.

Navicular Drop predicts ACL Injured or non-injured individuals.
- Practical and Cost Effective to Measure.
- May be the result, and not the cause.

Q-Angle not yet correlated to ACL Injury risk, partly due to clinical test metrics.
Risk Factor Identification

Hormonal Differences

- Are we sure measurements are precise?
  - Is it one hormone, or change?

- Great individual variation of hormonal profile, and release timing
- Varying strategies to assess menstrual cycle.

Is it any one hormone, or the change in hormones?
Follicular?
Follicular + Luteal?
Ovulatory?
Menstrual?
Pre-Menstrual?
Risk Factor Identification

Intrinsic Risk Factors
- Anatomical
- Hormonal

Extrinsic Risk Factor
- Environmental
  - Friction at the Shoe-Surface Interface
    - Field temperature [Orchard]

Greater friction at SSI increases risk, but improved sport performance.

Warmer, Drier, ‘stickier’ surfaces increase injury risk.

These factors offer ease of intervention, but don’t explain sex-based differences.
Risk Factor Identification

Intrinsic Risk Factors
- Anatomical
- Hormonal

Extrinsic Risk Factor
- Environmental
  - Biomechanical

Biomechanical
- Landing and Cutting
- Neuromuscular
Risk Factor Identification

Biomechanical

- Landing and Cutting
  - ↑ Excursion = ↑ Time [Lephart, et al.]
  - Tactical decision do not allow for ↑ Excursion [Liederbach, et al.]
Risk Factor Identification

- **Biomechanical**
  - **Landing and Cutting**
    - SLL = ↑ ACL injury incidence [Olsen, et al.]
    - LESS does not prospectively predict ACL Injury [Padua, et al.]
    - LE Kinematics = GRFs [Cacolice, at al.]

- **Intrinsic Risk Factors**
  - Anatomical
  - Hormonal

- **Extrinsic Risk Factor**
  - Environmental
    - **Biomechanical**
Risk Factor Identification

Biomechanical
- Landing and Cutting

Ankle Dorsiflexion PROM predicts 17% of GRFs
Risk Factor Identification

- **Neuromuscular**
  - **Hip Lateral Rotators**

- Intrinsic Risk Factors
  - Anatomical
  - Hormonal

Hip Lateral Rotator Peak Force predicts 22% of GRFs
Risk Factor Identification

- Neuromuscular
  - Use The Force!

- GRFs predict ACL Injury [Hewett, et al.]

- Intrinsic Risk Factors
  - Anatomical
  - Hormonal

- Extrinsic Risk Factor
  - Environmental
  - Biomechanical
Risk Factor Identification

- Neuromuscular
  - Joint Stability and Tissue Strain are dependent upon applied forces and torques [Devita & Skelly, Lafortune, et al. Neumann, Andrews & Axe]

- Intrinsic Risk Factors
  - Anatomical
  - Hormonal

- Extrinsic Risk Factor
  - Environmental
  - Biomechanical
Learning Objective 3 & 4

- **COMPARE** predictive value of power for ACL risk identification to other predictive strategies.

- **CONTRAST** the established guidelines to optimize force dissipation with landing to the tactical limitations in field- and court-based sport.
Learning Objective 5

- **IDENTIFY** practical strategies to develop power for the Athletic Trainer in a high school or college setting.
Power

1. What is it?
2. How do we measure it?
3. How can we increase it?
What is Power

- Power = (Mass / Distance) / Time
- Rapid and strong muscle contraction
- Over
- A Big(ger) Range of Motion
What is Power

- Power = (Mass / Distance) / Time

- Functional Tests
  - Margaria-Kalamen Test
  - Single Leg Triple Hop
  - Vertical Leap
  - Standing Long Jump

- Olympic Lifts
  - Snatch / Clean / Jerk
Testing Power

1. What is it?
2. How do we measure it?
3. How can we increase it?

- Functional Tests
  - Margaria-Kalamen Test
  - Single Leg Triple Hop
  - Vertical Leap
  - Standing Long Jump

- Olympic Lifts
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\[ \text{Power} = \text{Mass} \times \text{Vertical distance} \times \frac{9.8}{t} \]
Testing Power

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Power = ?
Testing Power

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Power = ?

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Power = ?
Testing Power

1. What is it?

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- Olympic Lifts
  - Snatch / Clean / Jerk

Power = ?
What is Power

- Maximize neural activation
- Maximize Strength
- Maximize Range of Motion

1. What is it?
2. How do we measure it?
3. How can we increase it?
Periodization

- Base / Corrective – 6 weeks
- Hypertrophic – 6 weeks
- Power – 6 weeks
- Maintenance – 8 weeks

1. What is it?
2. How do we measure it?
3. How can we increase it?
Thank you