Athletes and Cartilage Injuries

Cartilage Injuries in Athletes vs. General Population

**Athletes**
- 36% of all athletes – Flanagan et al., Med Sci Sports Exer 2010
- 38% Football (NFL Draft) – Hirshorn, Arthroscopy 2010
- 45% Basketball, Preseason MRI – Kaplan et al., Arthroscopy 2005

**General Population**
- 20% Isolated Lesions – Aronen et al. AJSM 2004
- 5% Isolated Lesions <40 yo – Curl et al. Arthroscopy 2007
Summary of Athletes vs. Population

<table>
<thead>
<tr>
<th>Athletes</th>
<th>Non-Athletes</th>
</tr>
</thead>
<tbody>
<tr>
<td>36-59%</td>
<td>5-20%</td>
</tr>
</tbody>
</table>

Loading
- Pattern
- Frequency
- Intensity

Type of Sport Impact

Risk of Osteoarthritis

Mets tens of et al. Cartilage 2013
**Associated Lesions**

Noyes et al. JBJS 1980

- 40-70% of cartilage lesions are associated with ACL rupture in Athletes
- 40-50% of meniscus injuries associated with Cartilage injuries in Athletes

**Consequences of a Professional Career**

Increased Risk of OA in professional athletes

- 32-49% Diagnosed with Symptomatic OA
- Increased Odds Ratio (2.1x) for TKA vs Control


**How to identify the ideal cartilage procedure for the individual patient?**
The Patient is an Individual
Needs an Individualized Treatment Solution
Surgery is an Art not an Algorithm
Evidenced based when possible

“The art of medicine consists of amusing the patient while nature cures the disease.” - Voltaire

The Patient Factors
Age
BMI
Smoker
Activity Level/Goals

“Patients who do well are those who were selected well”
Age

Younger patients do better.
- Knutzen JBJS 2007
- 77% satisfactory <30
- Kon AJSM 2011
- Low failure rates <40

BMI

Obesity
- "Joint biologic preservation starts in the kitchen." - Dr. Brian Cole
- BMI > 30 – Significantly worse clinical outcome with Microfracture
- Osteotomy Literature significantly worse survivorship and outcomes with BW > 1.32 x normal
- Insurance often will not approve at BMI > 30, 35

Smoking

The Effect of Smoking on Ligament and Cartilage Surgery in the Knee: A Systematic Review

Lower IKDC, KOOS, mod Cincy, ICRS scores
Decreased macroscopic and microscopic Hyaline-like tissue at 2nd Look.
Activity Level / Goals

The Knee
- Alignment
- Stability
- Meniscus
- Cartilage Lesion/OA

The Lesion
- Size
- Location
- Depth
- Borders & Subchondral Bone
- Previous Treatment
Surgical Management

Surgical Management of Symptomatic Articular Cartilage Defects in the Young Adult Knee

- Nonresponsive to appropriate conservative treatment
- Neutral Alignment
- Stable
- Lack of Inflammatory Disease
- Functional Meniscus Tissue

What is the ideal Cartilage Treatment?

- Restore Hyaline Cartilage
- Restore Subchondral Bone
- Low Morbidity
- High Durability
- Early Return to activity
- Low Cost
- Technically Reproducible

Surgical Treatment Types

- Debridement/Marrow Stimulation
  - Chondroplasty, Microfracture, Abrasion Arthroplasty
- Osteochondral Grafting
  - Autologous and Allograft, Cartiform
- Osteochondral Scaffolds
  - TrueFit Plugs, Biocartilage
- Cell Therapy
  - MACI, Minced Cartilage
- Stem Cell Treatment / Innovative Options
  - Largely European
Debridement/Marrow Stimulation

Osteochondral Grafting

Cell Based Therapies
Considerations
Not all Cartilage Lesions are symptomatic
Surgical intervention reserved for Grade III/IV symptomatic Lesions

Lesion Specific Considerations
CAUTION
SIZE DOES MATTER
Size the Lesion

Post Debridement

Area = Length x Width = cm²

Consider relative size of the knee

Treatment Options: < 2cm²

Bone Marrow Stim (BMS), Osteochondral Graft, Cell Therapy

Absence of Comparative Trials in Small Lesions

Cost of Cell Therapy

Treatment Options: 2-4cm²

Cell Based Therapies (MACI), Osteochondral Grafts

• Intermediate Term results of BMS are poor

• High Donor Site Morbidity of Osteochondral Autografts

• Augmented Microfracture Techniques (Microfx + Biocartilage)

• May be considered but current evidence is inconclusive

• May be an option if cost or insurance limits alternatives
Treatment Options: >4cm²

BMS, Osteochondral Autograft NOT indicated

Cell Based Therapy or Osteochondral Allograft

- Considerations of cost, availability and risk of infection/disease transmission.

How do we define success?
What are our benchmarks?

What do our patients expect?

"More and more patients are going to the Internet for medical advice. I keep my practice going. I changed my name to Dr. Google."
What do we expect our benchmarks to be?

- Improved Pain
- Improved Function
- Long term outcomes that are **DURABLE**

*** There is no ideal solution thus we cannot expect our outcomes to be perfect.

Case Example

24 yo Female
- Right Knee Pain
- OCD Pinning 2011
- Progressive Symptoms over 2 years

Treatment Options?

- Marrow Stimulation
- Osteochondral Autograft Transfer
- Osteochondral Allograft Transfer
- ACI/MACI/Cell-Based Therapies
Case Example

How do treatment options compare?

Wide Variation in how Outcomes are Reported
- Success/Failure
  - Survivorship from TKA vs. Reoperation vs. Good/Excellent
- Patient Reported Outcomes
  - KOOS, IKDC, Lysholm
- Activity Level
  - Return to sports, Tegner, Metrics
What is the solution?
EQ-5D
KOOS
IKDC
Tegner
Kujala
THE C R S Workflow

How does my patient compare?

"Ideal" lesion
Early OA in young patient

Defect 2.8 ± 1.4 cm²
Mean 2 year follow-up
100% simple lesions
0% combined procedures

Defect 8.4 ± 5.5 cm²
Mean 12 year follow-up
8% simple lesions
62% combined procedures
Activity Level
Matched Cohort OATs vs Microfracture

Chondral lesions only
Prospective randomized trial
Volume control matched
A priori power analysis
Matched for age, gender, defect location and size (2:1 ratio)

Similar clinical outcomes
- SF-36
- IKDC
- KOOS ADLs

Very difficult functional scores

Graph showing changes over time (baseline to 5 years) for the OAT and MFC groups with numerical values for each time point.
Timing of Surgery
Peterson, L. CORR (2000)

- Acute Surgery within 1 year onset of symptoms had better clinical outcomes.
  - Athletic and Quadriceps conditioning
  - Thickened Subchondral Bone
  - Expanding Large Lesions
  - Joint Homeostasis

What do we expect our benchmarks to be?

Improved Pain
Improved Function

Long term outcomes that are DURABLE
- No Failures
- No Osteoarthritis
- No Total Knee Arthroplasties

Will I have improvement in pain?

Patient
- "I will be pain free"

Clinician
- "We can improve your pain during activities of daily living"
SUMMIT TRIAL

- MACI vs MFX at 5 years
- 128 of 140 patients
- Continued Superior KOOS Pain Scores and Function Scores for MACI Group

KOOS Pain after TKA

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre-operative score (mean±SD)</th>
<th>Post-operative score (mean±SD)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IKP-F</td>
<td>20 (5–81)</td>
<td>77 (20–100)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>KOOS Function</td>
<td>47 (10–92)</td>
<td>50 (20–100)</td>
<td>0.003</td>
</tr>
<tr>
<td>KOOS-ADL</td>
<td>57 (1–81)</td>
<td>53 (20–100)</td>
<td>0.008</td>
</tr>
<tr>
<td>KOOS sports and recreation</td>
<td>45 (5–95)</td>
<td>35 (20–100)</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>KOOS QoL</td>
<td>47 (0–75)</td>
<td>69 (20–100)</td>
<td>&lt;0.001</td>
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Will I have improvement in pain?

- **Patient**
  - "I will be pain free"
- **Clinician**
  - "We can improve your pain during activities of daily living"
What do we expect our benchmarks to be?

**Improved Pain**

**Improved Function**
Long term outcomes that are DURABLE
- No Failures
- No Osteoarthritis
- No Total Knee Arthroplasties

Will I have improvement in function?

<table>
<thead>
<tr>
<th>Patient</th>
<th>Surgeon</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;I will be back to sports without limitation&quot;</td>
<td>&quot;We can improve your daily function and hopefully get you back to some sporting activities&quot;</td>
</tr>
</tbody>
</table>

Microfracture Results

**Good short term results**
Cerynik et al. KSSTA 2009 (NBA)
- 71% Return for >/= 2 seasons

Steadman et al. J Knee Surg 2003 (NFL)
- 70% Return for avg. 4.5 seasons
Microfracture Results

- 67 Athletes, Prospective Study
- Average 15.1 year follow-up
- IKDC, Lysholm, Tegner increased at 2 yr.
- 89% survival at 5 years
- Deterioration with time
- 43% at 15 years
- Small lesions, younger patients do better

Fibrocartilage Fill at 5 years

Osteochondral Autograft Results

- Prospective MultiCenter Study
- Athletes
- 354 Athletes followed for average of 9.6 years
- 1-4cm² Lesions
- Good to Excellent Results in 91% Femoral Lesions
- Patellofemoral harvest morbidity 5%

Osteochondral Allograft Results

- 43 Athletes
- Age 32.9 (18-49)
- IKDC, KOOS, Marx, Cincy
- 2.5 yr follow up
- Limited RTS 88%, Full RTS 79%
- Risk factors for poor outcome: Age >25y,
  Drawing Board > 17 mm
ACI Results

Articular Cartilage Treatment in High-Level Male Soccer Players
A Prospective Comparative Study of Arthroscopic Second-Generation Autologous Chondrocyte Implantation versus Microfracture

- 41 Professional Soccer Players
- 7.5 yr Follow-Up
- 21 MFX vs 20 ACI
- 86% Return to Sport ACI vs 80% MFX
- MFX results deteriorated with time, ACI durable

Best Return to Sport Data

Return to sport after the surgical management of articular cartilage lesions in the knee: a meta-analysis

- 44 Studies
- 2549 Patients
- Overall 76% Return to Sport

Best Return to Sport Data

Return to sport after the surgical management of articular cartilage lesions in the knee: a meta-analysis

- OATS 93% RTS
- OATS Fastest RTS, 5.2 mo.
- OATS highest KOOS Score
Healing Time / Return to Sport

Varies by Procedure

- OATS: 6 +/- 2 Months
- Microfracture: 8 +/- 1 Month
- Osteochondral Allograft: 12 +/- 3 Mo
- ACI: 12 +/- 4 Months

Will I have improvement in function?

- Improved Pain
- Improved Function
- Long term outcomes that are DURABLE
  - No Failures
  - No Osteoarthritis
  - No Total Knee Arthroplasties
**Will I have a good long term outcome?**

**Patient**
- "I am having this surgery to prevent any future arthritis and knee replacement" 

**Clinician**
- "We are building a bridge to the future—a future which is at risk for progression of arthritis and to knee replacement"

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**Long Term Osteochondral Autograft**

- **610 Patients >10 Yr FU**
- **Mean Defect Size:** 2.6cm
- **Lysholm improvement:** 21 points
- **IKDC 42 points**
- **72% Success at Long Term Follow Up**

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**Long Term OATS vs MFX**

- **Randomized Controlled Trial**
- **20 OATS, 20 MFX**
- **Lysholm:** 1yr, 5yr, 10yr, 15yr
- **Both groups improved at all time points**
- **Lysholm Superior in OATS at ALL Time Points**
Long Term Osteochondral Allograft

Distal Femoral Fresh Osteochondral Allografts
Followup at a Mean of Twenty-two Years
Gonzalez MD, O'Brien, T. A., Apple, M. K., Hancock, P. L., and Allen E. Graz, MD, BHS, SMA, CMA, CHS, CHS.

- 58 patients
- Mean 22 yr follow up
- Survivorship:
  - 91% @ 10 yrs
  - 84% @ 15 yrs
  - 69% @ 20 yrs
  - 59% @ 25 yrs

Long Term Osteochondral Allograft

Do Fresh Osteochondral Allografts Successfully Treat Femoral Condyle Lesions?

- 122 patients, avg age 33 yrs
- 13.5 yr follow up
- Survivorship:
  - 62% at 10 yrs
  - 66% at 20 yrs
  - Age >30 risk factor

Long Term ACI

The John Insall Award
A Minimum 10-year Followup Study of Autologous Chondrocyte Implantation

- 210 patients
- Defect Size 8.4cm²
- Mean 12 year follow up
- 71% Survivorship
- Improved Function 76%
- Better with HTO, Worse with prev. MFX
Long Term ACI

Autologous Chondrocyte Implantation
A Long-term Follow-up

- 224 patients
- Defect 5.3 cm²
- Mean 13 year follow up
- Lysholm 69.5
- 92% Satisfaction
- Bipolar Lesions Worse

Will I have a good long term outcome?

Patient
- "I am having this surgery to prevent any future arthritis and knee replacement"

Clinician
- "We are building a bridge to the future—a future which is at risk for progression of arthritis and to knee replacement"

Conclusions about cartilage injuries & treatment?

Common in Athletes
Patient Factors and Concomitant Pathology Need Consideration
No Perfect Solution for All Lesions
Treatment Improves Pain
Treatment Improves Function
Long-term outcomes are durable
- Slows OA Progression
- Some Arthroplasties