

# Cartilage Repair: State of the Art

What you should know even if you don't do it....

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SCORE



# Disclosure

- Joint Restoration Foundation
  - Medical Advisory Board, Consultant, research support
- Allosource
  - Medical Advisory Board
- Arthrex
  - Consultant
- I have no intellectual property in cartilage repair
  - Everything I know is in the public domain
- I prefer fresh allografts to other cartilage techniques
- I perform a lot more joint replacement than cartilage repair surgery

# Cartilage Repair

- Exciting field
- Lots of ideas, science and innovation
- Predictable clinical success is still elusive
- 75%/25% rule for most interventions
- New treatments are adopted with little clinical validation
- Expensive



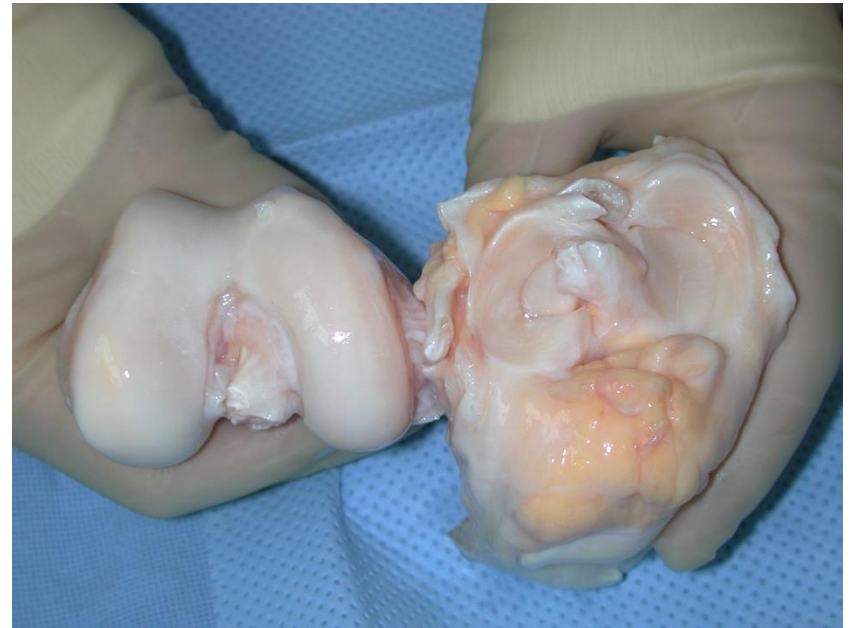
# What Does An Orthopaedist Need To Know About Cartilage Repair in 2021?

- Evolution of “Cartilage Repair” to “Joint Preservation”
  - Treating the organ vs the tissue
- Patient evaluation
  - Background factors
  - Ideal vs salvage situations
  - Treatment strategies
- Technical considerations
  - Surgical skill set
  - Technology and devices
- Clinical outcome

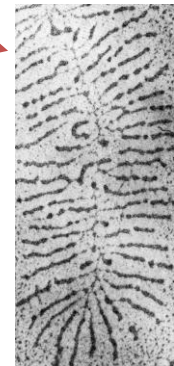
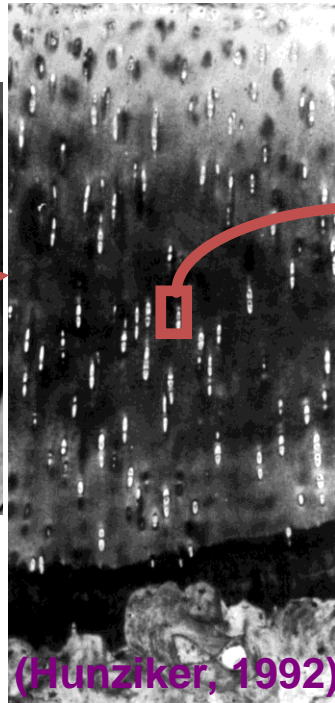
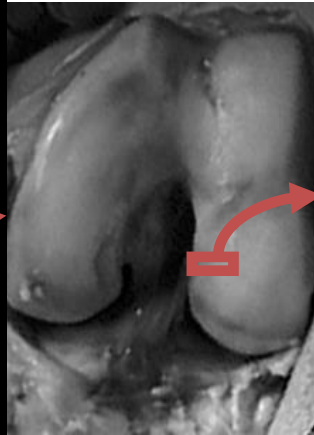


# A Synovial Joint is Really an Organ

- **Organ:** a group of tissues in a living organism that have been adapted to perform a specific function.



# Cartilage is part of a biologic system



organ

tissue

cell,  
matrix

molecule

m

cm

mm

$\mu$ m

nm

(Hunziker, 1992)

(Hunziker, 1992)

(Buckwalter, 1986)

(Doherty, 1994)



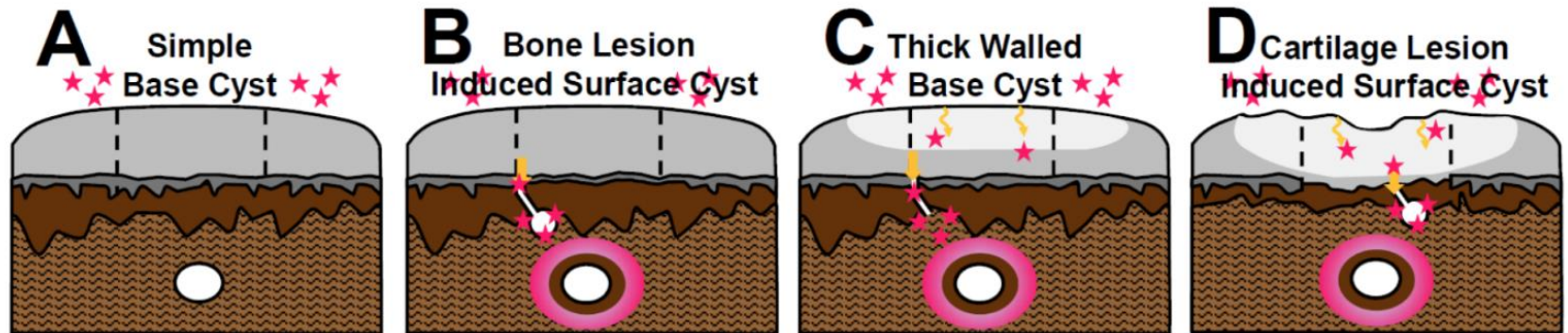
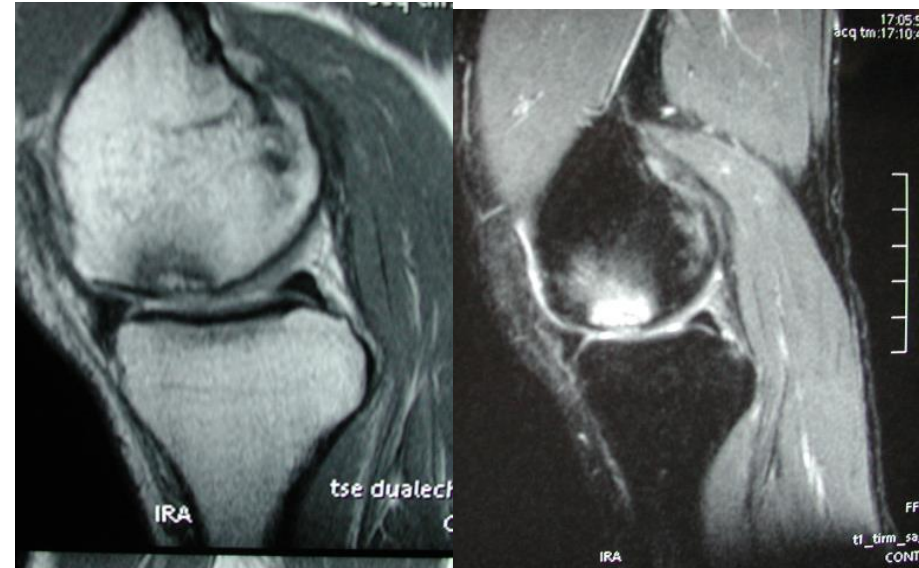
# The importance of subchondral bone behavior

Knee Surg Sports Traumatol Arthrosc (2010) 18:434–447  
DOI 10.1007/s00167-010-1072-x

KNEE

## The subchondral bone in articular cartilage repair: current problems in the surgical management

Andreas H. Gomoll · Henning Madry ·  
Gunnar Knutsen · Niek van Dijk · Romain Seil ·  
Mats Brittberg · Elizaveta Kon



C depressurization —  
ScB permeability —

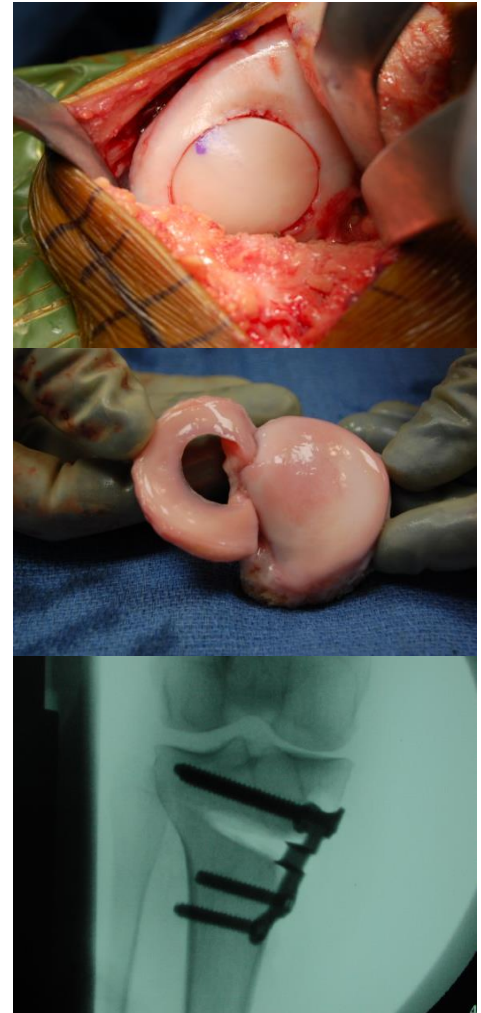
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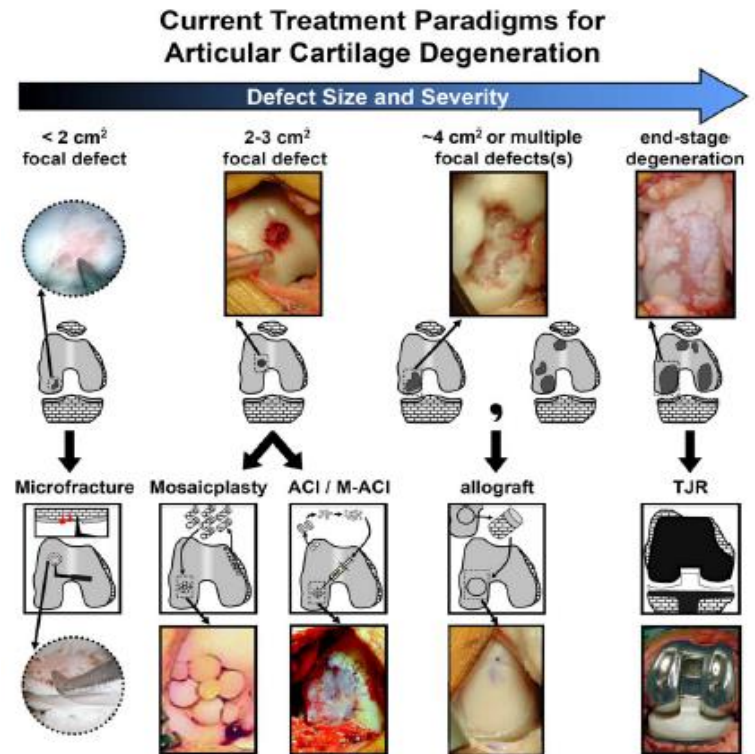
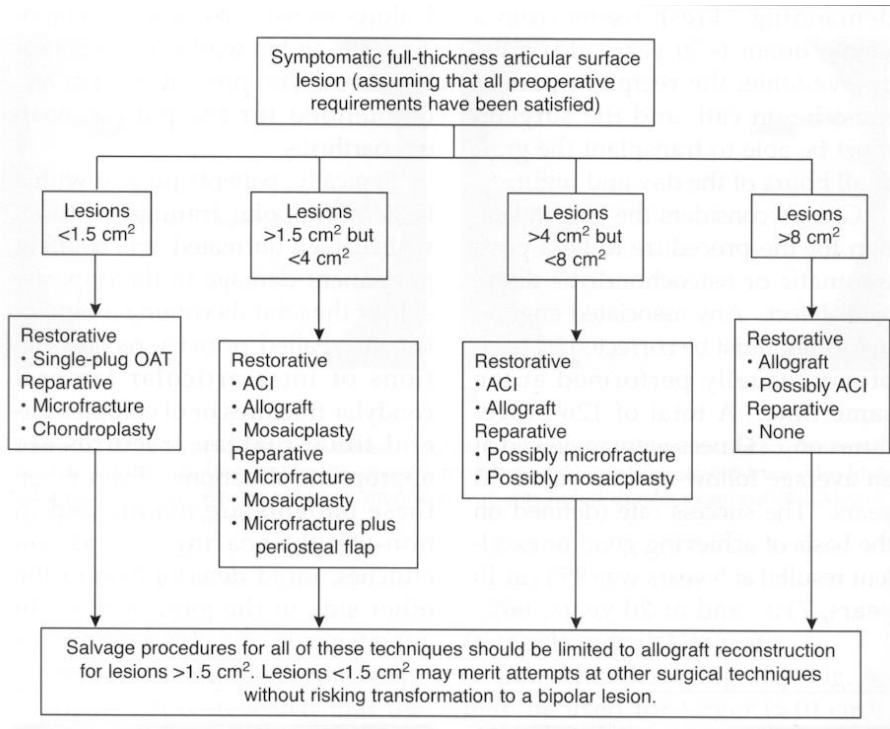
# :Cartilage Repair” has evolved into “Joint Preservation”

- Cartilage restoration
- Meniscal repair/ transplantation
- Osteotomy
- Ligament reconstruction
- Biologics/ disease modification





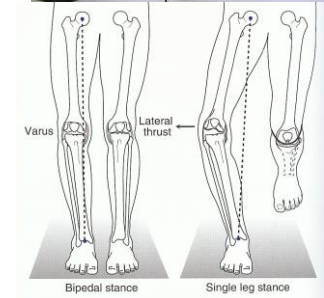
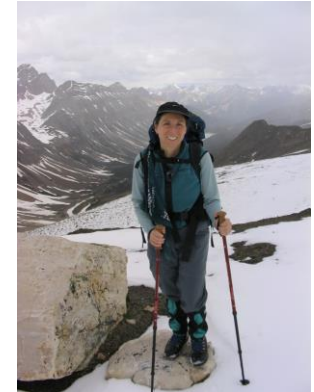
# What we used to say: The “lesion size” algorithm Where we started



# What we say now: “Background Factors”

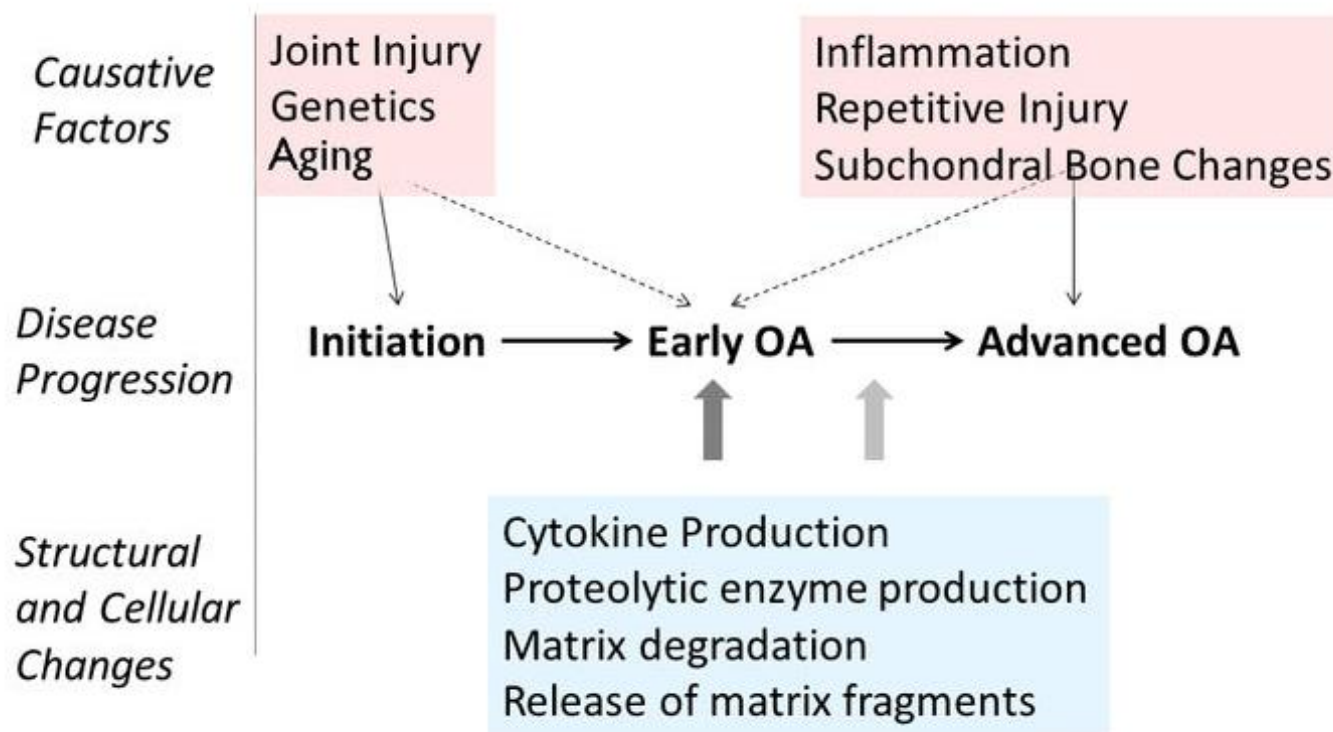
## The new hierarchy in cartilage repair

- Patient personality and expectations
- Neuromuscular status
  - Fit or fat
- Limb alignment
  - Subtle or obvious
- Joint stability
  - Mechanical and biological
- Ligament and meniscus status
- Cartilage lesion characteristics
  - Subchondral bone status



# The Arthritis Cascade

## The New Post Traumatic OA Paradigm



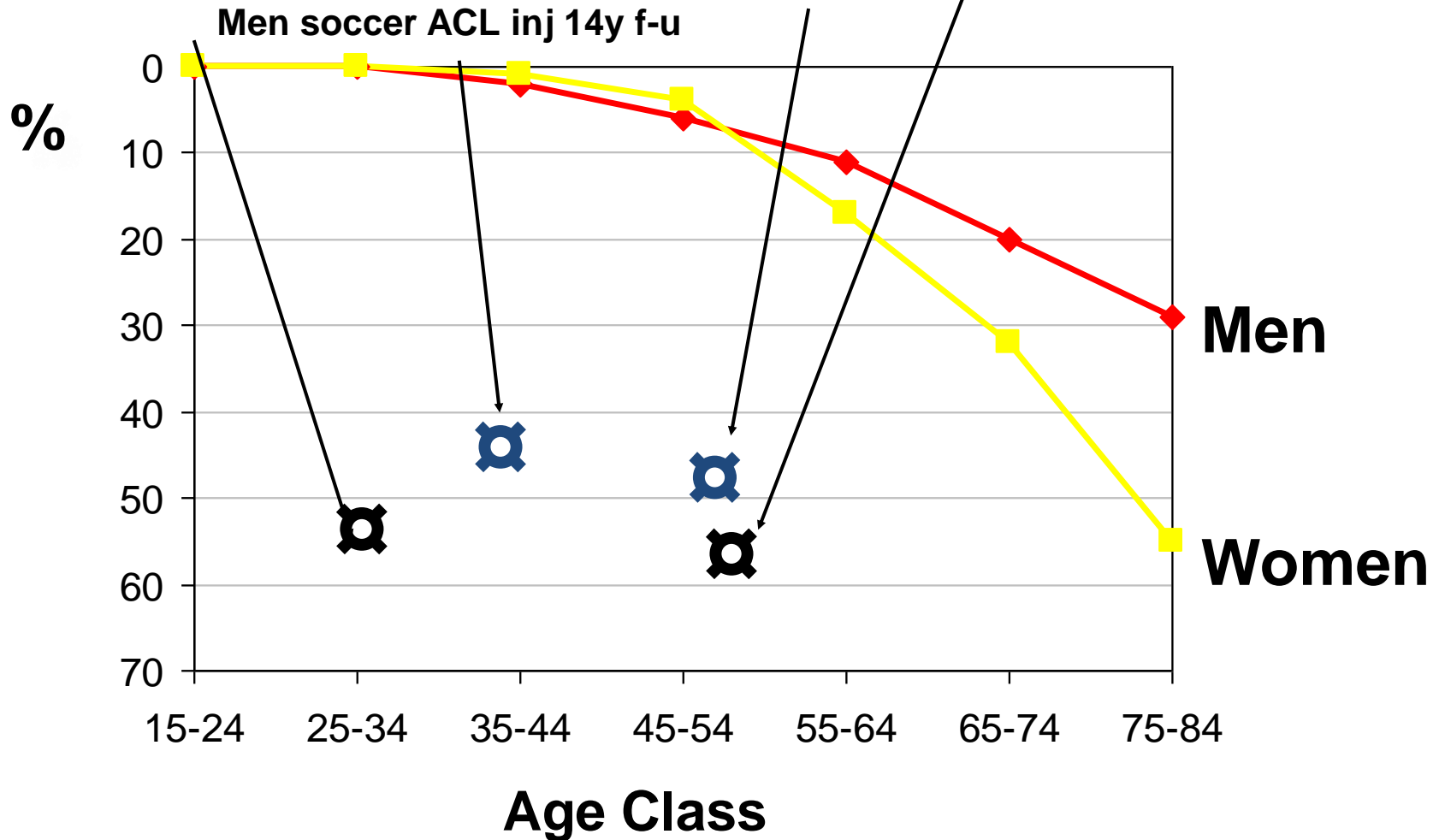
**Every cartilage patient you treat has some form of post traumatic osteoarthritis**

# Prevalence of radiographic knee

## OA

Women soccer ACL inj 12y f-u

Men & Women meniscus inj 15-20y f-u



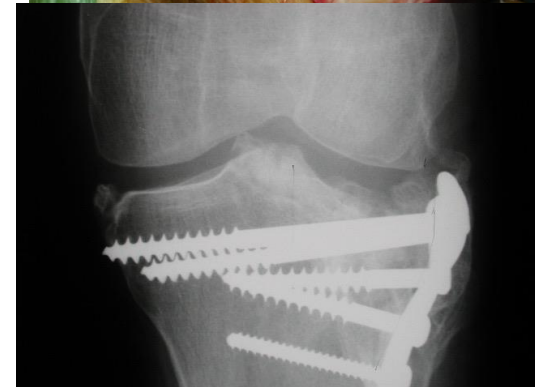
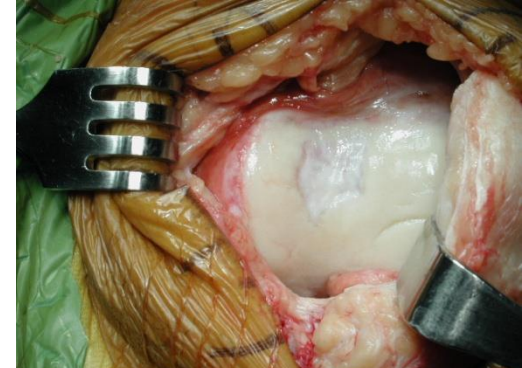
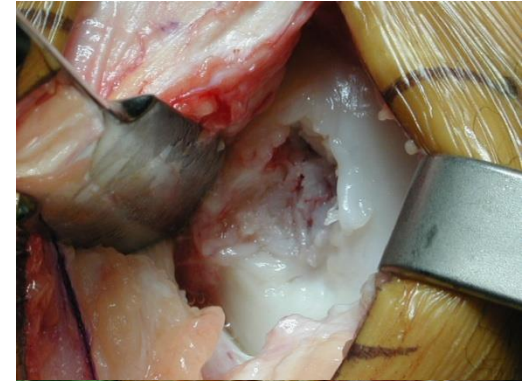
# Synthesizing the Clinical Information

- Complexity of clinical situation
  - Burden of disease
  - Simple, complex or salvage situations
    - SIMPLE:
      - single unipolar grade III/IV lesion femur
      - tibial surface or patella no worse than grade II
      - no generalized chondromalacia
    - COMPLEX:
      - multifocal unipolar grade III/IV lesions, femur
      - unipolar lesion patella/tibia
      - OCD
      - concurrent correction of tibiofemoral/patellofemoral malalignment
    - SALVAGE:
      - bipolar focal chondral lesions
      - osteophytes or radiographic joint space narrowing present
      - generalized chondromalacia grade II or greater
      - osteonecrosis



# Joint Restoration: Diagnostic Categories

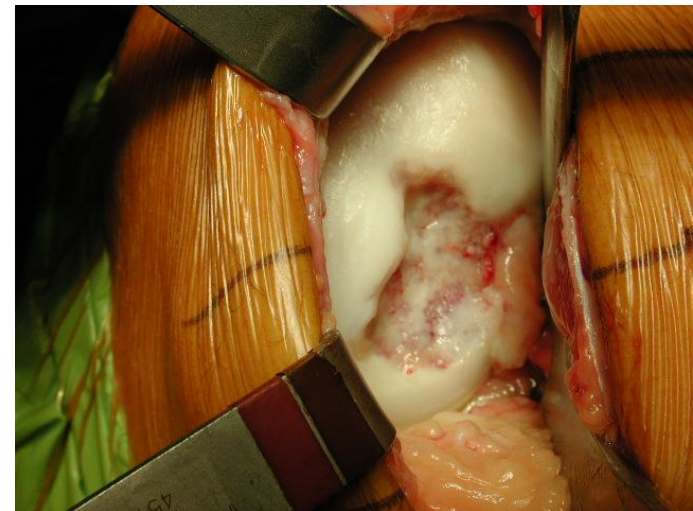
- Osteochondritis dissecans/OLT
- Traumatic chondral/ osteochondral lesions
- Revision of previous cartilage surgery
- Osteonecrosis/ SONK
- Fracture malunion (tibial plateau)
- Focal/ multifocal degenerative chondral lesions
- Osteoarthritis



# Ideal Candidate for Cartilage Restoration

These people should get cartilage!

- Age under 30
- Few previous surgeries
- Isolated femoral condyle lesion
  - Traumatic or OCD
- Sound mechanical environment (meniscus, ligament, alignment)
- Biologically “quiet” joint
- Prefers lower demand lifestyle
- No genetic risk factors
- Not too many of these people!!!
  - My failure rate in these patients is 4%



# Surgical Skill Set for Joint Preservation

## Technical Execution Matters

- Autologous Chondrocyte Implantation (MACI)
- Osteochondral Allograft Transplantation (OCA)
- ACL (multi-ligament) reconstruction
- Meniscal Repair/ Allograft
- Osteotomy (tibial and femoral)
- Patellofemoral joint re-alignment procedures
- What are you capable of doing and what do you need help with?



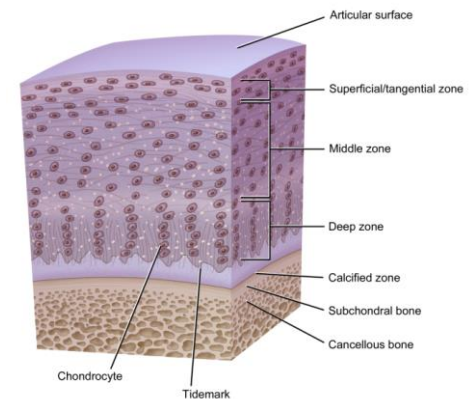
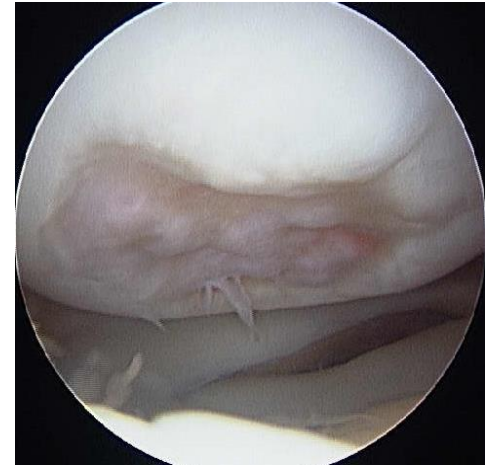
# The concept of staging procedures

the home run slugger vs. the singles hitter

- Valid approach
- Lower risk
- Many patients wont need everything done
- Avoids the accumulated adverse event phenomenon
  - 3 procedures with 80% success rate have a combined 51% success rate when performed together. . . .

# Two Fundamental Strategies of Cartilage Restoration

- Cell based
  - Induce cells to form (chondral) tissue in situ
    - Marrow stimulation/ MFX plus
    - (M)ACI
    - Minced tissue (alive or dead)
    - Other cell sources +/- scaffolds
- Whole tissue based
  - Restore defect with mature tissue
    - Osteochondral autograft (OAT)
    - Osteochondral allograft (OCA)
    - Processed chondral/ osteochondral tissue allografts





# Cartilage Repair Procedures

	2014	2015	2016E	2017E	2018E	2019E	2020E	
US Population	318,748,017	321,368,864	323,995,528	326,625,791	329,256,465	331,883,986	334,503,458	0.80%
Ages 20-64	190,357,594	191,429,110	192,396,917	193,285,802	194,079,271	194,779,772		0.40%
<b># of Procedures</b>								
No. Knee Cartilage Repair Procedures	566,022	583,294	601,129	618,151	635,462	653,269	671,586	2.90%
Debridement/Articular Cartilage Shaving	382,403	391,963	401,762	411,806	422,101	432,654	443,470	2.50%
Microfracture	183,619	191,331	199,367	206,345	213,361	220,615	228,116	3.70%
No. Ankle: Microfracture/Abrasion arthroplasty	227,029	238,835	251,254	264,319	278,064	291,967	306,565	5.20%
No. Osteochondral Autograft Procedures	9,615	9,616	9,617	9,618	9,839	10,016	10,176	0.80%
No. Osteochondral Allograft Procedures	2,554	2,683	2,769	2,837	2,902	2,960	3,013	2.35%
No. Allograft-Derived Implants	4,612	5,090	5,212	5,799	6,651	7,634	8,547	10.92%
No. Cell Based Transplantations (ACI, Juvenile Chondrocytes)	4,567	4,535	4,454	4,500	4,520	4,535	4,538	0.0%
No. ACI Procedures	989	1,007	1,067	1,249	1,399	1,538	1,661	10.5%
No. Juvenile Chondrocyte Procedures	3,578	3,528	3,387	3,252	3,122	2,997	2,877	-4.00%
<b>Total No. Cartilage (Knee and Ankle) Procedures</b>	<b>814,422</b>	<b>844,586</b>	<b>875,868</b>	<b>907,018</b>	<b>939,390</b>	<b>972,371</b>	<b>1,007,303</b>	<b>3.60%</b>

# The US Regulatory Environment

## 21 CFR 1271.10

Minimally manipulated,  
homologous use, not combined  
with other articles\*, etc.

Yes

No

Regulated by 361 of PHS Act  
e.g. BMT, organ transplants, blood

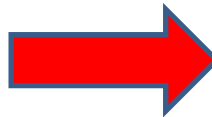
Qualify for exceptions under 21 CFR  
1271.15?  
e.g. reproductive cells, IVF, done in same surgical procedure

No

Regulated as drug, device and/or biologic  
product under 351 of PHS Act

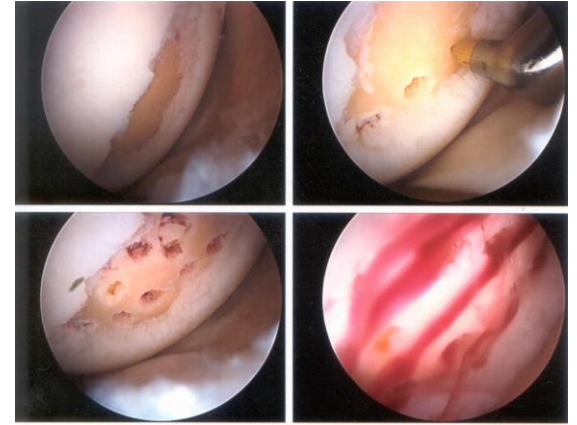
- 21 CFR Parts 200, 210, 600, 810, etc.
- Apply for IND

\*except for preservation, storage, etc.



# Microfracture is no free lunch

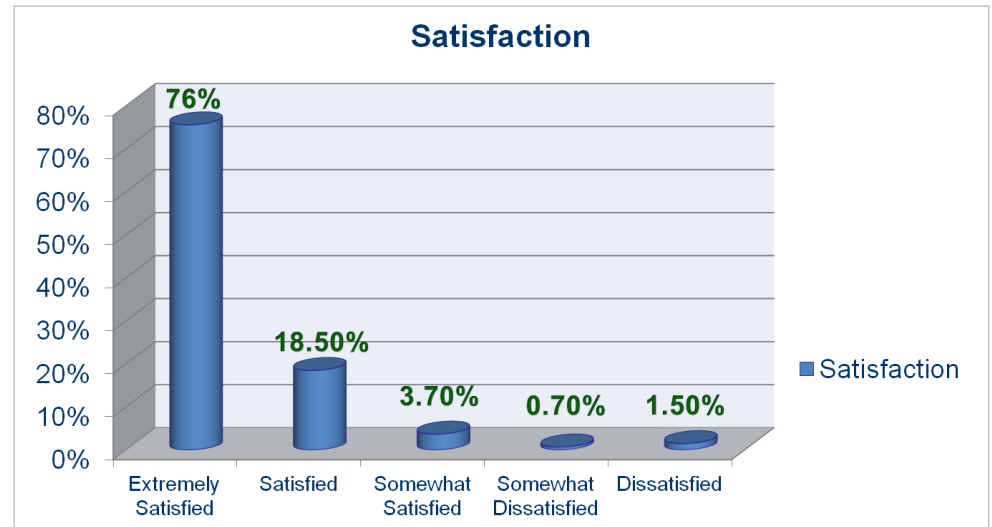
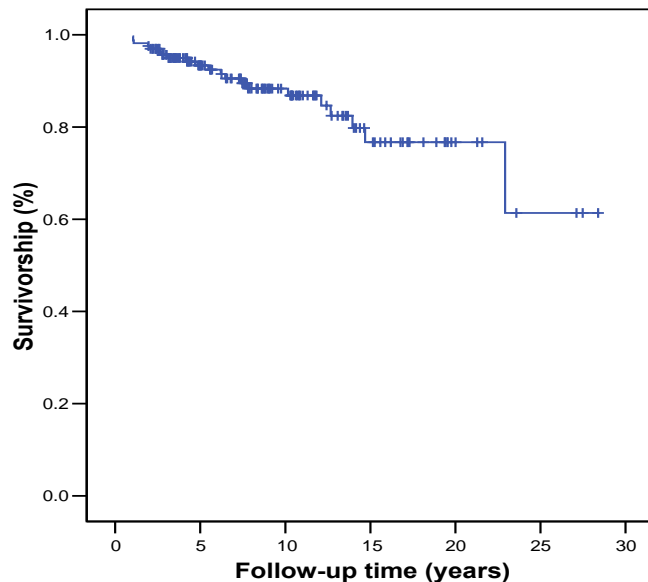
- Worse outcome for next cartilage surgery
- Delay in getting the “right” procedure(s)
- Discouraged patients
- Chondroplasty may be a better initial option
- Do the “best” option first!



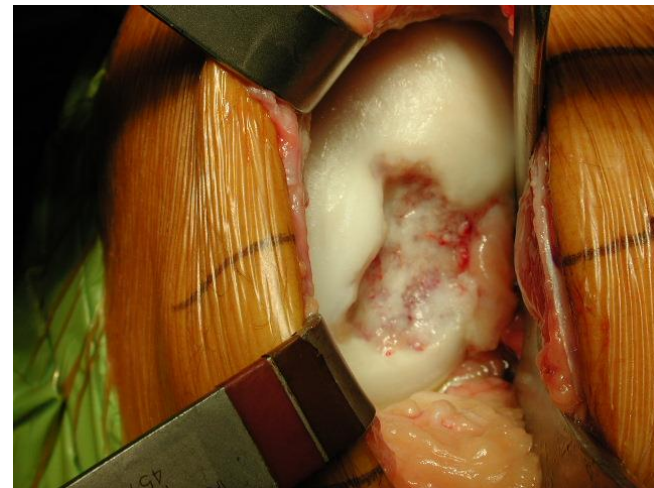
# Osteochondritis dissecans is the best condition to treat with cartilage repair

## Osteochondral Allograft Transplantation in Patients With Osteochondritis Dissecans of the Knee

Kamran N. Sadr,<sup>\*</sup> MD, Pamela A. Pulido,<sup>†</sup> BSN, Julie C. McCauley,<sup>†</sup> MPHc,  
and William D. Bugbee,<sup>‡§</sup> MD  
*Investigation performed at Scripps Clinic, La Jolla, California, USA*



# Osteochondral Allograft Transplantation in “Ideal” Candidates: Clinical Outcomes and Graft Survivorship



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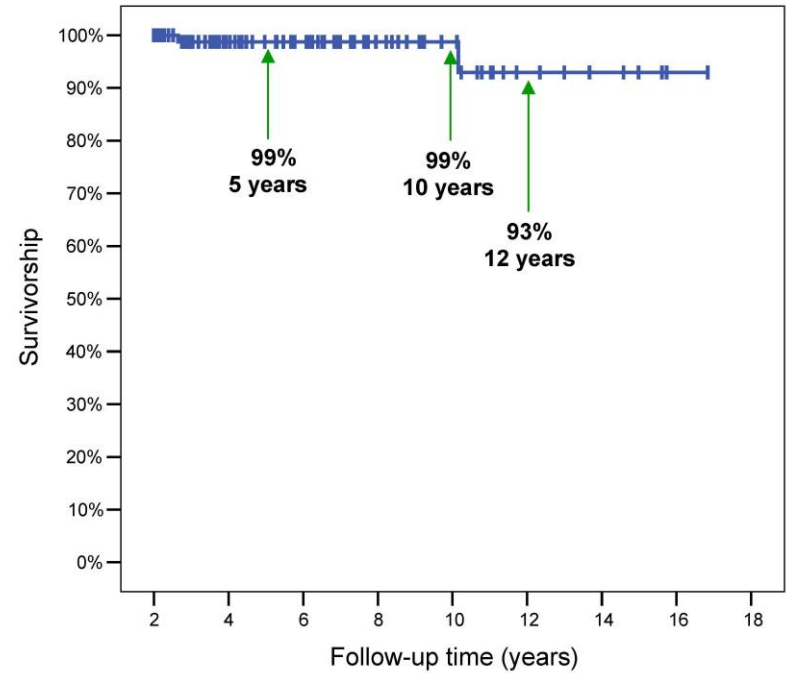
# My Best Experience

## *Who are the best patients for OCA of the knee?*

- Age  $\leq$  30 years
- Osteochondritis dissecans or traumatic chondral lesion
- Femoral condyle or trochlea
- Lesion size  $\leq$  8 cm<sup>2</sup>

## *Outcomes in this patient population:*

- 2% failure rate
- 18% reoperation rate
- 99% graft survivorship at 10 years
- 93% satisfaction rate
- Median 32 point improvement in IKDC total scores



# Osteoarthritis is the worst condition to treat

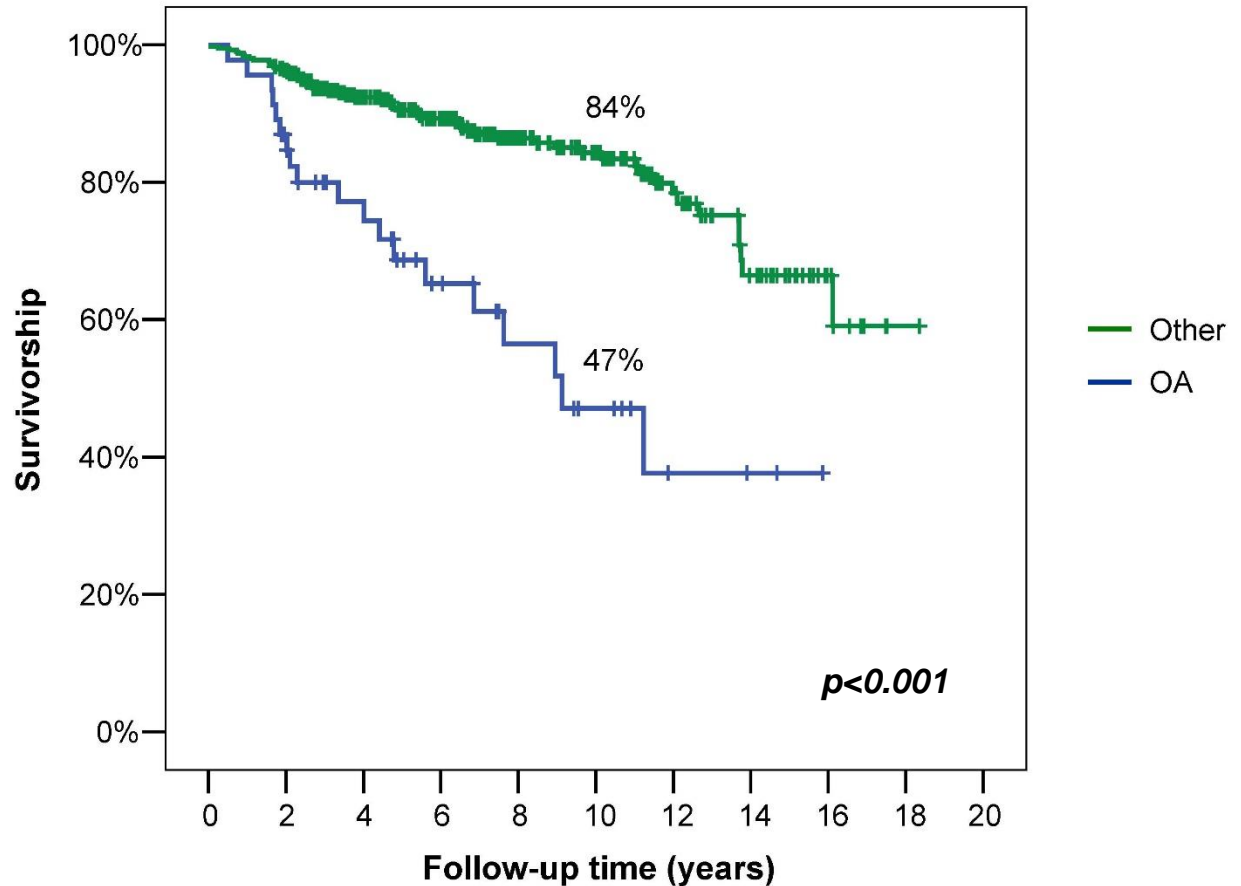
## OA vs other diagnoses

### Failure rate

- 14% Other
- 41% OA

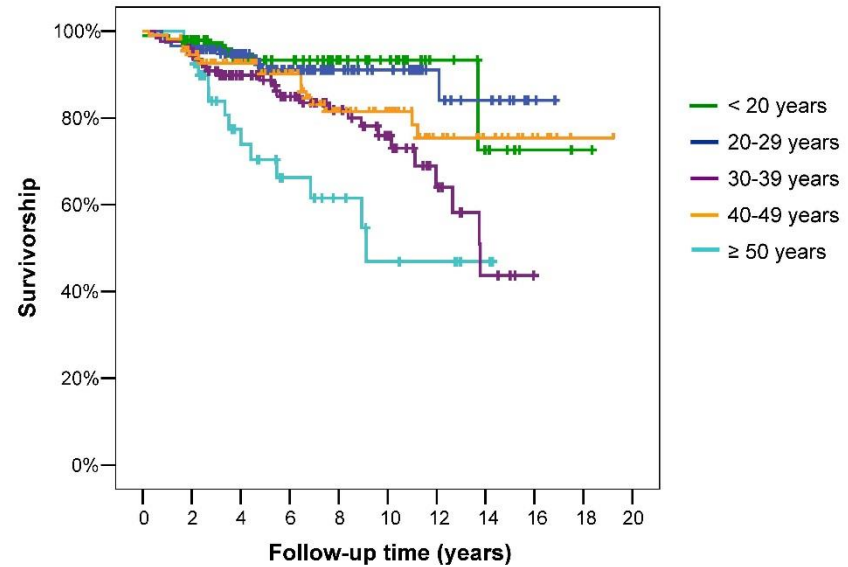
$p < 0.001$

### Survivorship

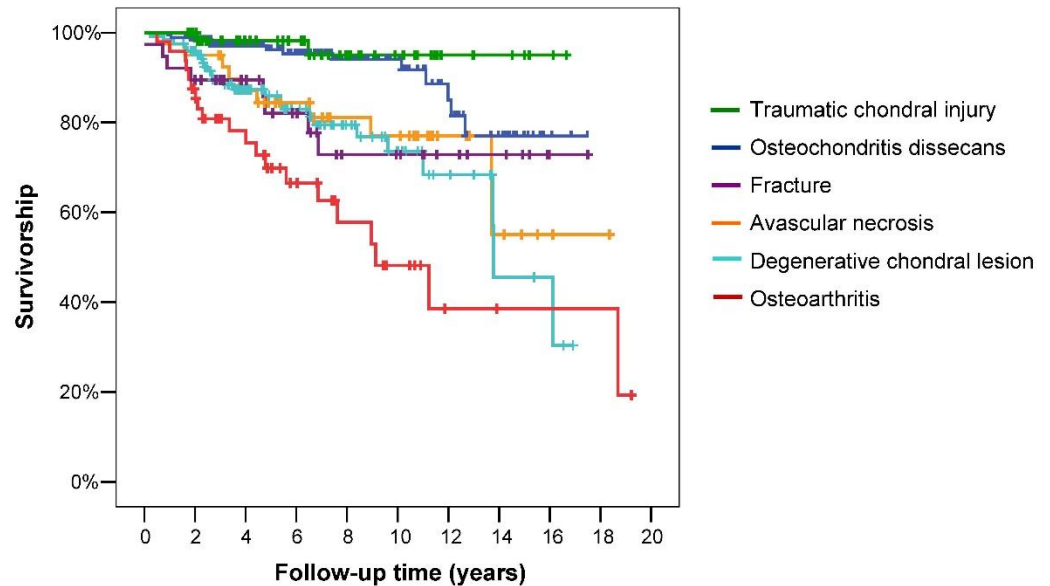


# OCA of the Knee

## Graft Survivorship by Age

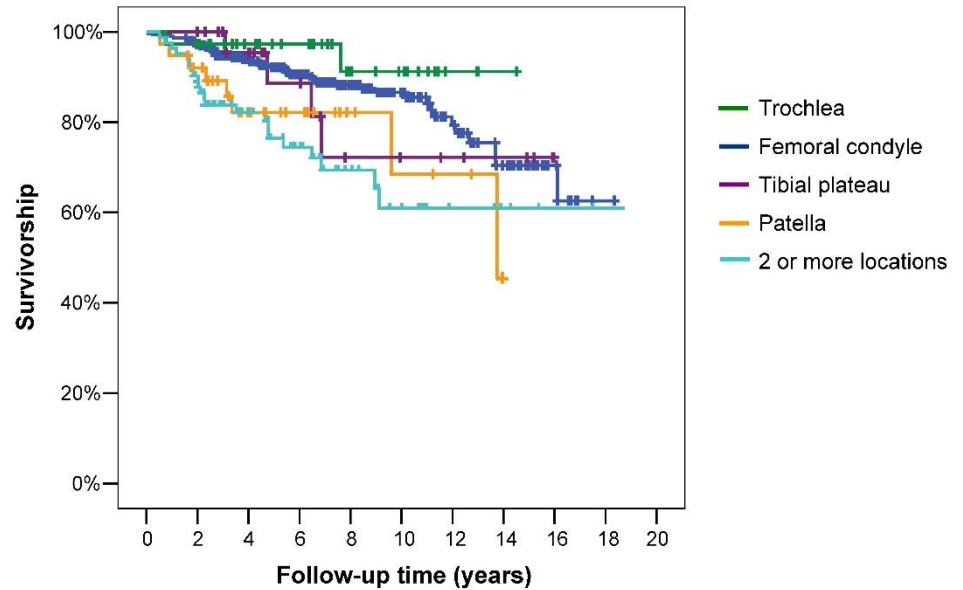


## Graft Survivorship by Diagnosis

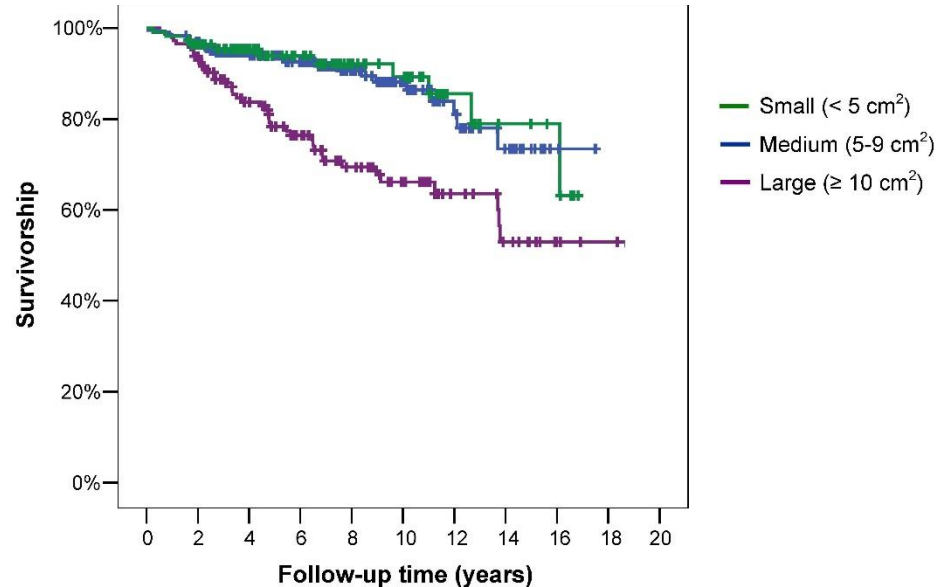


# OCA of the Knee

## Graft Survivorship by Anatomic Location



## Graft Survivorship by Lesion Size



# Typical care path of the injured knee

- Primary care
- Rheumatologists
- Non operative sports medicine
- General orthopaedist
- Surgical treatment: removal of tissue
- Nonoperative care: “palliation cycle”
- Incomplete evaluation of cartilage deficiency and candidacy for potential restorative procedures

A small % of patients get evaluated by a joint preservation specialist

## SORT: KEY RECOMMENDATIONS FOR PRACTICE

CLINICAL RECOMMENDATION	EVIDENCE RATING	REFERENCES
Physical therapy using land-based or water-based exercise can help reduce pain and improve function in patients with osteoarthritis.	B	10–12
Acetaminophen should be used as first-line therapy for mild osteoarthritis.	A	16
Nonsteroidal anti-inflammatory drugs are superior to acetaminophen for treating moderate to severe osteoarthritis.	A	16
Intra-articular corticosteroid injections can be beneficial for short-term (i.e., less than eight weeks) relief of osteoarthritis pain of the knee.	A	21, 22
Compared with intra-articular corticosteroids, intra-articular hyaluronic acid injections of the knee are less effective in the short term, equivalent in the intermediate term (i.e., four to eight weeks), and superior in the long term.	B	26, 27
The combination of glucosamine and chondroitin may decrease pain in patients with moderate to severe knee osteoarthritis, although the evidence for this effect is limited and inconsistent.	B	30
Patients who have continued pain and disability from osteoarthritis of the hip, knee, or shoulder despite maximal medical therapy are candidates for total joint replacement.	B	35



# Thank you

