



***The Inconvenient Truth:***  
**A Discussion of the Risk of Post-Traumatic  
 Osteoarthritis Development Following  
 Acute Knee Injury**

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*I have no professional or financial affiliations  
 that would bias this work.*



**Learning Objectives**

You will learn...

1. how the risk of knee osteoarthritis compares other chronic diseases treated by sports medicine healthcare professionals
2. the risk of the development of knee osteoarthritis following joint injuries
3. the specific factors that may increase the risk of knee osteoarthritis in patients following joint injury
4. how to identify risk factors that increase the potential for osteoarthritis following knee injury



**Osteoarthritis**

- A traditional view...



*Link et al., 2003*



## Definition

- A complex **disease**
  - initiated by micro- or macro-injury
  - Abnormal joint tissue turnover
  - structural changes throughout the joint
- An **illness** defined by patient-reported symptoms
  - For example: pain, stiffness, crepitus

Lane NE et al. 2011; <http://oarsi.org/research/standardization-osteoarthritis-definitions>



## Phenotypes

- A set of phenotypes (e.g., subsets, conditions, diseases) with a common endpoint
  - For example:
    - Post-traumatic OA after a meniscal injury
    - Repetitive overloading from malalignment or obesity

Zhang W et al. 2009, Driban et al. 2010, Felson DT 2010, Kapoor M et al. 2010, Kraus VB et al. 2010, Bijlsma J et al. 2011



## How bad could it really be?

- >27 million Americans with OA<sup>1</sup>
- Knee OA is one the top 15 causes of disability<sup>2</sup>
  - 8-13% meet current physical activity guidelines<sup>3</sup>
- OA is related to multiple comorbidities<sup>4,5</sup>

1. Lawrence RC et al., 2008; 2. Vos T et al., 2013; 3. Dunlop D et al., 2011; 4. Rahman MM et al., 2013; 5. Katz JD et al., 2010;

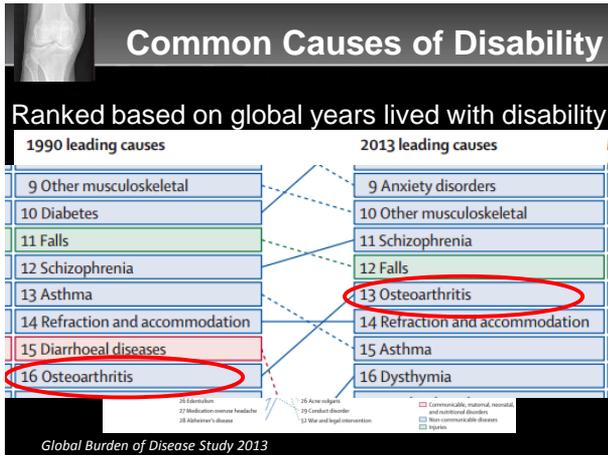


## How bad could it really be?

- Annual absenteeism costs are \$10.3 billion<sup>1</sup>
- Lower extremity post-traumatic OA costs ~\$3 billion/year in direct health care expenses<sup>2</sup>



1. Koltarz H et al., 2010; 2. Brown TD et al., 2006;



## Male Master-Level Track and Field

Self-Reported Complaint	Percent (number)
Knee Osteoarthritis	20% (17)
Knee Pain	24% (20)
Achilles Tendinopathy (pre 45 y/o)	16% (8)
Achilles Tendinopathy (post 45 y/o)	33% (14)
Achilles Tendon Rupture (post 45 y/o)	13% (5)
Shoulder Tendinopathy (pre 45 y/o)	2% (1)
Shoulder Tendinopathy (post 45 y/o)	30% (14)
Shoulder Tendon Rupture (post 45 y/o)	20% (9)
Hospitalization for Back Disease	15% (13)
Hypertension	41% (26)
Heart Attack	6% (4)

Why don't we discuss chronic musculoskeletal conditions more in athletic training?

*Kettunen JA et al., 2006*

## Retired NFL Players

Condition	Percent (number)
Physician-Diagnosed Osteoarthritis <sup>4</sup>	38%
Physician-Diagnosed Arthritis <sup>4</sup>	43%
- Among those under 60 y/o	41%
Lifetime History of Depression <sup>1</sup>	11% (269)
- Among those with 3+ concussions <sup>1</sup>	20%
Cognitive Impairment <sup>2</sup>	35% (180)
Hypertension <sup>3</sup>	38% (97)

1. Guskiewicz KM et al., 2007; 2. Randolph C et al., 2013; 3. Albuquerque FN et al., 2010; 4. Gollightly YM et al., 2009

## Retired NFL Players

- Most Commonly Reported Retirement Problems
  - Difficulty with pain (48%)
  - Loss of fitness and lack of exercise (29%)
  - Weight gain (28%)
  - Trouble sleeping (28%)
  - Difficulty with aging (27%)

*Scwenk TL et al., 2007*

## Retired NFL Players

Los Angeles Times | ARTICLE COLLECTIONS

-- Back to Original Article

Op-Ed

Limping through life after football -- and how doctors can help

*A room full of former players usually means a room full of joint pain. But there is hope.*

February 02, 2014 | By Richard Diana

- "...my teammates had suffered terribly from their years in...football. Several already had undergone knee and hip replacements... **Most had arthritis, and virtually everyone complained of joint pain... Yet most of them were younger than 55.**"

## So What?

- OA is major problem for our retired athletes
- Athletic Training Practice Domain
  - Injury/Illness Prevention & Wellness Protection
- We are in a unique position to advocate and help with OA prevention
- We can help our older athletes (coaches)

## Risk of Knee OA & Joint Injury

- Knee injuries
  - 3 to 6 times more likely to have OA<sup>1</sup>
  - 26% of knees with ACL injury have OA within 5 yrs<sup>2</sup>
  - 15-25% of symptomatic knee OA could be prevented by preventing knee injuries<sup>3</sup>



1. Muthuri SG et al., 2011; 2. Frobell R et al., 2013; 3. Felson & Zhang 1998.  
Image from: <https://www.flickr.com/photos/joncandy/8048470875/>

## Doesn't surgery fix it all?

- Percent of patients with knee OA after an ACL injury
  - ACL reconstruction: 33% to 51%
  - Conservative care: 25% to 42%
- 1 in 3 ACL injured patients will develop PTOA in the first 10 years

Harris K, et al., 2015 (in press); Luc B et al., 2014

## Timing of ACL Reconstruction

- Timing may not influence risk of OA<sup>1,2</sup>
  - Surgery 2 to 24 weeks of injury<sup>1</sup>: 52%
  - Surgery 99 to 136 weeks of injury<sup>1</sup>: 63%

	Number of studies	Significant relationship	No relationship	Best-evidence synthesis
Tibiofemoral OA	6	1 (Longer time = more OA)	5	Moderate evidence for no relationship
Patellofemoral OA	3	0	3	Moderate evidence for no relationship

van Meer BL et al., 2015

1. Ajuied A et al., 2013; 2. van Meer BL et al., 2015

## Graft Type & Surgical Techniques

- Patellar tendon vs hamstring grafts<sup>1,2</sup>
  - More tibiofemoral OA with a hamstring graft
  - No differences in patellofemoral OA
- Double bundle vs single bundle<sup>3</sup>
  - No difference in tibiofemoral or patellofemoral OA



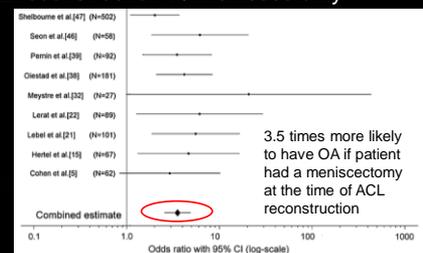
1. Leys T et al., 2011; 2. Barenius B et al., 2014;  
3. Suomalainen P et al., 2012

## Something to Consider

- Typical follow-up is 10-12 years
- Surgical techniques evolve quickly
- MRI and biochemical measurements may enable us to study risk of OA in the first year or two after an injury
  - Moves the concern about OA into our clinical practice

## The Menisci are Important

- OA at 10-12 years after an injury
  - 16% w/ ACL reconstruction w/ no meniscectomy
  - 50% w/ ACL reconstruction w/ meniscectomy



Claes S et al. 2012



## The Menisci are Important

- 14 years after ACL reconstruction
  - Medial meniscal injury at time of surgery
    - 2.5x more likely to have medial tibiofemoral OA
  - Concomitant medial meniscectomy
    - 4.2x more likely to have medial tibiofemoral OA than meniscal repair or no meniscal injury

*Barenius B et al., 2014*



## The Menisci are Important

- Influences long-term benefits of surgery
  - Isolated ACL reconstruction relative risk increase of 43%
  - ACL reconstruction w/ meniscectomy relative risk reduction of 11%

*Claes S et al. 2012; Luc B et al., 2014*



## Menisci are Important

	No OA	Developed OA within 30 months
Presence of baseline meniscal damage	18%	54%

*1. Englund M et al., 2009;*



## Other Injuries

- MCL Sprain
  - ~9-10 years post injury<sup>1,2,3</sup>
    - Grade 2: 0-13% OA (n = 54 patients)
    - Grade 3: 63-68% OA (n = 27 patients)
  - 10 years post injury<sup>4</sup>
    - MCL sprains with other injuries has more OA than isolated MCL sprains

*1. Kannus P 1988; 2. Kannus & Jarvinen M 1988; 3. Lundberg & Messner 1996; 4. Lundberg & Messner 1997*

### Other Knee Injuries

- Traumatic knee dislocations
  - 2-9 years post injury (n = 85 patients)<sup>1</sup>
    - 87% vs 35% in the opposite knee
  - > 5 years post injury (n = 44)<sup>2</sup>
    - 23% had OA
  - ~12 years post injury (n = 56 patients)<sup>3</sup>
    - 38% had OA



1. Engebresten L et al., 2009; 2. Fanelli GC et al., 2014; 3. Hirschmann MT et al., 2010

### Other Injuries

- Patellar Dislocation
  - 6-26 years post injury (85 patients)
    - 22% vs 11% uninjured knee



Mäenpää H & Lehto MU 1997

### Other Injuries

- Recurrent patellar dislocations
  - 12 years post medial patellofemoral ligament reconstruction<sup>1,2</sup>
    - Possible increased risk of patellofemoral OA/OA progression but no clear evidence
  - ~4 years post Insall's proximal realignment surgery<sup>3</sup>
    - 37% have OA
  - Number of dislocations relate to OA<sup>4</sup>



1. Nomura E et al., 2007; 2. Sillanpaa PJ et al., 2011; 3. Schuttler KF et al., 2014; 4. Vollnberg B et al., 2012

### Other Injuries

- Lateral tibial plateau fracture<sup>1</sup>
  - 4.5 years post injury: 68% OA
  - Contralateral knee: 32% OA
- Tibial plateau depression fracture<sup>2</sup>
  - 5.75 years post injury: 44%
- Distal femur intra-articular fractures<sup>3</sup>
  - > 5 years post injury: 83%
- Tibial spine fracture (OR-IF)<sup>4</sup>
  - > 5 years post injury: 19% OA



1. Parkkinen M et al., 2014; 2. Jensen DB et al., 1988; 3. Rademakers MV et al., 2004; 4. Rademakers MV et al., 2009; image: David Puebla via radiopaedia.org

## What about my athlete?\*

- 20 years of age: injures ACL and meniscus
- 25-35 years: radiographic osteoarthritis
- 45-64 years: total knee replacement
- 90 years: death

\* Mock Case Study

## Impact on Quality of Life

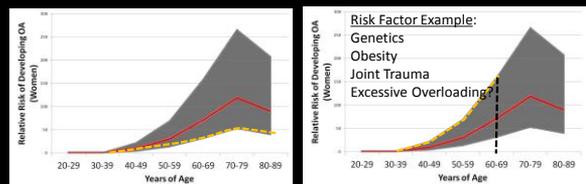
- 20-55 year olds with hip or knee OA
  - 4x more likely to be highly psychologically distressed
  - 67% report OA-related work disability
  - 40-49 y/o: ~40% reduction in quality of life
  - Most were diagnosed in previous 5 years

Ackerman IN et al., 2015

*This cannot be an acceptable outcome by clinicians that emphasize injury and illness prevention.*

- We know this population is at risk for OA
- We know OA is a considerable burden, on par with other chronic conditions
- We often fail to address OA as we do with other chronic conditions

## Standard Warranty



*"The warranty does not cover damage caused by accident, misuse, abuse, failure to follow instructions given in the product documentation,... external environmental causes..."*

## Other OA Risk Factors

- Limited range of motion and OA
  - Limited knee flexion at RTP: 60% more likely to have OA ~10.5 years post surgery
  - Limited extension at RTP: no related to OA



Shelbourne KD et al., 2012

## Body Weight

- Overweight: ~2x more likely to have knee pain/OA<sup>1</sup>
- Obese: ~2.7x more likely to have knee pain<sup>1</sup>
- > 15 lb weight gain within 5 years of ACL-R is a key predictor of poor outcomes<sup>2</sup>

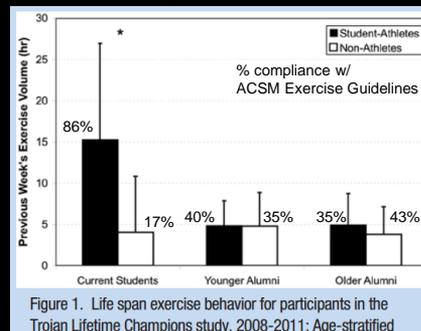
1. Silverwood V et al., 2015; 2. Spindler KP et al., 2005

## A Need to be Active

- ACL Reconstruction (1-8 years post-injury)
  - 50-79% return to pre-injury level of sports
  - Influenced by...
    - Quadriceps strength
    - Knee effusion
    - Knee pain
    - Kinesiophobia
    - Etc.

Czuppon S et al., 2014

## A Need to be Active



Sorenson SC et al., 2014



## Physical Activity and OA

- Physical activity and many sports are safe or even protective<sup>1</sup>
- Men in soccer and certain high-level sports may be at risk for hip or knee OA<sup>2-4</sup>

1. Urquhart DM et al., 2011; 2. Driban JB et al., 2015 (in press); 3. Michaelsson K et al. 2011; 4. Tveit M et al. 2012.



## Physical Activity and OA

- High level long-distance skiers are at high risk for knee or hip OA<sup>2</sup>

Former athletes with more knee OA <sup>1</sup>	Increase in odds of having knee OA
Elite male competitive weightlifting	6.9 (3.3, 14.5)
Elite male wrestling	3.8 (1.8, 8.0)
Elite and nonelite male soccer	3.5 (2.5, 4.8)
Elite male long-distance running	3.3 (1.4, 7.5)

- Military personnel may be at greater risk for knee OA than some athletes<sup>1</sup>

1. Driban JB et al., 2015 (in press); 2. Michaelsson K et al. 2011



## How does OA affect my practice?

- Is it the sport, the amount of training, or injuries?
- A lack of data among female athletes
- A lack of data among former college and HS athletes



## Physical Activity and OA

- Habitual running is not related to OA later in life<sup>1</sup>
- Habitual running while having OA is not related to worsening symptoms or disease<sup>2</sup>

1. Lo GH et al., 2014 (ACR abstract); 2. Lo GH et al., 2015 (OARSI abstract)



### What to look for

- Meniscal injuries
- Severe injuries
- Overweight/obesity
- Factors that may lead to lower physical activity



### When in doubt...

- Think long-term and be proactive



### Thinking Long-Term

- Would you recommend...
  - Brushing teeth to prevent tooth decay?
  - Taking medication to manage high cholesterol or hypertension to reduce the risk of heart attacks?
- Why not also try to prevent OA?



### Thinking Long Term

- Athletic Training Practice Domain
  - Injury/Illness Prevention & Wellness Protection



## What we can do

- Education
  - Defining OA and their risk
  - Behavior modification to reduce OA risk factors
    - Strength training
    - Stretching
    - Maintaining a healthy body weight
    - Regular check-ups



## Things Patients Need to Know

1. Regular physical activity and individualized exercise programs can reduce their pain, prevent worsening of osteoarthritis, and improve their daily function
2. If they are overweight it will be beneficial to lose weight and maintain a healthy weight

*French SD et al., 2015*



## Things Patients Need to Know

3. Living a sedentary life could worsen their risk of osteoarthritis, and also increase their risk of other lifestyle-related diseases such as diabetes and cardiovascular disease

*French SD et al., 2015*



## In the Years to Come

1. We may be key to identifying high-risk patients and intervening early
2. Structure-modifying interventions
3. May need to combine biomechanical and pharmacological interventions
4. May need to individualize treatment strategies

## NATA and ATs are Committed





## What about my athlete?\*

- 15 year old, female, HS athlete in soccer
- BMI = 20 kg/m<sup>2</sup>
- No history of any major joint trauma
- **Let's get this athlete (and her team) engaged in injury prevention programs**

\* Mock Case Study

## What about my athlete?\*

- 20 year old, female, college athlete in soccer
- BMI = 22 kg/m<sup>2</sup>
- Diagnosed with ACL and meniscal tear
- *Advise patient to maintain a healthy lifestyle & optimize neuromuscular control*
  - *For example: maintain healthy body weight*

\* Mock Case Study

## Thank you

- Questions?