Disclosures

Matthew Matava, M.D.

The following relationships with commercial interests existed during the past 12 months:

- Research Support: Arthrex Inc.  
  Breg Inc.
- Stock: Ostesys
- Governing Board: NFL Physicians Society  
  Southern Orthopedic Association
- Board/Committee: AOSSM STOP Sports Injuries 
  AOSSM Public Relations Committee
Impact of ACL Injury

175,000 ACL Reconstructions Performed in the U.S.

- Increased awareness of ACL injury
- Improved diagnostic methods
- Increased exercise patterns
- Extensive basic science and clinical research
- Title IX and female sports
- Increased media awareness
- Availability of electronic information
Epidemiology of ACL Tears

Dragoo et al., *AJSM* (2012)

ACL injury risk by player position
Epidemiology of ACL Tears

Dragoo et al., *AJSM* (2012)

ACL injury risk by basic mechanism

Games: 10x risk
Artificial turf: 1.4x risk
NFL Combine Data

- 50% incidence of previous knee injury
- ACL injuries: 35% of all knee injuries sustained

- 25% incidence of previous knee surgery
- 8% of participants have a history of ACL injury

- ACL injury is #1 reason for receiving a medical failure grade
- Only 46% of players reporting an ACL injury played at least 1 game
### Incidence of ACL Sprains

<table>
<thead>
<tr>
<th>Year</th>
<th>Preseason</th>
<th></th>
<th>Regular Season</th>
<th></th>
<th>Preseason + Regular Season</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Practice</td>
<td>Game</td>
<td>Total</td>
<td>Practice</td>
<td>Game</td>
<td>Total</td>
</tr>
<tr>
<td>2011</td>
<td>9</td>
<td>9</td>
<td>18</td>
<td>4</td>
<td>33</td>
<td>37</td>
</tr>
<tr>
<td>2012</td>
<td>15</td>
<td>16</td>
<td>31</td>
<td>3</td>
<td>29</td>
<td>32</td>
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<tr>
<td>2013</td>
<td>15</td>
<td>12</td>
<td>27</td>
<td>3</td>
<td>27</td>
<td>30</td>
</tr>
<tr>
<td>2014</td>
<td>12</td>
<td>10</td>
<td>22</td>
<td>0</td>
<td>27</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>12.8</td>
<td>11.8</td>
<td>24.5</td>
<td>2.5</td>
<td>30.5</td>
<td>33.0</td>
</tr>
</tbody>
</table>

4 Year Average
## ACL Injuries by Position

<table>
<thead>
<tr>
<th>Position at Time of Injury</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Contact with Player</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Offense Total</strong></td>
<td>8</td>
<td>14</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td><strong>Offensive Line</strong></td>
<td>2</td>
<td>7</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td><strong>Running Back</strong></td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Tight End</strong></td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td><strong>Quarterback</strong></td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Wide Receiver</strong></td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Defense Total</strong></td>
<td>8</td>
<td>9</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td><strong>Defensive Secondary</strong></td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Defensive Line</strong></td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td><strong>Linebacker</strong></td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Special Teams</strong></td>
<td>7</td>
<td>3</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td><strong>Unclassified Position</strong></td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>27</td>
<td>26</td>
<td>26</td>
<td>25</td>
</tr>
</tbody>
</table>

| **Non-contact**            |      |      |      |      |
| **Total**                  | 15   | 19   | 14   | 11   |
| **Unclassified Position**  | 2    | 0    | 0    | 0    |
Playing Surface and Risk of ACL Injury

Balazs et al., *AJSM* (2014)
- Systematic review of 10 studies (963 ACL tears) evaluating risk of ACL tears in football and soccer as a function of surface
- 4 football-specific studies (753 ACL tears) found an increased risk on synthetic surfaces
- “Spatting” likely reduces risk for injury

Hershman et al., *AJSM* (2012)
- Epidemiologic study of 10 NFL seasons (2000-2009)
- 2680 games; 1528 knee sprains
- 67% higher incidence of ACL tears on Field Turf than grass
Mechanism of ACL Injury

- Valgus-external rotation
- Internal rotation with fixed leg
- Hyperflexion
- Direct contact
  - Hyperextension
  - Varus or valgus force
  - Combined force

60% of NFL ACL Tears are *Contact* Injuries
Mechanism of ACL Injury: NFL

Schnub et al., AAOS Annual Meeting (2015)

- Retrospective video analysis of 27 ACL injuries from 2013-14 NFL season
- Videos analyzed by 3 orthopedists
- Most common limb position:
  - Hip flexion and abduction
  - Knee valgus and slight flexion
  - Foot external rotation
Examination of ACL Injury

- Lachman is the most sensitive test
  - Diminished with tibial avulsion

- Pivot shift best predictor of future instability
  - Implies anterior translation >10mm
  - Pivot-glide seen with joint laxity
  - Side-to-side comparison helpful

- Anterior drawer
  - False+ with joint laxity
  - False- with effusion
  - False- with hamstring spasm

Always examine other knee: eases patient and assess degree of physiologic laxity
Magnetic Resonance Imaging

Primary findings:
- Abnormal course of ligament
- Abnormal signal intensity
- Discontinuity of fibers

Secondary Findings
- Bone contusion
- Uncovering of lateral meniscus
- Anterior tibial translation
- PCL line
- PCL angle <115
Factors Affecting Treatment

Timing of Injury
- Time of season
- Duration of playing career (amateur or professional)
- Player age if skeletally immature
- Prior surgery

Concurrent Injuries
- “Locked” meniscal tear
- MCL sprain (2° or 3°)
- Prior ACL surgery
- Size of effusion
- Stiffness (extension)
ACL Graft Options - 2015

- Patellar Tendon Autograft
- Patellar Tendon Allograft
- Achilles Tendon Allograft
- Hamstring Autograft
- Tibialis Anterior Allograft
- Quadriceps Autograft
- Double-Bundle Reconstruction
Graft Options: Survey of NFL and NCAA Surgeons


**Elite Athlete**
- Single-bundle ACL graft: 99%
- Return to play within 6-9 months: 68%
- Recommend brace wear in running back: 36%

**Recreational Athlete**
- Other (please specify)
- Quadriiceps tendon autograft
- 4-strand semitendinosus-gracilis autograft
- Bone-patellar tendon-bone allograft
- Bone-patellar tendon-bone autograft
- Achilles tendon allograft
- 4-strand semitendinosus-gracilis autograft
- Bone-patellar tendon-bone allograft

**A**

**B**
Autograft vs. Allograft Reconstruction

Pallis et al. *AJSM* (2013)

- Cohort study of US Military Academy (2007-2013)

- 122 ACL reconstruction (120 cadets)
  - Mean: 1.5 year f/u *from entry to academy*
  - 50% BTB auto, 37% HS auto, 13% allo

- 1.6% cumulative failure rate

- Allograft had higher failure rate: vs. BTB, HS AUTO
  - *Allograft (44%)*, BTB auto (11%), HS auto (13%)
  - Cadets with an allograft ACL 7.7x more likely to re-rupture than BTB auto group
Autograft vs. Allograft Reconstruction

Kraeutler et al., AJSM (2013)

- Meta-Analysis: 76 studies
- Primary ACL reconstructions included: BTB auto vs. BTB allo
- 5182 ACLs reviewed (1998-2012)
  - Graft re-rupture rate, return to pre-injury level
  - IKDC, Lysholm, Tegner activity level, Cincinnati Knee Rating
  - Pivot shift, single-legged hop test
  - KT-1000

BTB autograft better vs. BTB allograft
  - Higher IKDC, Lysholm, Tegner, single-legged hop, KT-1000
  - Allograft BTB had 3x re-rupture rate vs. auto BTB
Autograft vs. Allograft Reconstruction


Odds of graft rupture: 4x higher with allografts

N=926
BTB vs. Hamstring Autografts

Heijne et al., KSSTA (2010)

- 68 patients: 34 BTB and 34 Hamstring autografts

- BTB showed improved outcomes at 2 years
  - Anterior knee laxity: 1.5mm vs. 2.5mm (p<.05)
  - Less rotational laxity
  - Higher return to sport (p<.01)

- Proven outcomes vs. hamstring autografts
  - Higher return to sport
  - Improved knee stability
  - Improved muscular strength
BTB vs. Hamstring Autografts

Gifstad et al, AJSM (2014)

- Cohort study of Scandinavian ACL registry (2004-2011)

- 45,998 primary ACL reconstructions

- 3-year follow-up
  - 15% BTB auto, 84% HS auto, 1% allograft/repair
  - 3% revision rate

- BTB autograft: improved outcome vs. hamstring
  - Lower risk of revision across all subgroups:
    - Age
    - Gender
    - Concomitant cartilage injury
My Choice: BTB Autograft

- Easy to harvest
- Rigid fixation
- Reliable graft size
- Autologous bone-to-bone healing
- No risk of disease transmission
- Tensile strength and stiffness > native ACL

Proven outcomes in the literature:
- Knee stability
- Low re-rupture
- Return-to-sports predictable
- Lowest revision rate
- “Gold standard” in the NFL
Ability to Return to Sports

Shah et al., *AJSM* (2010)

- 47 BTB autografts and 2 hamstring ACL-R
- Mean age: 26.2 years
- **63% return-to-play at NFL level**
- Mean time to return to game play: 10.8 months
- Increased return-to-play odds ratio for players:
  - Drafted in rounds 1 through 4 (12.2X)
  - With >4 years of NFL experience (5.5x)

Literature: 56%-76% return-to-play

We may not be as good as we think!
Performance Metrics Following Injury

Carey et al., *AJSM* (2006)

- NFL ACL data from 1998-2002 for running backs and receivers

- Power Rating = \( \frac{\text{total yards}}{10} + (\text{touchdowns} \times 6) \)

- Control group: All running backs and receivers without injury

- Results:
  - 31 running backs and wide receivers
  - >20% of players never returned to the NFL
  - Injured players: 33% in performance (Power Rating)
Performance Metrics Following Injury

Carey et al., AJSM (2006)
Effect of ACL Tear on Career Length

Brophy et al., *AJSM* (2009)

- Compared NFL players with ACL-R to non-surgical control group over 14 seasons

- Meniscectomy alone:
  - Decreased career length (mean: 1.4 years)

- ACL reconstruction alone:
  - No difference in career length

- ACL reconstruction + meniscectomy
  - Decreased career length (mean: 1.8 years)
Osteoarthritis Risk and Football


- 53% incidence of knee injuries in 2,538 retired NFL players
  - 74% ligament/tendon injury
  - 14% ACL tears

- Risk of O.A. in players <40 years:
  - 40% of retired players vs. 12% of U.S. males

- Risk of O.A. in players >60 years:
  - 49% of retired players vs. 41% of U.S. males

- Risk of O.A. associated with:
  - Younger age
  - Higher BMI
  - History of knee or ligament injury
Onset of O.A. is accelerated but not increased in retired players
Conclusions – ACL Tears in Elite Athletes

- High recognition of ACL tears in U.S. – significant sports culture

- Treatment algorithm should take ALL relevant factors into account, *not just the knee injury*

- Consider literature when deciding on graft

- Return-to-sports likely NOT as good as we think

- ACL reconstruction NOT proven to reduce the risk of arthritis
Thank You

Washington University Sports Medicine