ARTICULAR CARTILAGE INJURIES OF THE KNEE

Evidence for Rehabilitation and Return-to-Sport

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Presenter Conflict

No Conflict

- The views expressed in these slides and the today's discussion are mine
- My views may not be the same as the views of my company's clients or my colleagues
- Participants must use discretion when using the information contained in this presentation

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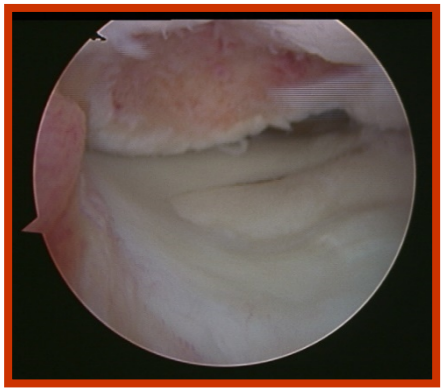
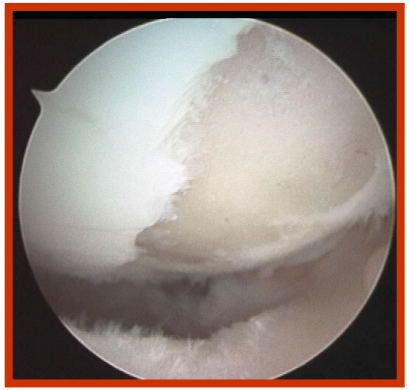
Learning Objectives

- Describe current treatment options for articular cartilage repair of the knee.
- Summarize the best available evidence regarding rehabilitation of articular cartilage injuries.
- Identify clinical outcomes related to return-to-sport following cartilage repair of the knee.

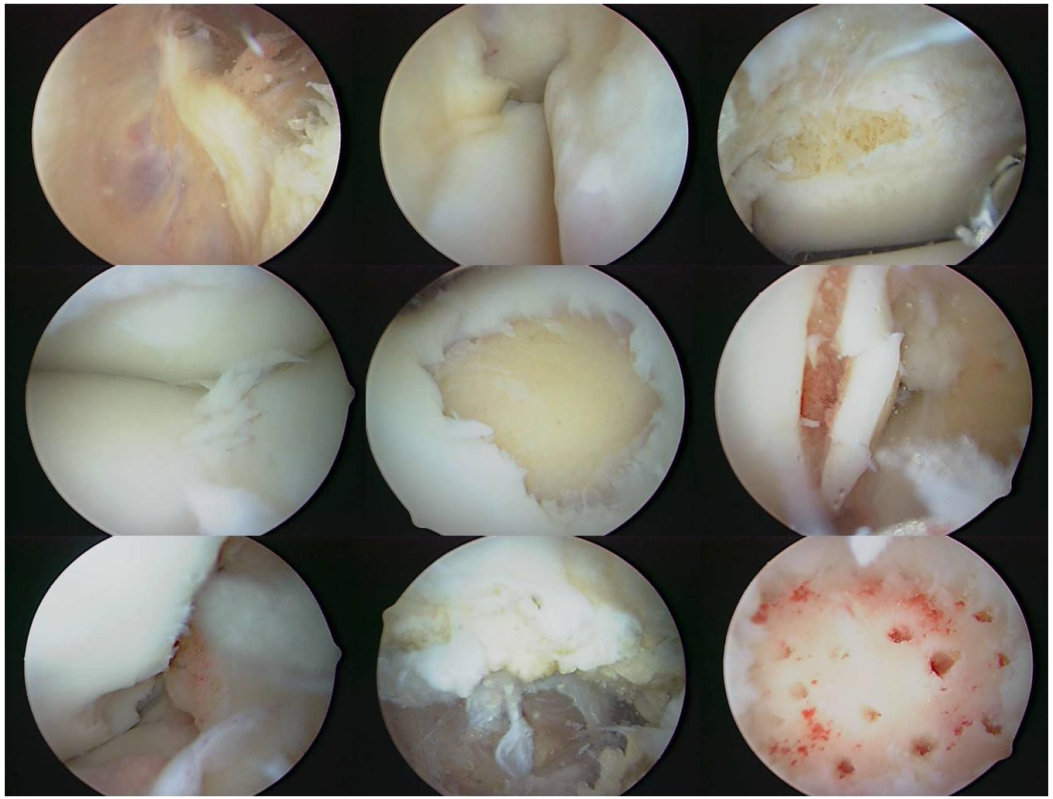
Incidence

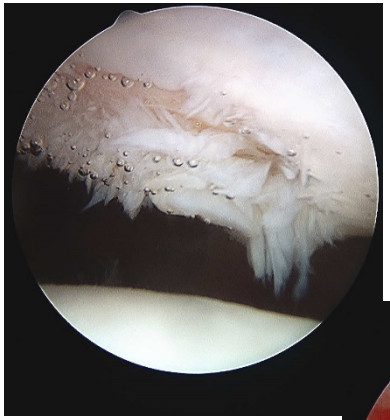
- <25,000 arthroscopies (Widuchowski et al, *The Knee*, 2007)
  - 60% chondral lesions
- Chondral defects observed in 16% to 46% of patients undergoing ACL-R
  (Harris et al., *Med Sci Sports Med*, 2010)
- Among athletes: 36% (Flanigan et al, *Med Sci Sports Med*, 2010)
  - 38% football

Articular Cartilage Tears

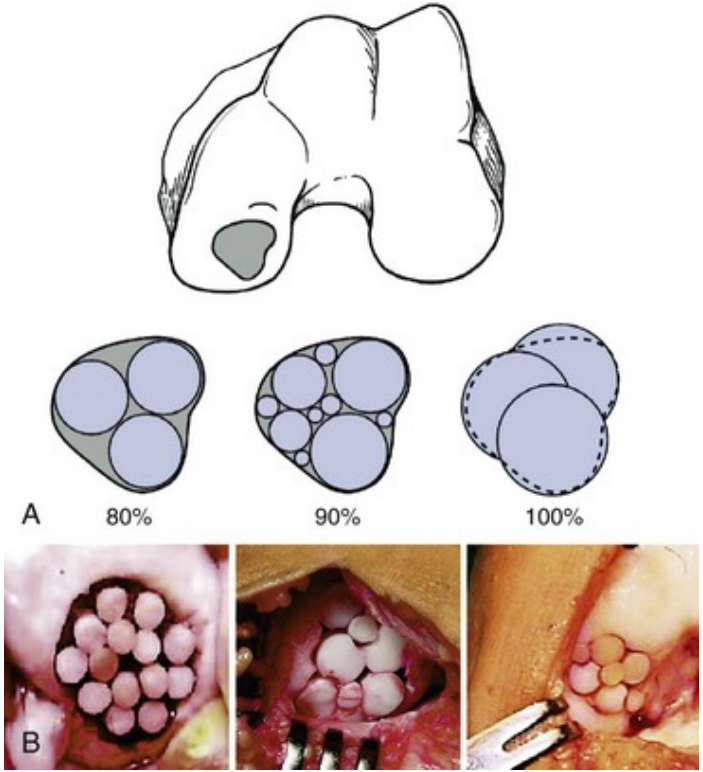




Microfracture





Osteochondral Autograft (OATS)



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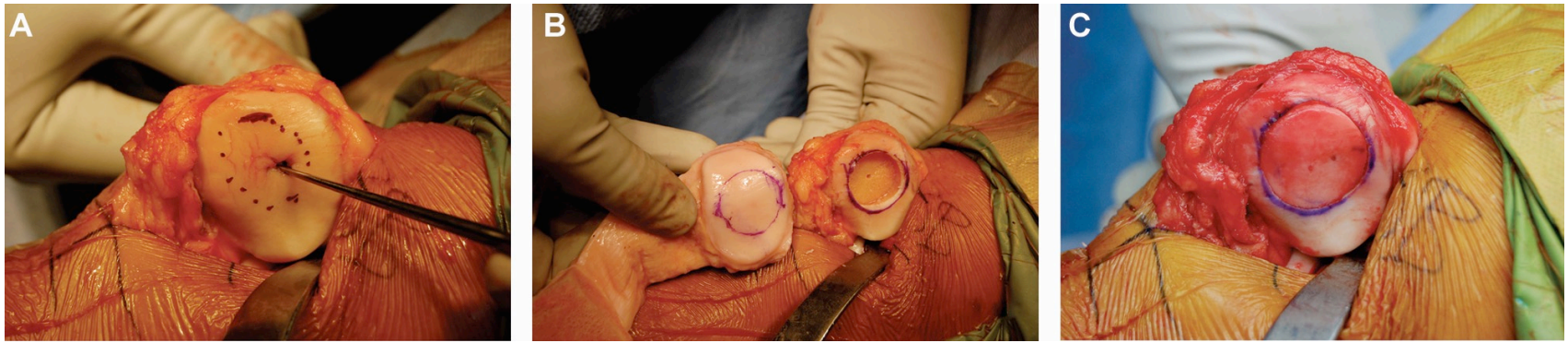
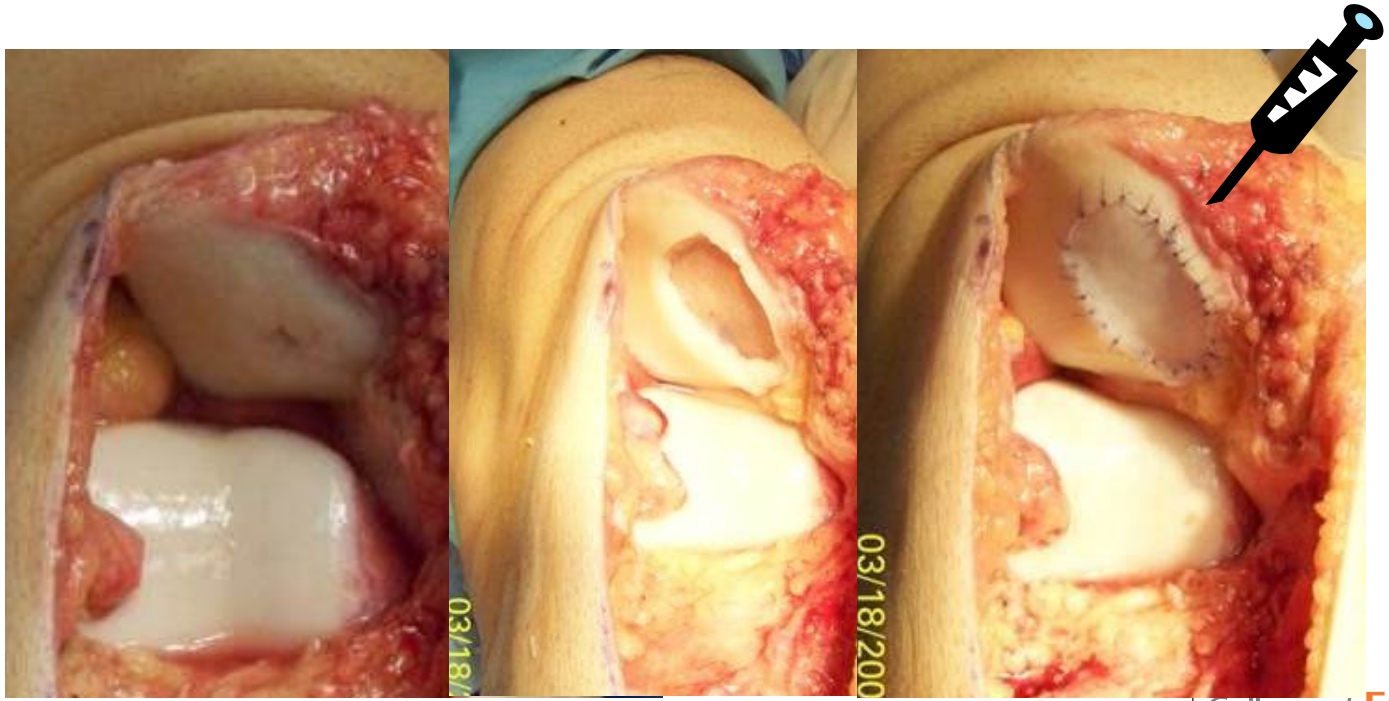
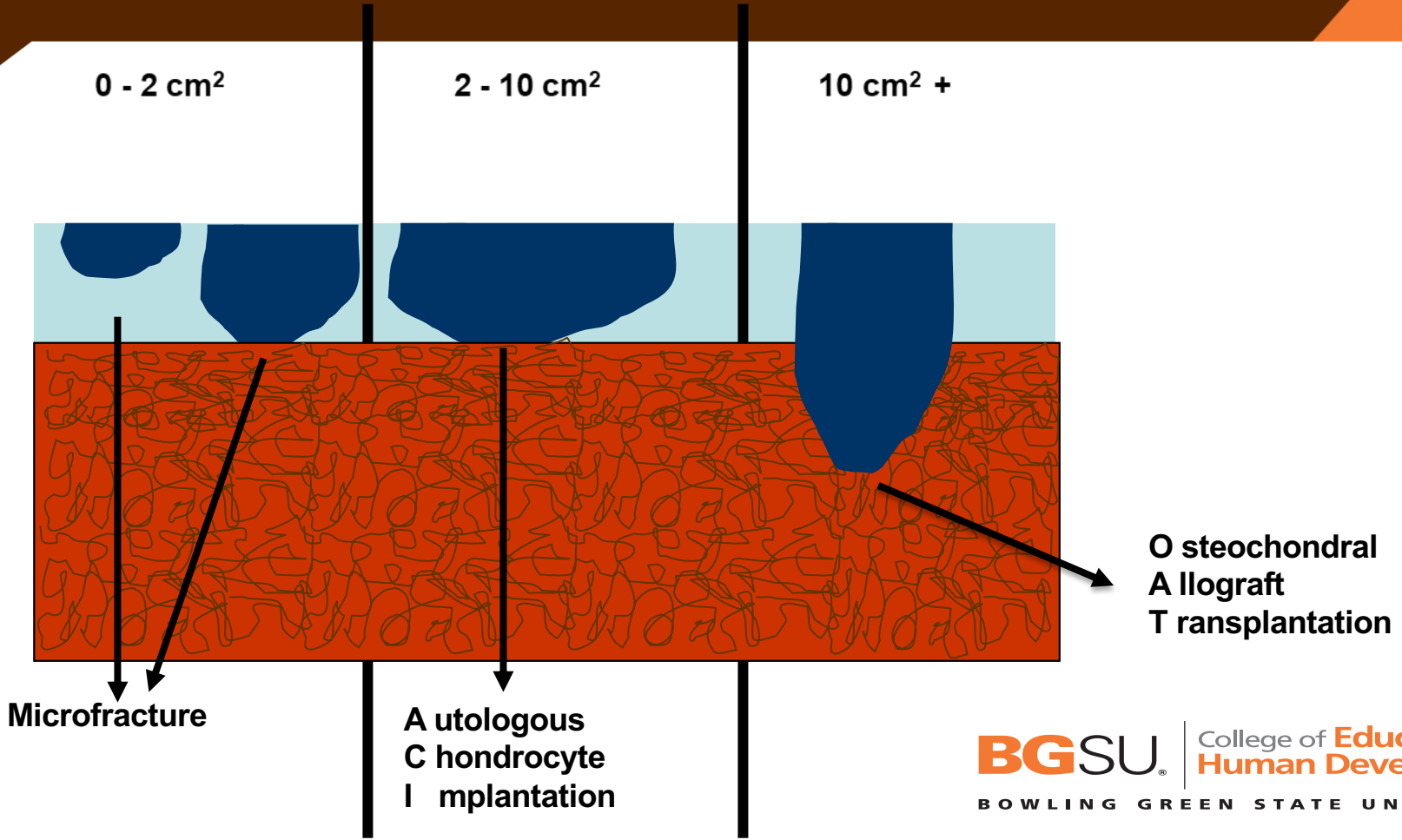
Osteochondral Allograft



(Gracitelli et al., Am J Sports Med, 2015)

Autologous Chondrocyte Implantation (ACI)




0 - 2 cm²
2 - 10 cm²
10 cm² +
Microfracture
A utologous
C hondrocyte
I mplantation
O steochondral
A llograft
T ransplantation

EVIDENCE FOR REHABILITATION

Evidence….or lack thereof

- High-level studies investigating rehabilitative practices following cartilage repair are lacking.

- Rehabilitation guidelines are based almost entirely on expert opinion, basic science, and biomechanics literature.

(Hambly et al., *Clin Sports Med*, 2006; Mithoefer et al., *JOSPT*, 2012)

Rehabilitation Principles

- **Goals:**
  - Provide an optimal environment for recovery and adaptation of repair tissue
  - Return to full function
- **Components:**
  - Progressive WB
  - Restoration of ROM
  - Improvement of Neuromuscular Control

(Hambly et al., *Clin Sports Med*, 2006)

Healing Timeline

Phase 1	Phase 2	Phase 3
• Graft integration & stimulation • **Goals**: joint protection/activation • 0-6 weeks	• Matrix production & organization • **Goals**: progressive loading/functional joint restoration • 6 weeks-9 months	• Cartilage maturation & adaptation • **Goal**: activity restoration • Up to 2 years

(Hambly et al., *Clin Sports Med*, 2006)

Understanding Maturation Consistency

- 1 Week → "Water"
- 3 Months → "Yogurt"
- 6 Months → "Dough"
- 9 Months → "Cheese"
- 1 Year → "Rubber"

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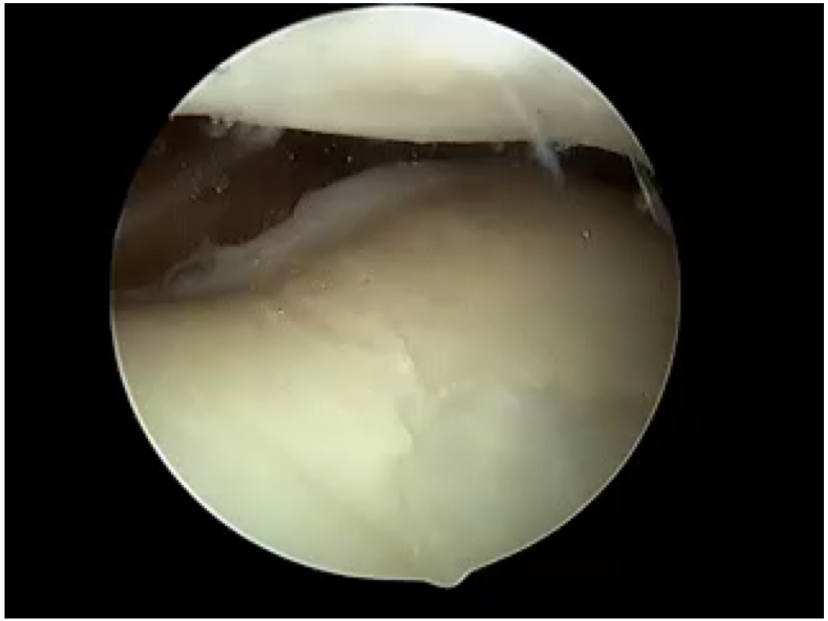
6 weeks Post-Op ACI

6 Months Post-Op ACI

15 Months Post-Op ACI



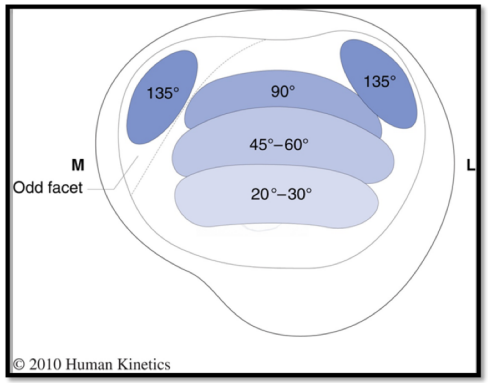
Individualization

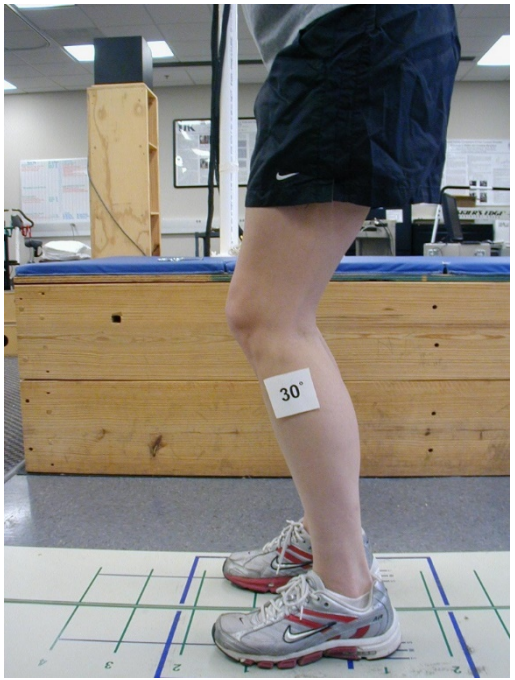
- Age
- Body Mass Index (BMI)
- History of previous injury
- Lesion characteristics
- Quality of surrounding tissue
- Patient expectations
- Activity level

Biomechanics

Patellofemoral Biomechanics

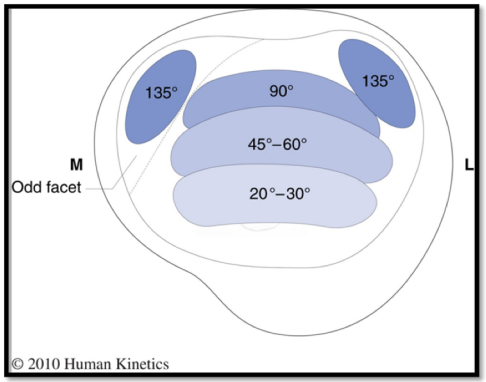
- At 30˚ the inferior facets are in contact
- Area is ~2cm^2





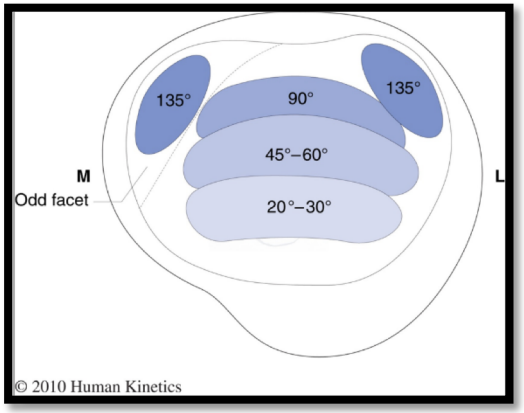
Patellofemoral Biomechanics

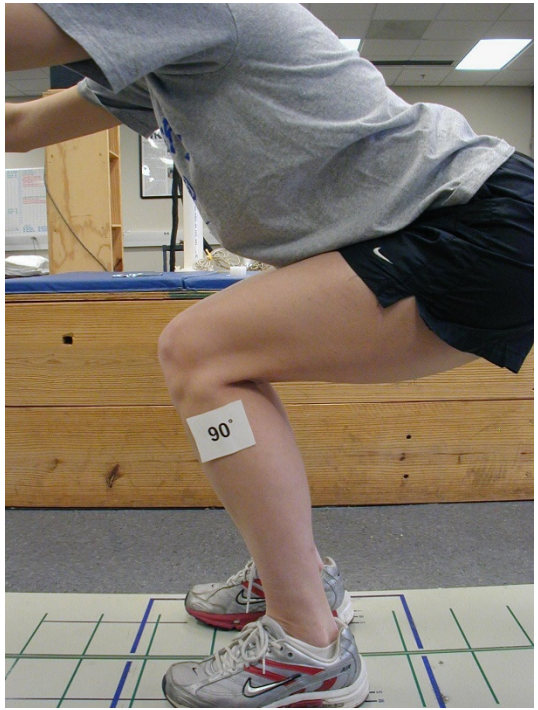
- At 60˚ of knee flexion, the middle facet of the patella is in contact



Patellofemoral Biomechanics

- At 90˚ of knee flexion, the superior facets are in contact
- Contact area is ~6cm^2





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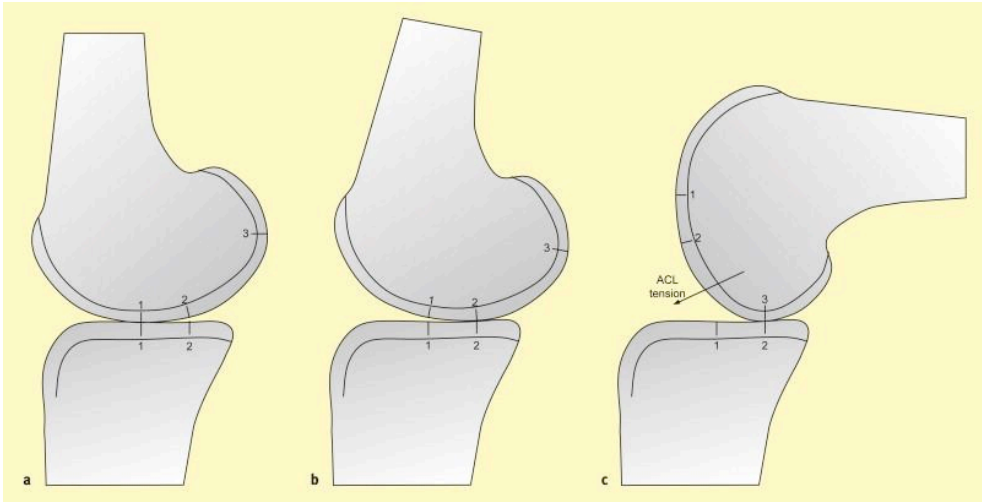
Tibiofemoral Biomechanics

- Hyperextension: contact is anterior
- 0˚: contact is central
- Early flexion: femoral condyles roll posterior
- Deep flexion: contact located posterior

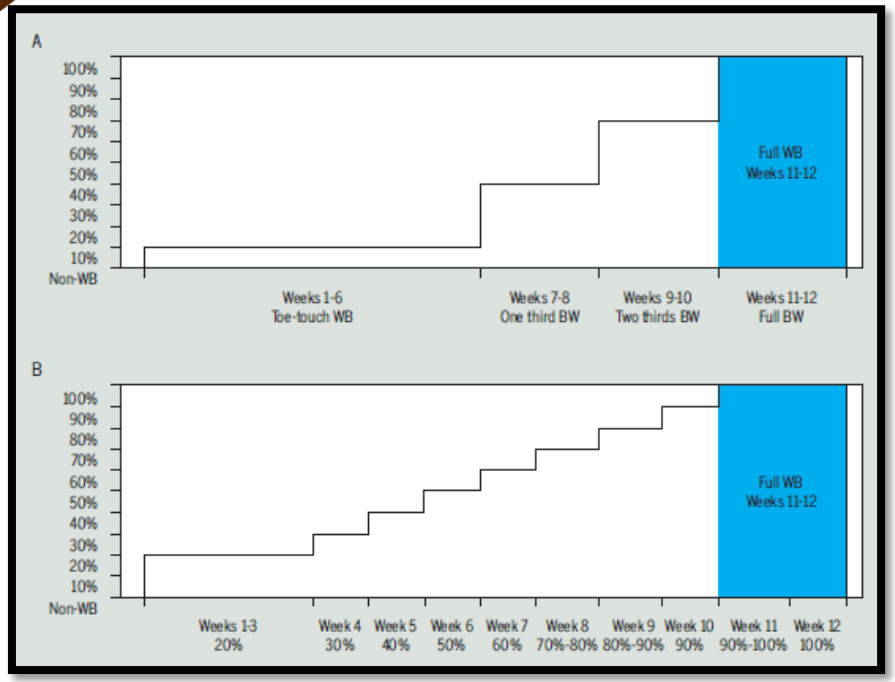


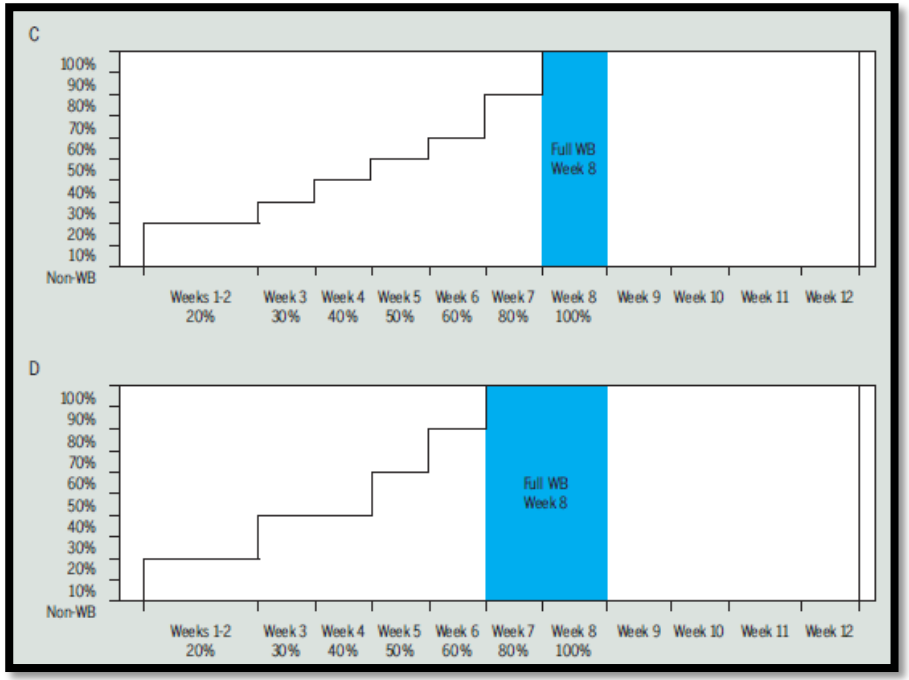
Biomechanics Take-Homes

- A lesion on the **anterior femoral condyle:**
  - May perform exercises in deeper ROM of flexion, but avoid hyperextension
- A lesion on the **posterior femoral condyle:**
  - Avoid exercise in deep flexion due to rolling-sliding
- A **patellofemoral lesion:**
  - In a position of 0˚ extension, the patella is not in contact with the trochlea (lock-out brace)
  - OKC: avoid 0˚- 30˚ due to PF joint compression forces
  - CKC: avoid 60˚ - 90˚due to PF joint compression forces

Weight-Bearing

- Unloading and immobilization have been shown to be detrimental to articular cartilage healing.
  (Vanwanseele et al., *Osteo Cartil*, 2002)
- Excessive loading may lead to cartilage degeneration.
  (Walker et al., *J Orthop Sports Phys Ther*, 1998)





The Evolution of Weight-Bearing

Ebert et al., *J Sport Rehabil*, 2014

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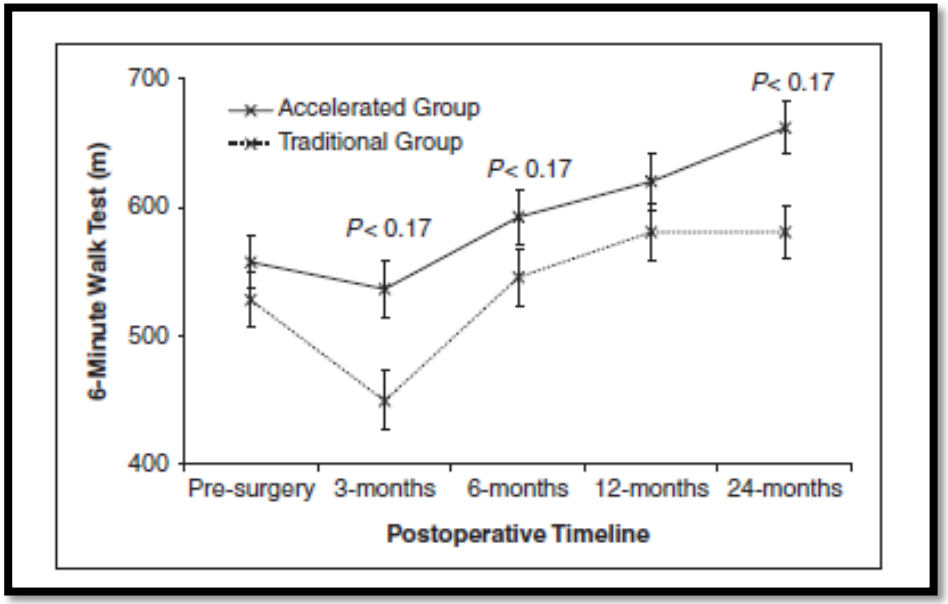
(Edwards et al, *JOSPT*, 2014)

WB: Short-Term Results

- 6-24 months post-surgery:
  - Improvements in pain, function, quality of life, and earlier attainment of full knee extension (4 weeks vs. 12 weeks) have been observed in patients undergoing an accelerated WB program. (Ebert et al., *Cartilage*, 2008; Edwards et al., *Am J Sports Med*, 2013)
  - No differences in graft quality between groups at 12 months. (Edwards et al., *Am J Sports Med*, 2013)
  - A lower level of gait dysfunction has also been demonstrated in patients undergoing an accelerated WB program. (Ebert et al., *Clin Biomech*, 2010)

WB: Short-Term Results



(Ebert et al., *Cartilage*, 2008)

WB: Long-Term Results

- 5 years post-op MACI femoral condyles:
  - No difference in MRI scores 5 years post-surgery between groups undergoing accelerated WB vs. delayed WB.
  - However, both groups exhibited a significant increase in bone edema at 2 and 5 years post-surgery.

(Wondrasch et al., *Am J Sports Med*, 2015)

Motion

- **Continuous Passive Motion**
  - Basic Science Support:
    - Stimulates chondrocyte synthesis, nourishes articular cartilage, prevents adhesions, and has an anti-inflammatory effect.
    - Supports the use of CPM dosages of 6-8 hours/day
      (Salter et al. *JBJS*, 1980; Ferretti et al., *J. Ortho Res*, 2005; Williams et al., *Clin Ortho Rel Res*, 1994)
  - Clinical Science Support:
    - 85% satisfactory outcome in patients using CPM 6-8 h/day compared to 55% satisfactory outcome in patients who did not utilize a CPM following microfracture
      (Rodrigo et al., *The Am J. Of Knee Surgery*, 1994)

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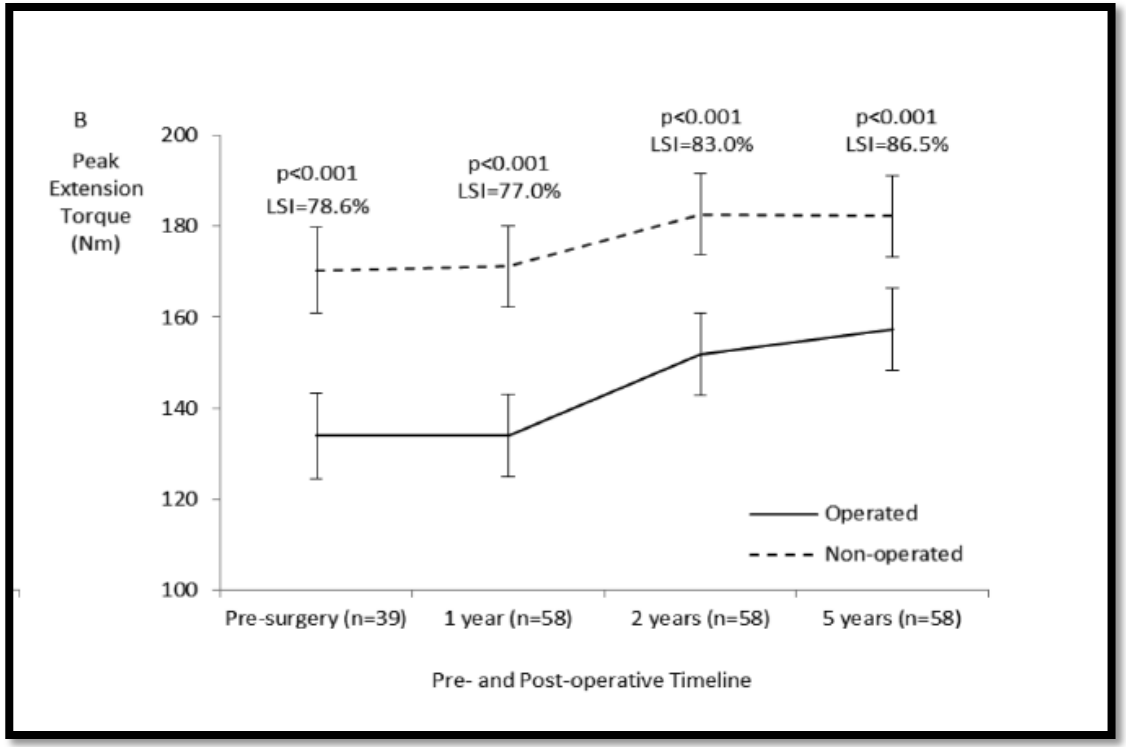
Motion

- **Active Motion**
  - Active ROM resulted in improved joint position sense compared to CPM
  - Active ROM reduces atrophy associated with NWB and immobilization
    (Freimert et al., *J Knee Surg Sports Traumatol Arthrosc*, 2006)

Strength

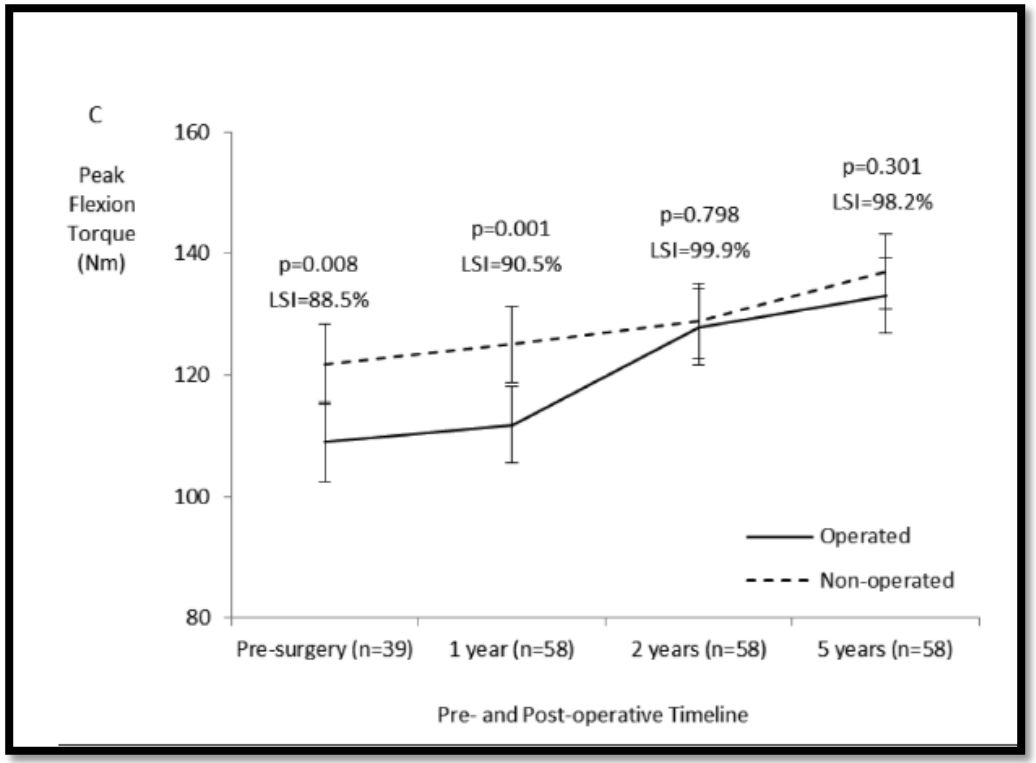
- Mid- and long-term results demonstrate that a majority of patients with femoral condyle lesions (53-73%) demonstrated an LSI for peak knee-extensor strength ≤ 90%. (Ebert et al., *J Sport Rehabil*, 2014)
  - 1 year: LSI=77%
  - 2 years: LSI=83%
  - 5 years: LSI=86.5%
  - 7.4 years: LSI=81.1% (Loken et al., *Knee Surg Sports Traumatol Arthrosc*, 2009)
- Significant decreases in peak extensor torque at 12 and 24 months in patients with patellofemoral lesions. (Ebert et al., *Am J Sports Med*, 2015)

Strength



(Ebert et al., *J Sport Rehabil*, 2014)

Strength



(Ebert et al., *J Sport Rehabil*, 2014)

Strength

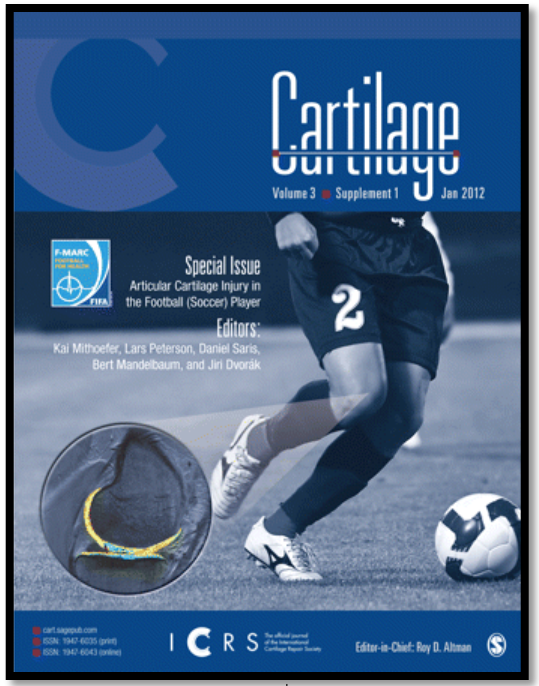
- Significant peak extensor strength deficits at 4 years in patients with femoral condyle and patellofemoral lesions. (Muller et al., *Knee Surg Sports Traumatol Arthrosc*, 2015)
  - Greatest strength deficits occurred in the patellofemoral group
- OKC vs. CKC?

EVIDENCE FOR RETURN-TO-SPORT

Return-To-Sport

- Existing research- predominantly in soccer
- Younger patients, earlier surgical intervention do better

(Steinwachs et al, *Cartilage*, 2013)



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Return To Sport

- Mithoefer et al., 2009
  - Systematic Review
  - 1,363 patients
  - Avg. f/u 42 ± 3 months (18-84 months)
  - Avg. defect size 3.6 ± 0.4 cm^2 (1.9-6.5)
  - Studies:
    - Microfracture (n=12)
    - ACI (n=7)
    - Osteochondral Autograft (n=5)
    - Osteochondral Allograft (n=1)

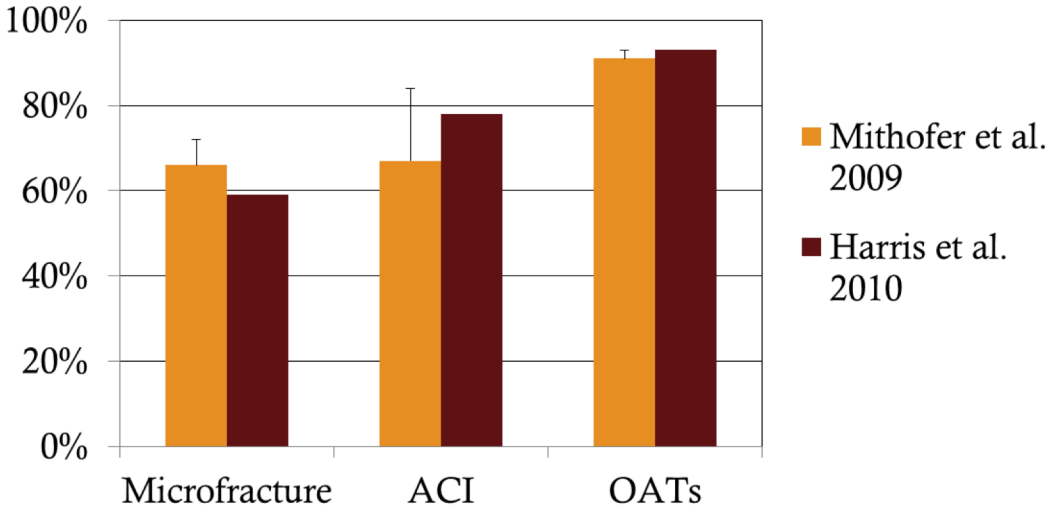
(Mithoefer et al., *AJSM*, 2009)

Return To Sport

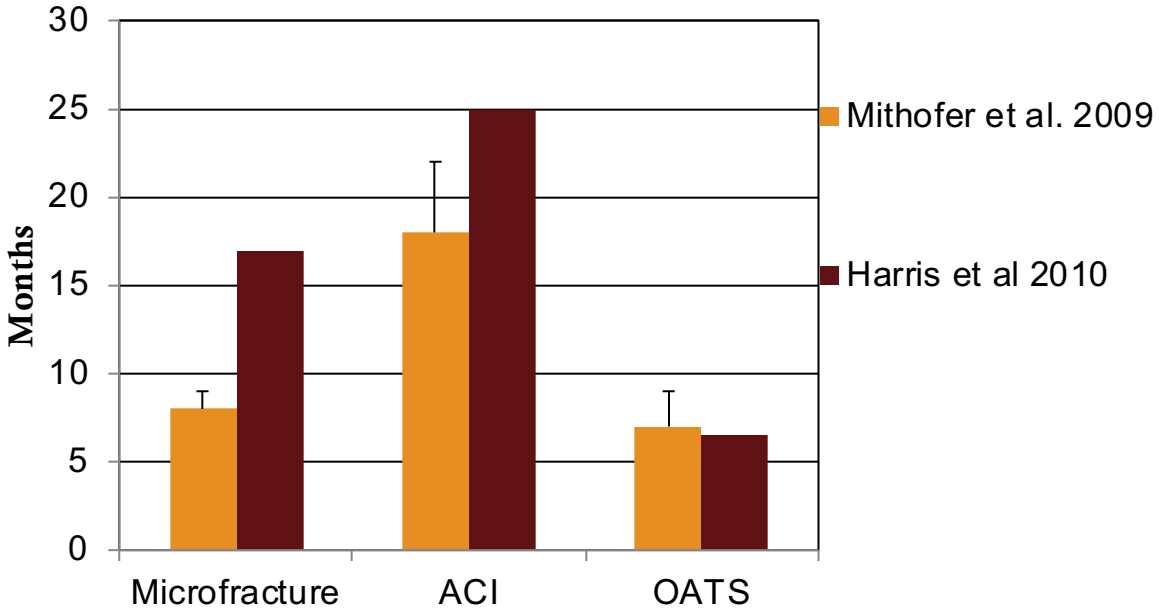
- Harris et al., 2010
  - Systematic Review
  - 730 patients
  - Studies:
    - Microfracture (n=8)
    - ACI (n=3)
    - Osteochondral Autograft (n=1)
    - Osteochondral Allograft (n=0)

(Harris et al., *Arthroscopy*, 2010)

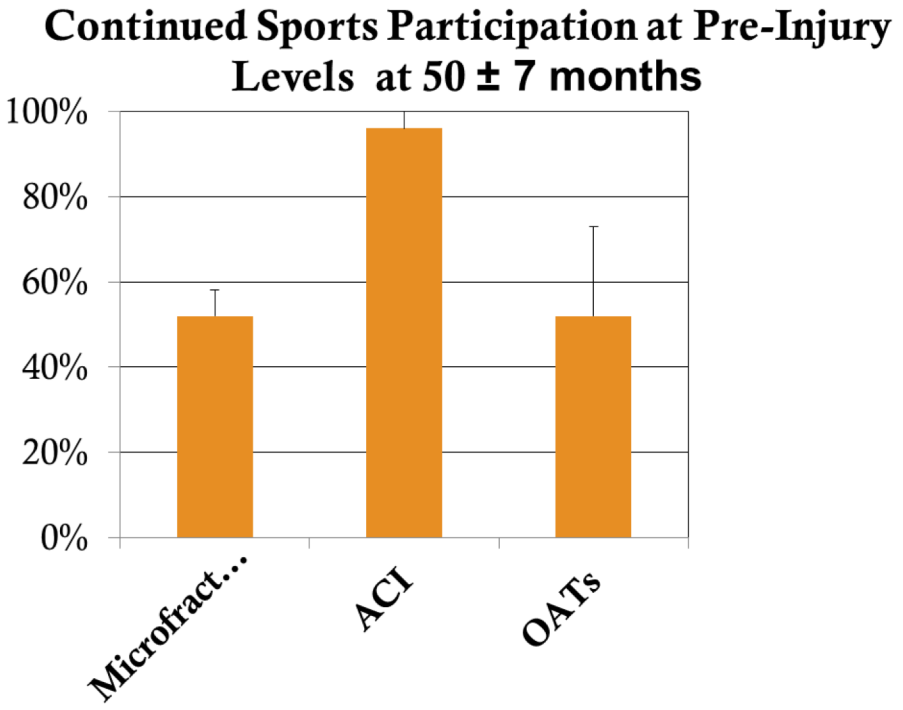
Rate of Return To Sport



Time to Return to Sport



Mithoefer et al., AJSM, 2009



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Return To Sport

- Niethammer et al., 2014
  - 44 patients with femoral condyle and patellofemoral lesions
  - MACI procedure
  - Mean age of 35 years
  - 2 year follow-up
  - 3 Groups:
    - Group 1: RTP <6 months
    - Group 2: RTP 6-12 months
    - Group 3: RTP >12 months

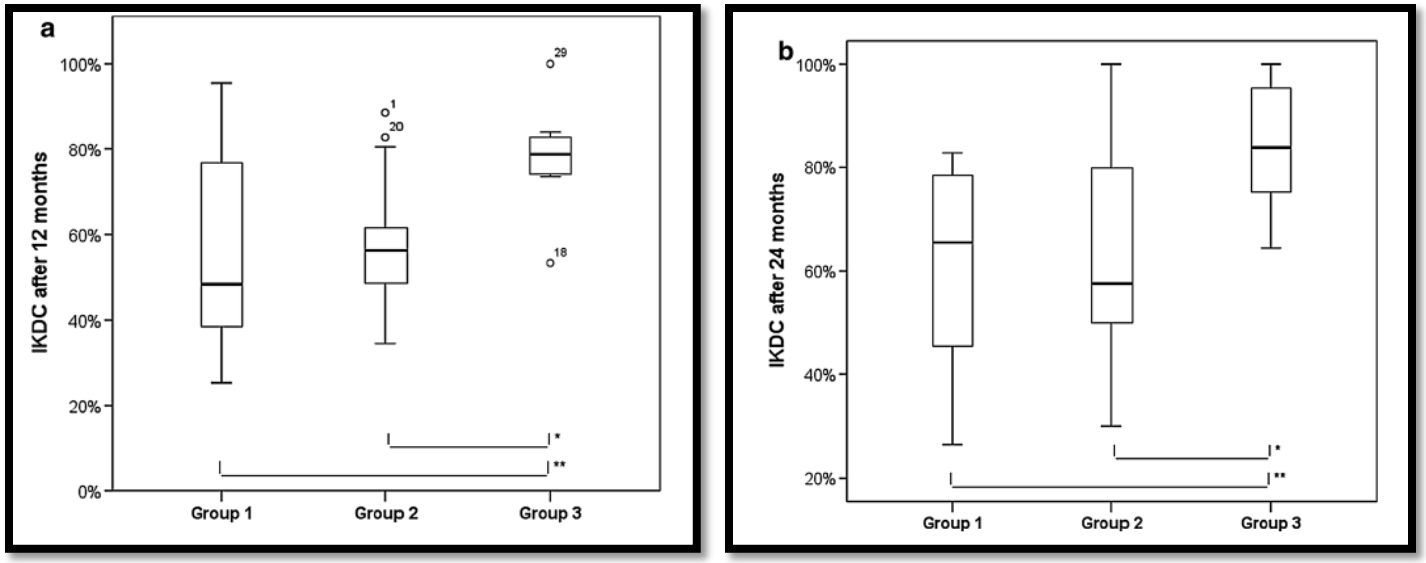
(Niethammer et al., *Knee Surg Sports Traumatol Arthros*, 2014)

Return To Sport

- Results:
  - Average time to RTP: 10.2 months
  - RTP rate 2 years post-surgery: 97.5%
  - 55% of patients able to return to pre-injury sport level
  - 35% of patients returned to sport at a lower level
  - **Group 3 (RTP >12 months) had significantly better clinical results after two years**

(Niethammer et al., *Knee Surg Sports Traumatol Arthros*, 2014)

Return To Sport



12 Months

24 Months

(Niethammer et al., *Knee Surg Sports Traumatol Arthros*, 2014)

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Return To Sport

- Campbell et al., 2016
  - Systematic Review
  - 1,170 patients
  - Studies:
    - Microfracture (n=529 patients)
    - ACI (n=259 patients)
    - Osteochondral Autograft (n=139 patients)
    - Osteochondral Allograft (n=43 patients)

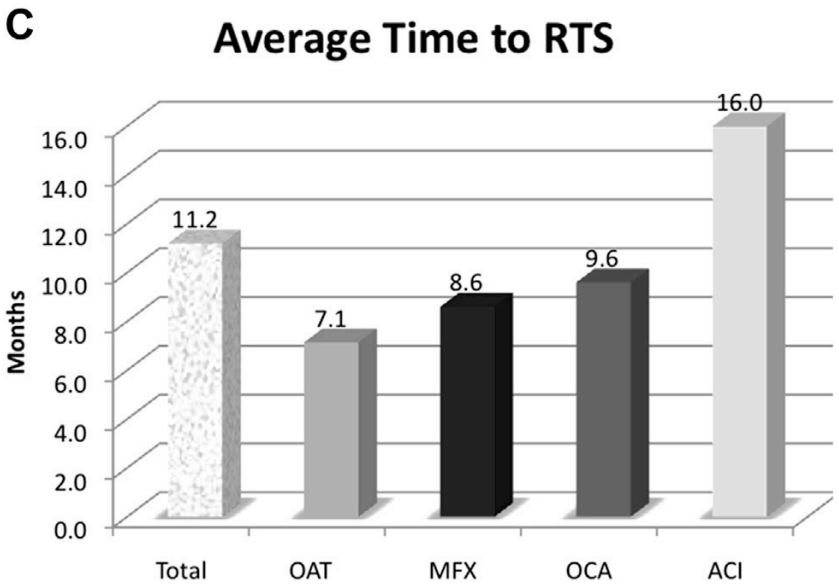
(Campbell et al., *J Arthroscop Rel Surg*, 2016)

Return To Sport

- Results:
  - Osteochondral autograft and ACI had statistically significantly greater rates of return to sport compared to microfracture
  - Time to return to sports was fastest after osteochondral autograft (mean 7.1 months)
  - Patient characteristics that impacted return-to-sport:
    - Age: <30
    - Pre-operative duration of symptoms: <12 months
    - History of previous surgeries: 67% of athletes that had undergone previous surgical interventions did not return-to-sport
    - Defect size and location: MFC, lesions <2 cm^2

(Campbell et al., *J Arthroscop Rel Surg*, 2016)

Return To Sport



(Campbell et al., *J Arthroscop Rel Surg*, 2016)

Clinical Take-Home Points

- The healing process cannot be rushed.
- Individualize the rehabilitation plan.
- Remember biomechanics!
- Communication with the surgeon is key.
  - Exact size and location of the lesion

Clinical Take-Home Points

- There is strong evidence to support accelerated weight-bearing without affecting outcomes.
- Moderate evidence suggests that extensor strength deficits persist as late as 5 years post-surgery.
- Weak clinical evidence supports the use of CPM.
- Return-to-sport:
  - Microfracture: quickest return to sport, but may deteriorate over time
  - ACI: longer return to sport, but may stay active longer
  - Patients returning to sport (impact) >12 months have better outcomes.

THANK YOU!

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