Articular Cartilage Surgical Restoration Options

Randy Schwartzberg, M.D.

Assistant Professor - UCF College of Medicine

Orlando Orthopædic Center Foundation

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National Child Abuse Hotline

1800-4-A-Child (1800-422-4453)

][V][GO BLUE!

~ The Chocolate Oracle

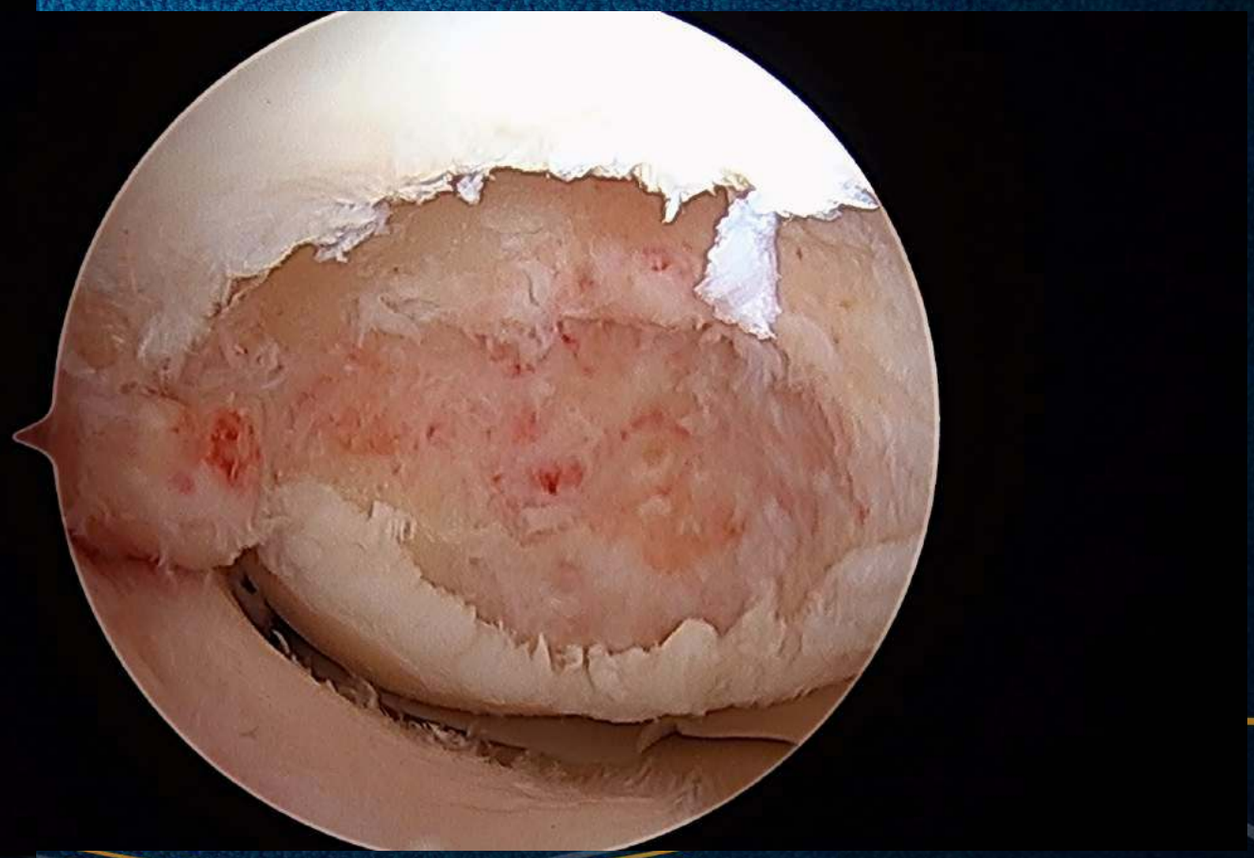
O-I-H-O.

IF THEY CARED ABOUT ACADEMICS,
THEY WOULD HAVE GONE TO MICHIGAN.

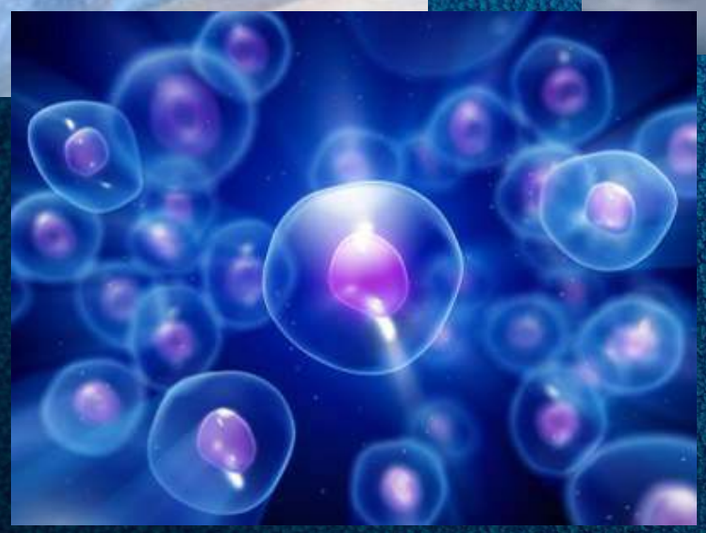

U CAN'T FIX STUPID
OSU

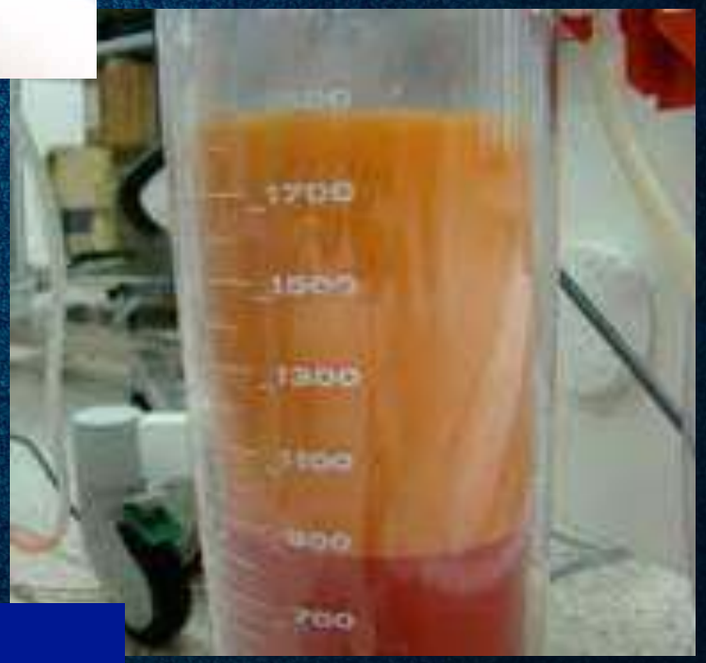
Rationale…

Our bodies do not make articular/hyaline cartilage.

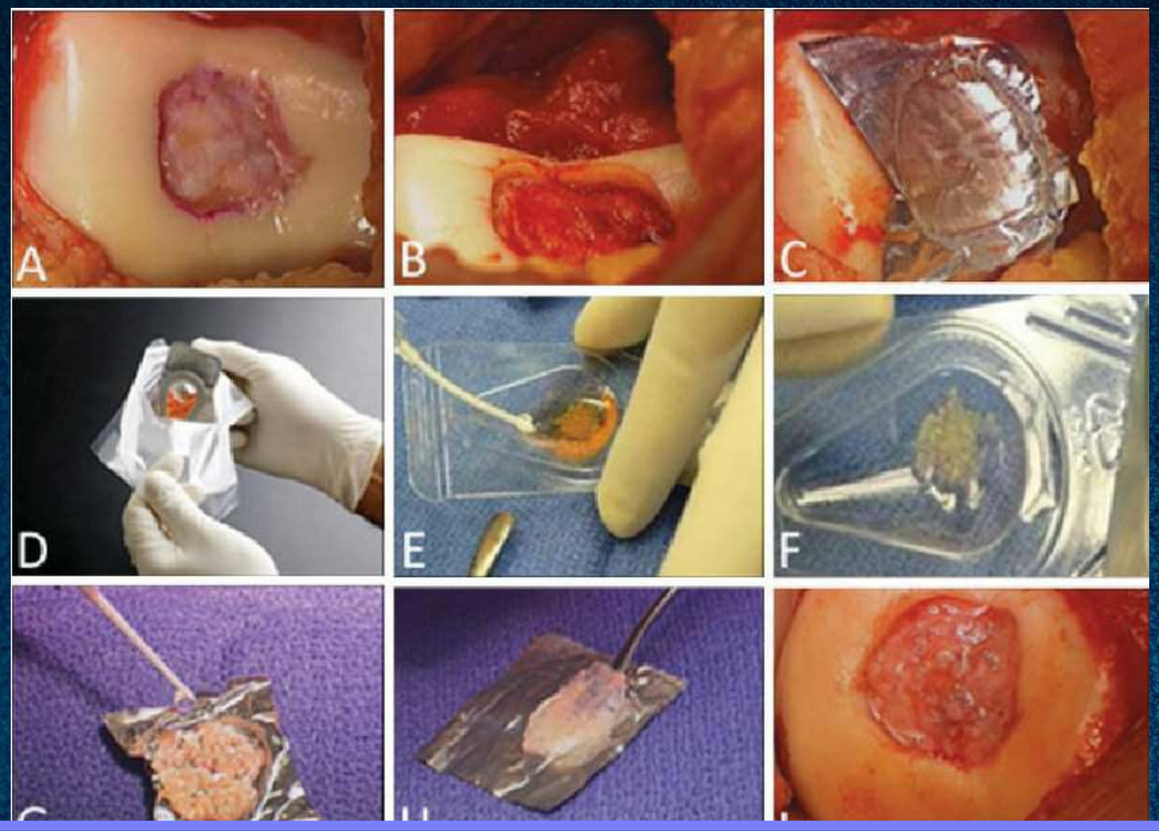


ogics injections to create hyaline cartila





Maybe in the future



Numerous Proprietary Surgical Techniques

DeNovo NT (Zimmer)

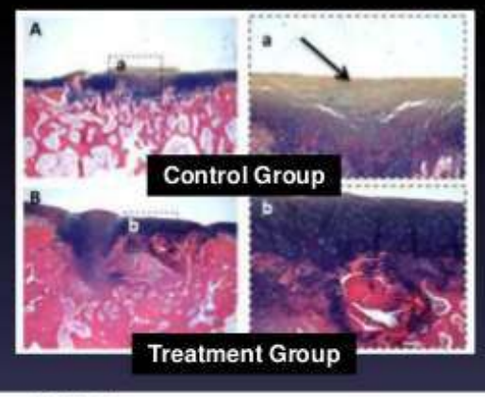
- DeNovo NT
  - Juvenile, allograft cartilage minced into 1 mm cubes
  - Priced around $4,500
    - BioCartilage = $750
  - Shelf life less than 1 month
    - BioCartilage = 4 years
  - Arthroscopic application is difficult
    - BioCartilage has paste like consistency when mixed with autologous blood, allowing for delivery through a needle

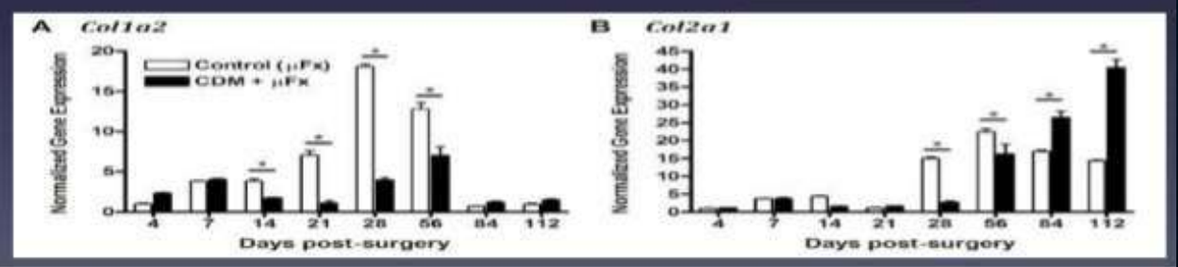




BioCartilage ECM Micronized Cartilage Matrix

- In vivo supportive evidence:
  - Same scaffolding material used within the previous mentioned in vitro study
  - Medial femoral condyle defects created within a rabbit model
    - Control group = microfracture performed
    - Treatment group = MFx plus lyophilized cartilage fragments formed into a scaffold
  - Treatment group had persistent upregulation of cartilage phenotypic markers: Type II Collagen and Aggrecan
  - Chadha N et al. Porous Cartilage-Derived Matrix Scaffolds for Repair of Articular Cartilage Defects. ORS 2012; Poster No. 0735.





es with significant evidence basis in the lit

- Microfracture
- Autologous chondrocyte implantation
- Osteochondral autograft transplantation
- Osteochondral allograft transplantation

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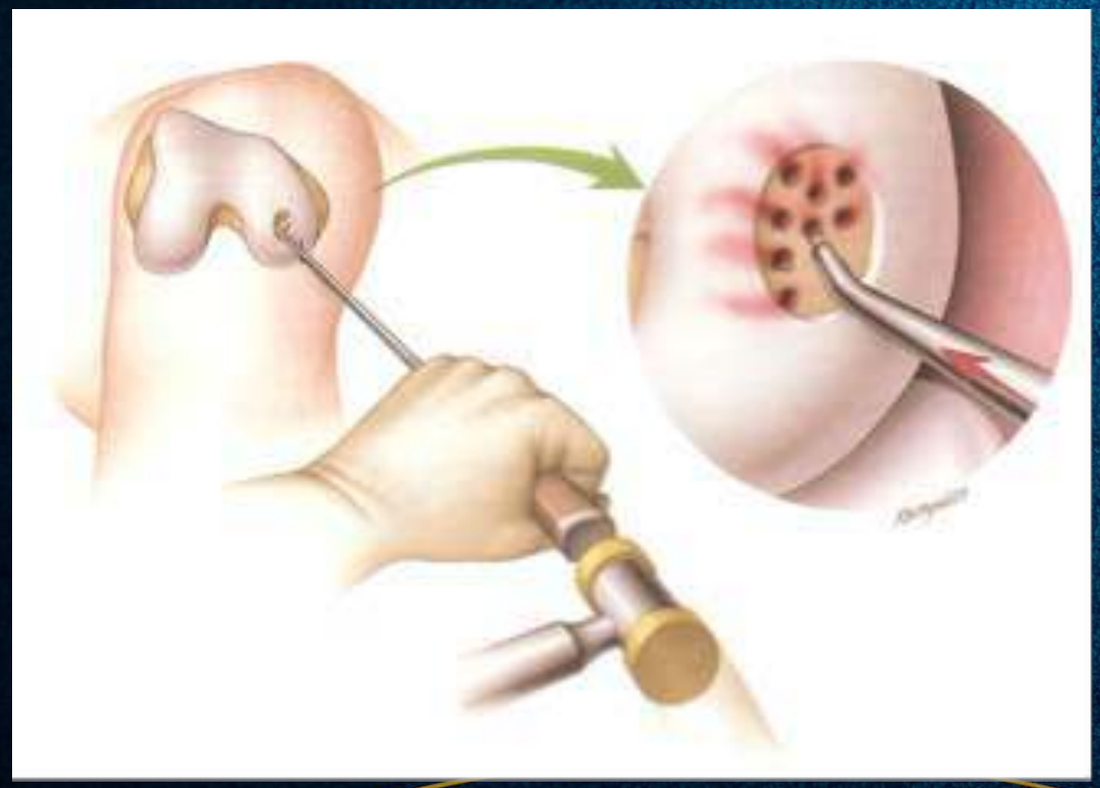
What is microfracture?

- Marrow stimulation technique
- Designed to grow fibrocartilage



Microfracture Positives

- Easy and quick procedure
- Inexpensive

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Microfracture Negatives

- Does not grow hyaline cartilage
- Unpredictable fibrocartilage growth
- Not very durable

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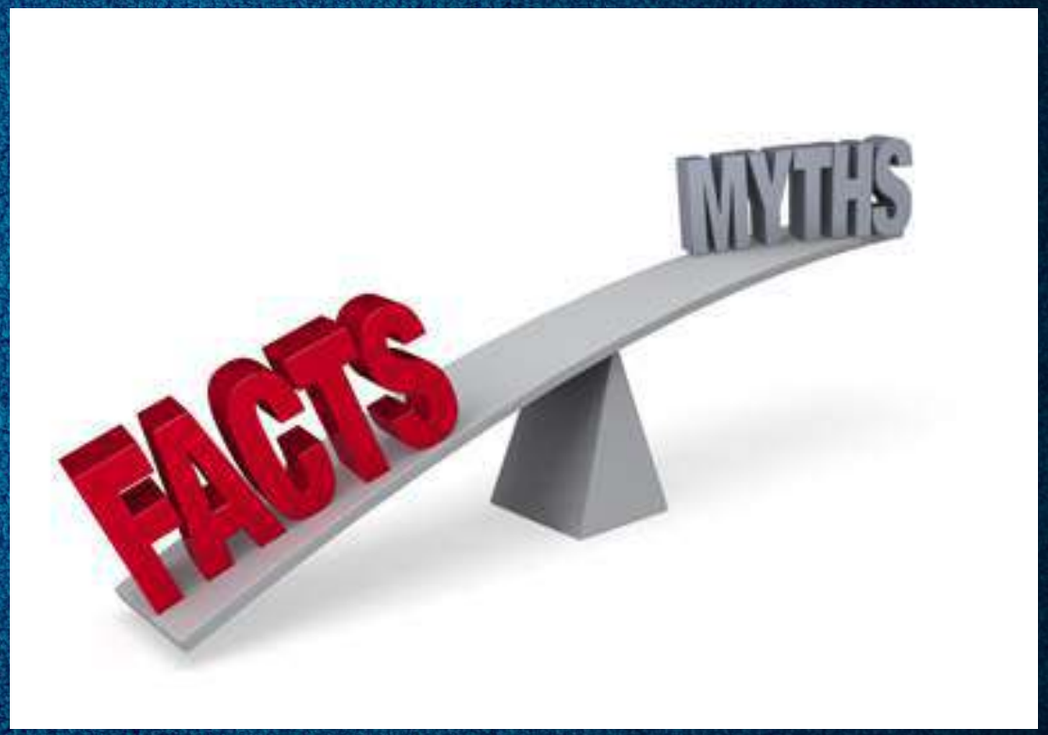
Hyaline Cartilage Solutions

- ~~Microfracture~~
- Osteochondral autograft transplantation
- Osteochondral allograft transplantation
- Autologous chondrocyte implantation

Best evidence in the literature…



Three procedures

Autologous Chondrocyte Implantation

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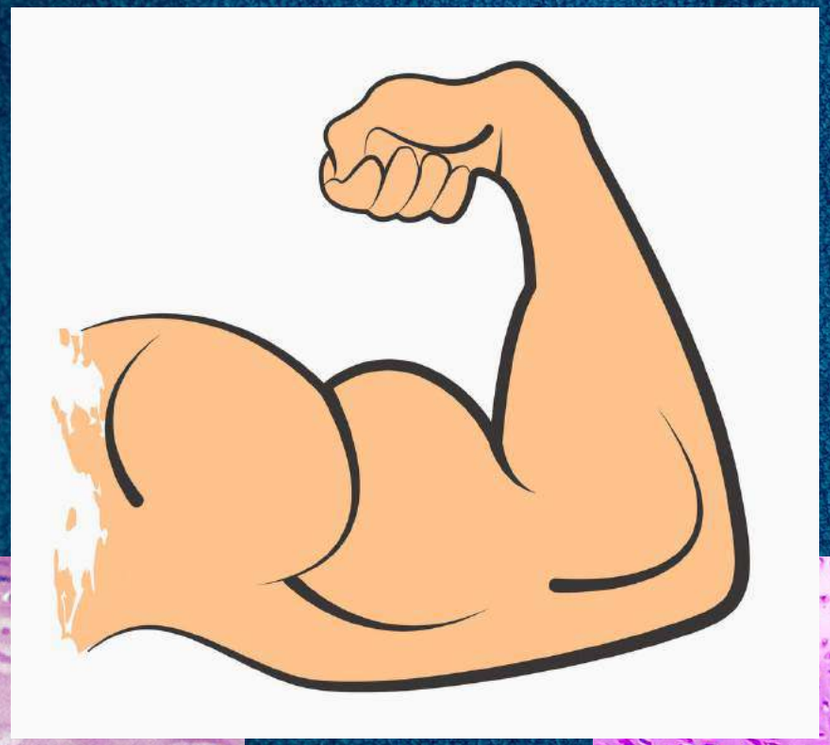
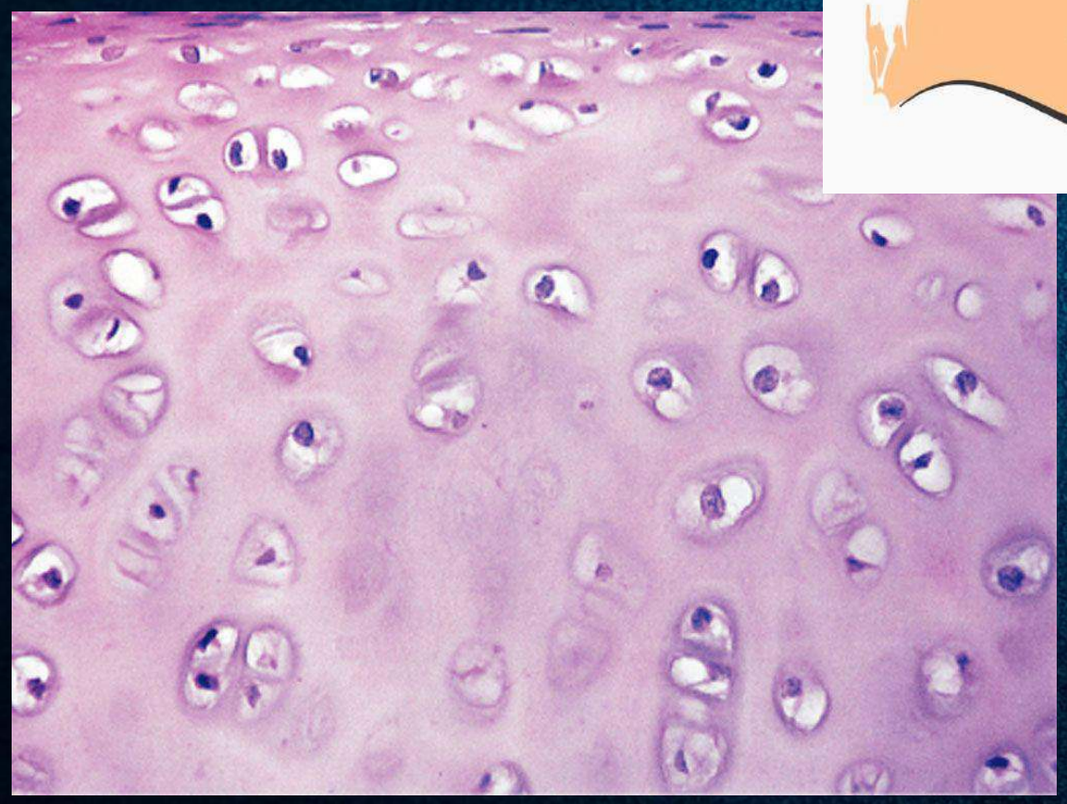
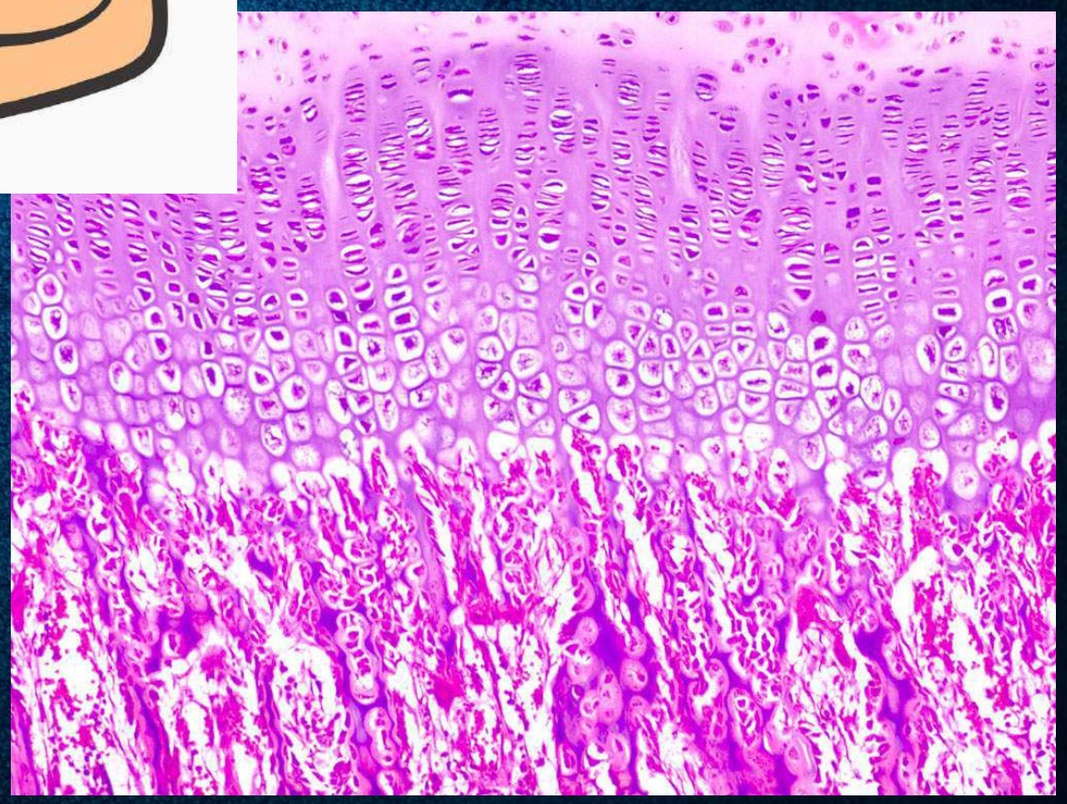
Harness the power of native healthy chondrocytes to synthesize hyaline cartilage.







ACI Step One

- Harvest of normal articular cartilage
- 6 weeks of culture
- Enzymatic digestion

- 12 million chondrocytes
- Deep frozen until needed for surgery

ACI Step Two

- Open procedure
- 1st generation - sutured patch with chondr
- 2nd generation - MACI

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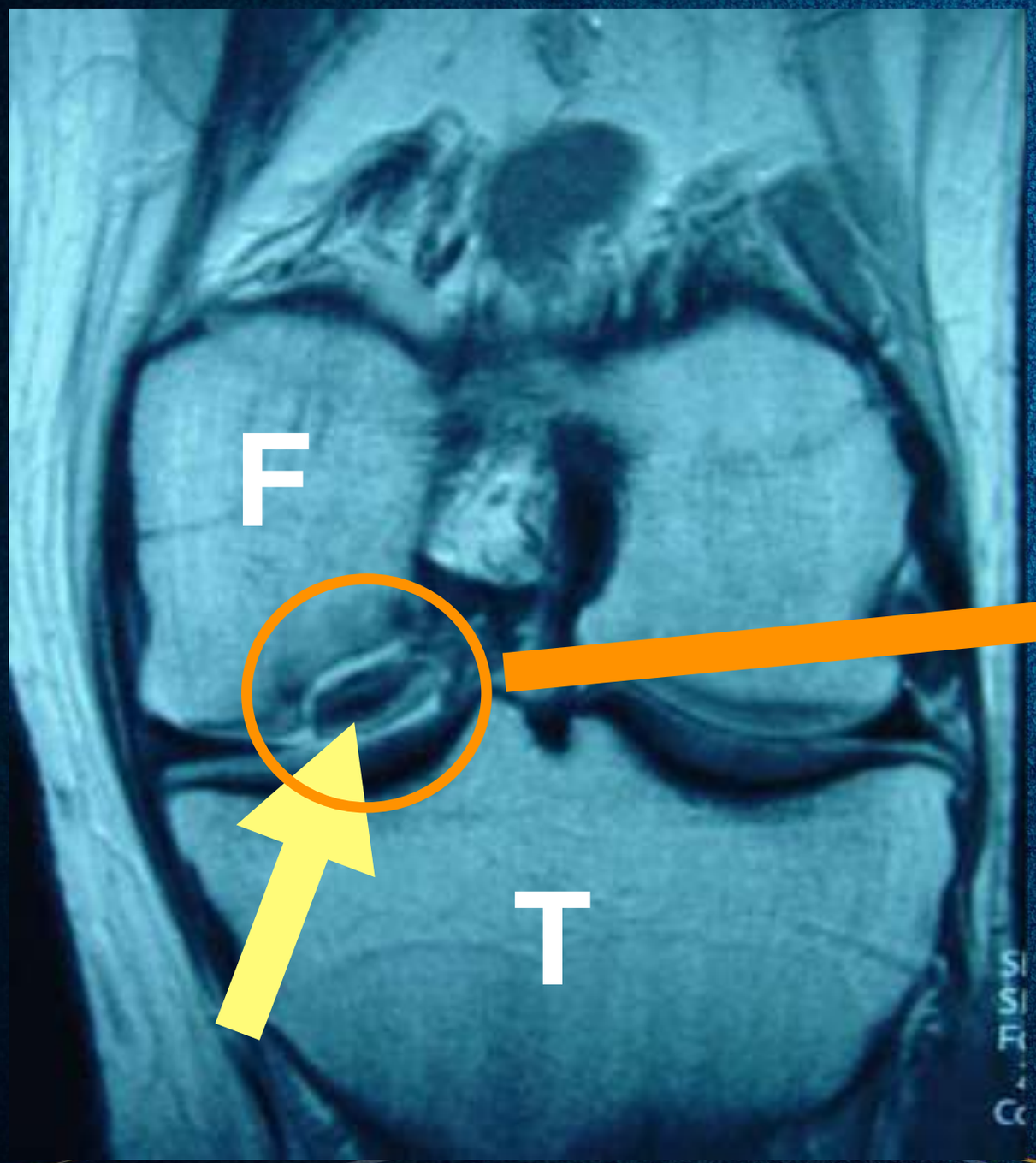
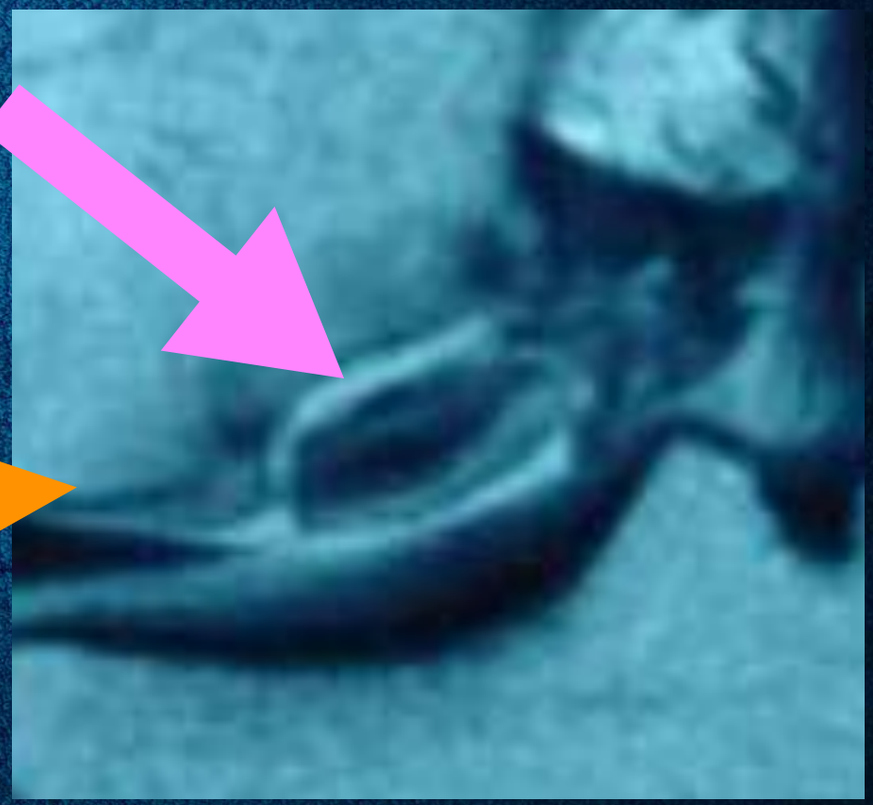
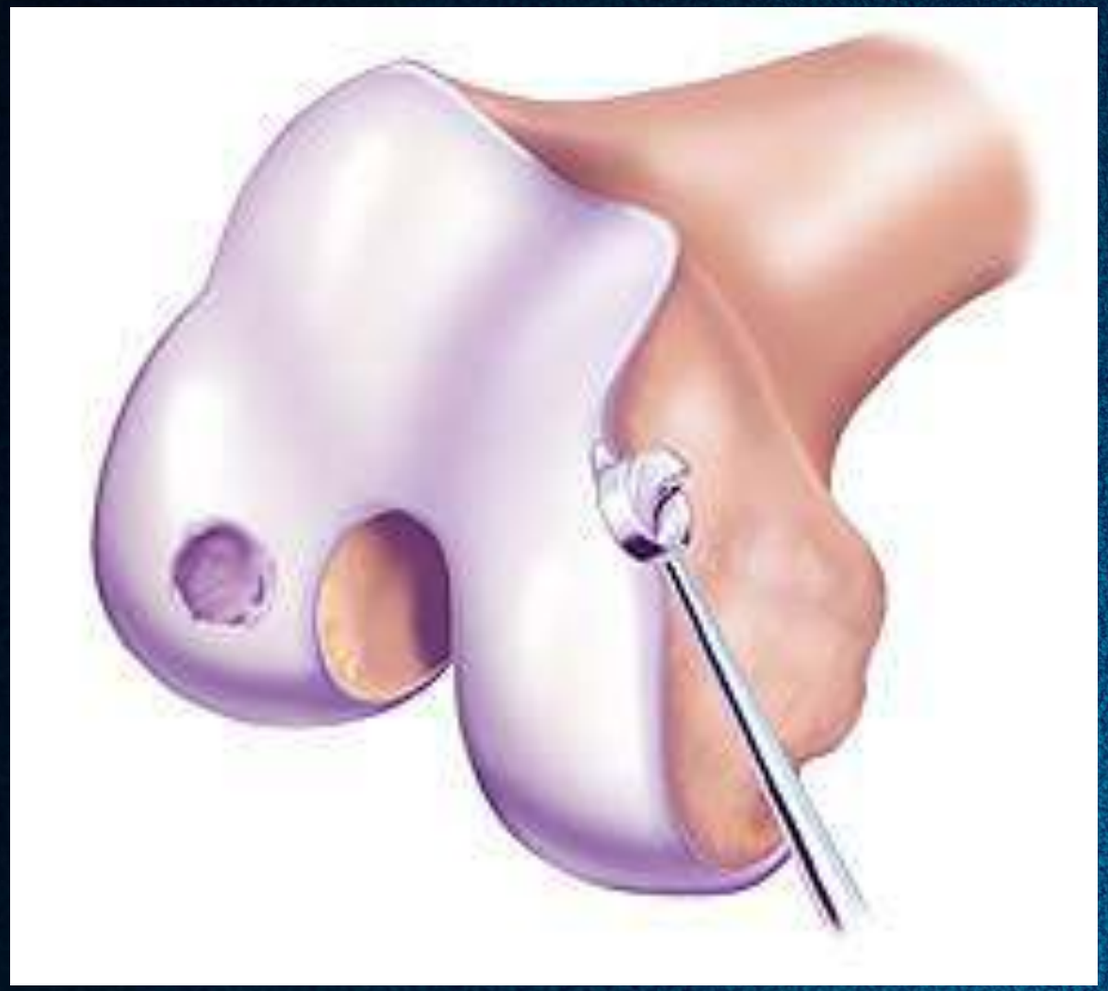
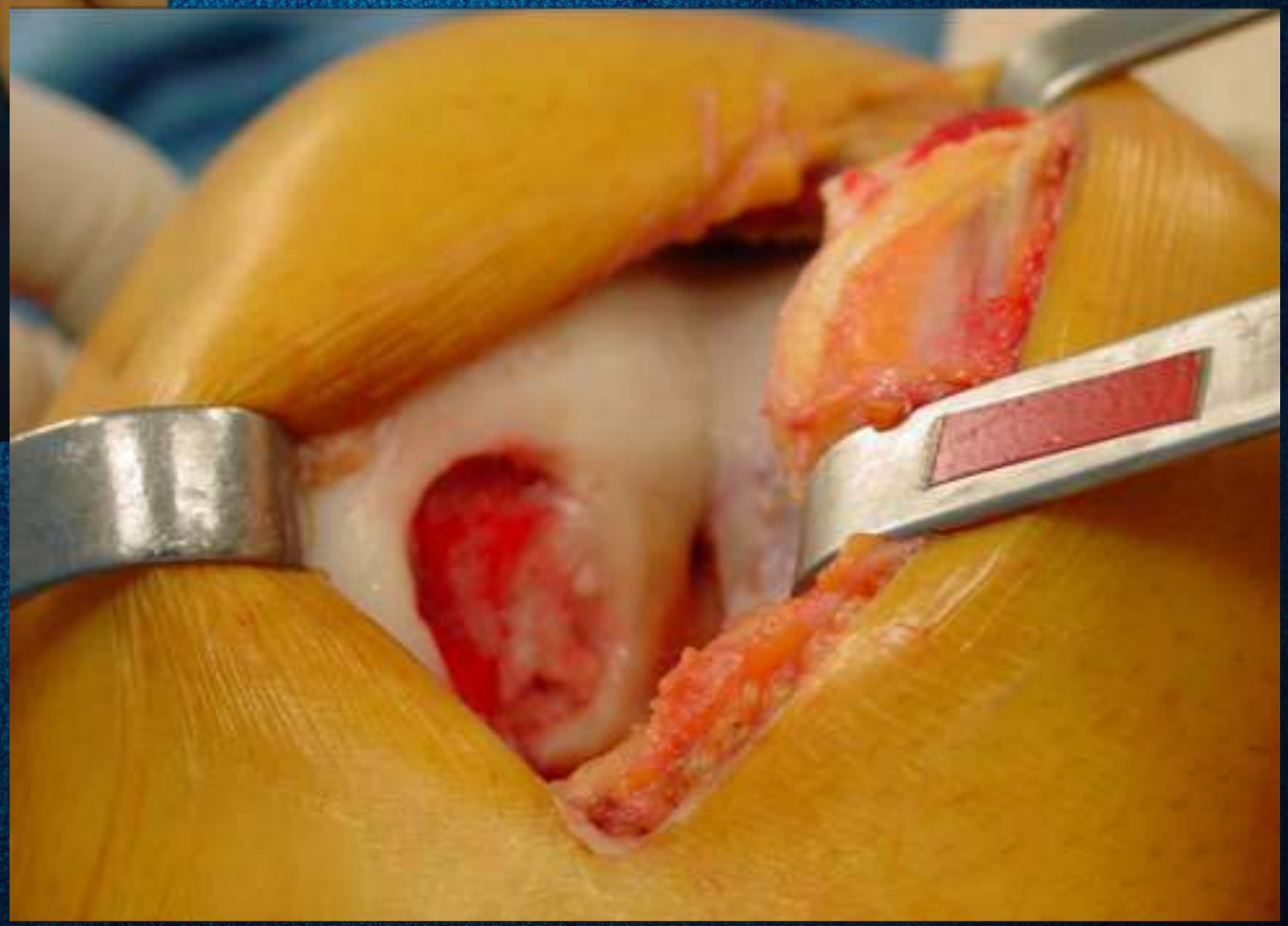
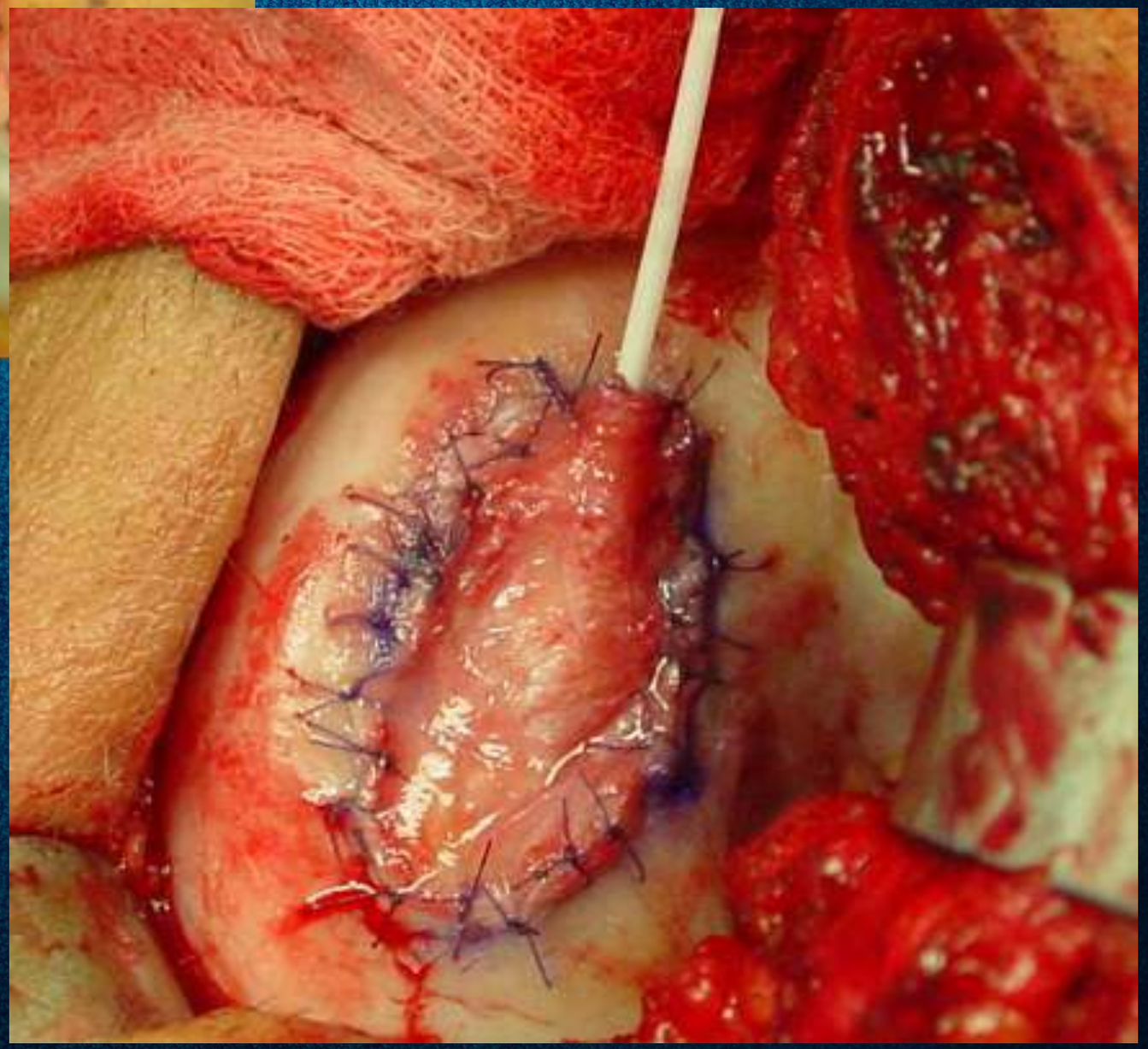
nale with medial femoral ostechondritis di

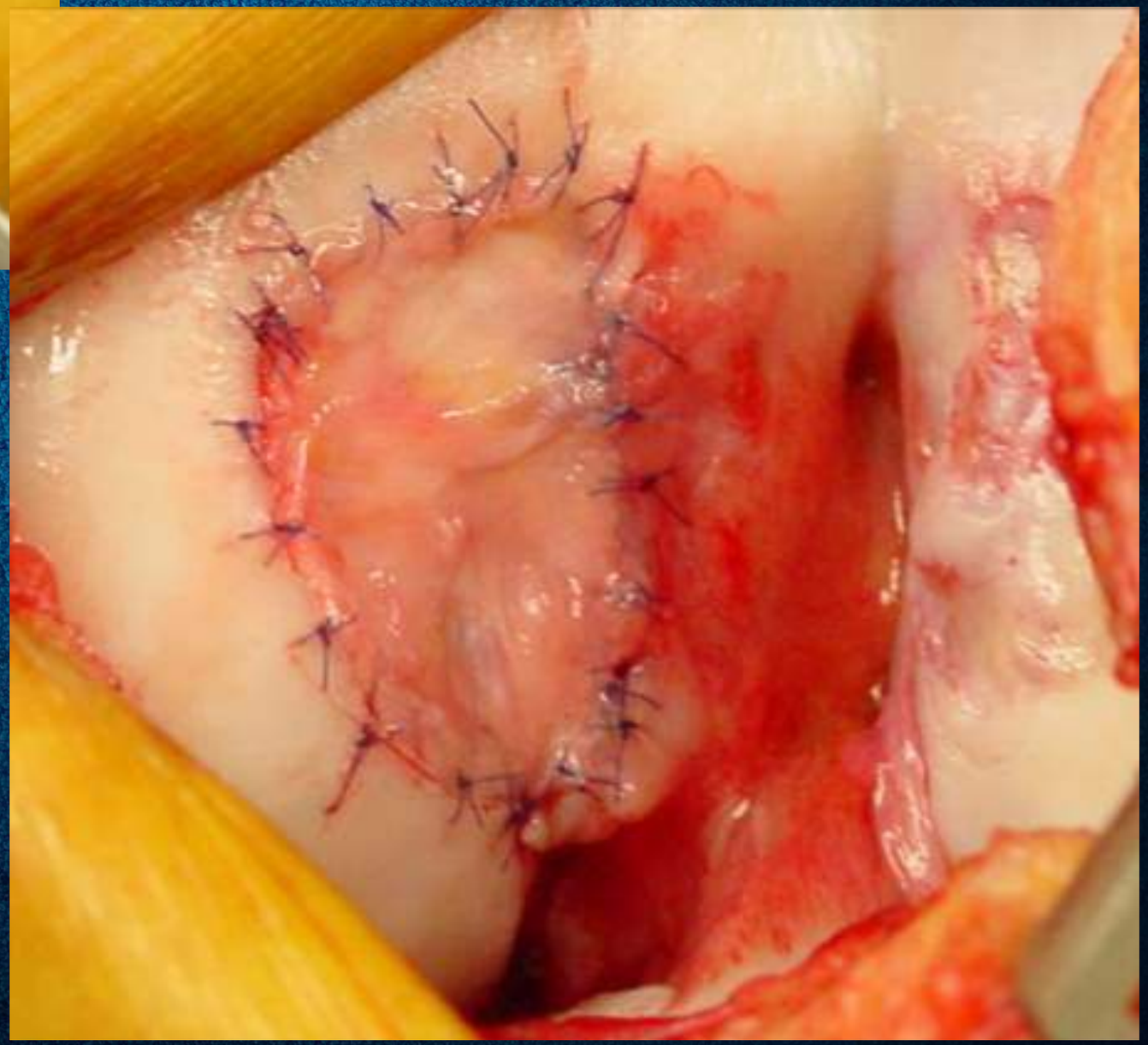












Early Good Results for ACI

- Brittberg (NEJM, 1994)
- Minas (CORR, 2001)
- Peterson (CORR, 2000)
- Peterson (AJSM, 2002)
- Cole (AJSM, 2012)

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Ten-year clinical and radiographic outcomes after autologous chondrocyte implantation of femoral condyles

David Martinčič · Damjan Radosavljevič · Matej Drobnič

2014

- Good subjective knee score to 10 years
- Progressive arthritis in 45%
- Low return to pre-injury activity levels

ACI Positives

- No disease transmission concerns
- Some reports of hyaline like cartilage

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ACI Negatives

- Inconsistent hyaline like cartilage formation
- Significant re-operation rates
- Two surgeries
- Most expensive technique

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Osteochondral Autograft Transplantation

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Transfer the patient's own normal articular cartilage into the cartilage defect.

OC Autograft Procedure

- One step
- Harvest core of cartilage & bone
- Transfer core(s) into defect
- Press fit
- Arthroscopic or open

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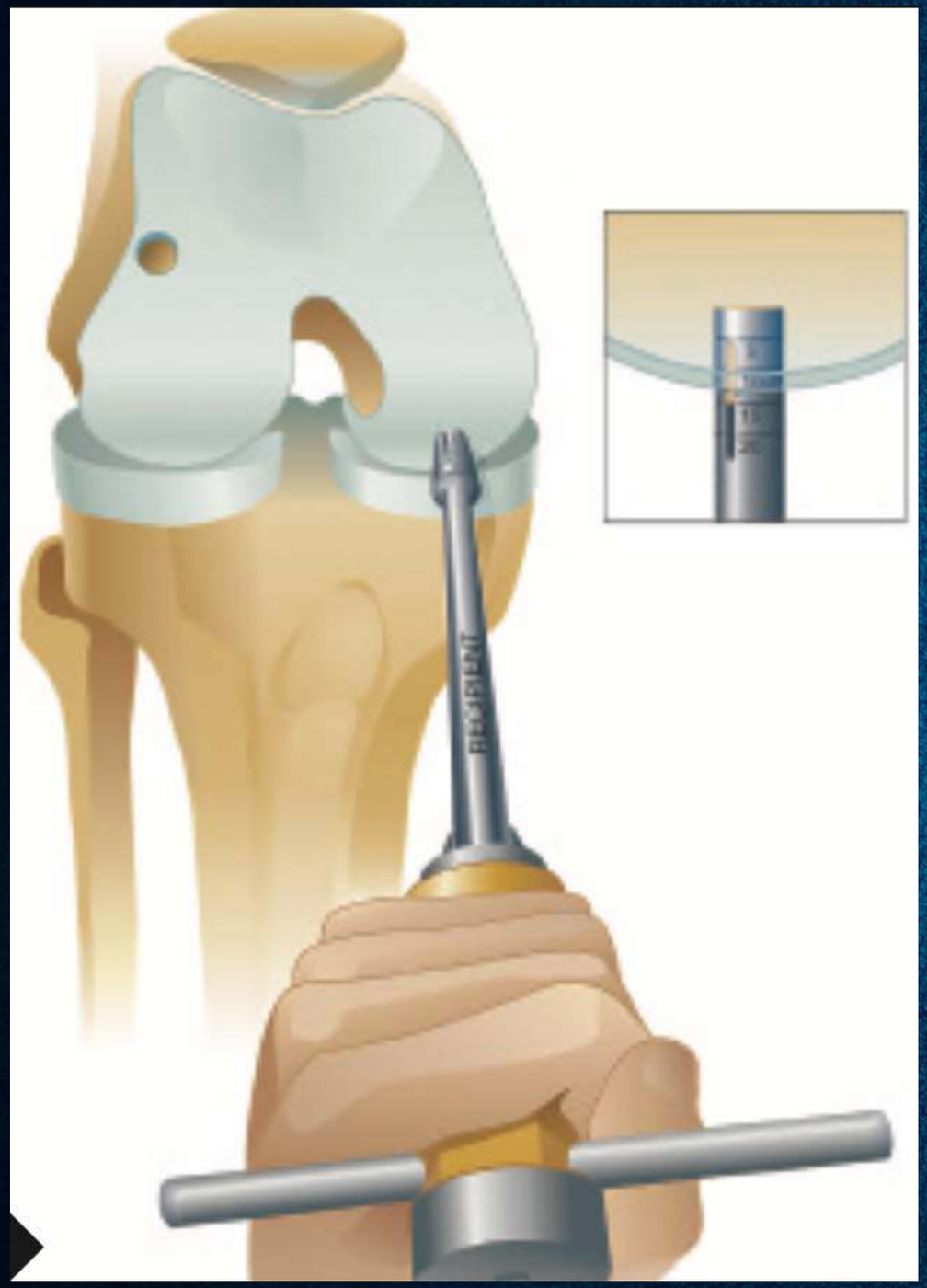

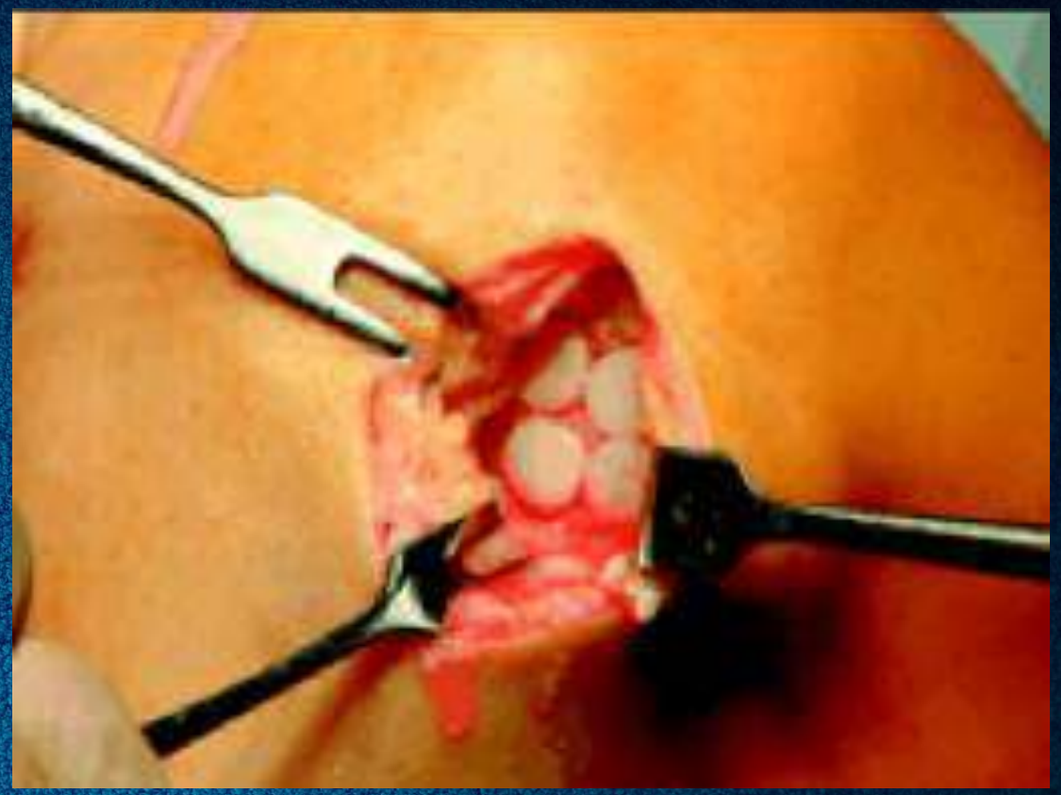

Good Results for OC Autografts

- Hangody (JBJS, 2003)
- Hangody (JBJS, 2004)
- Chow (Arthroscopy, 2004)
- Gudas (Knee Surg Sp Tr Arthr, 2006)

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OC Autograft Positives

- Readily available grafts
- Good solution for small defects
- Hyaline cartilage transfer

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OC Autograft Negatives

- Replication of articular surface convexity - difficult
- Increased contact pressures
- Tougher for large defects
- Robbing Peter to pay Paul?

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Osteochondral Allograft Transplantation

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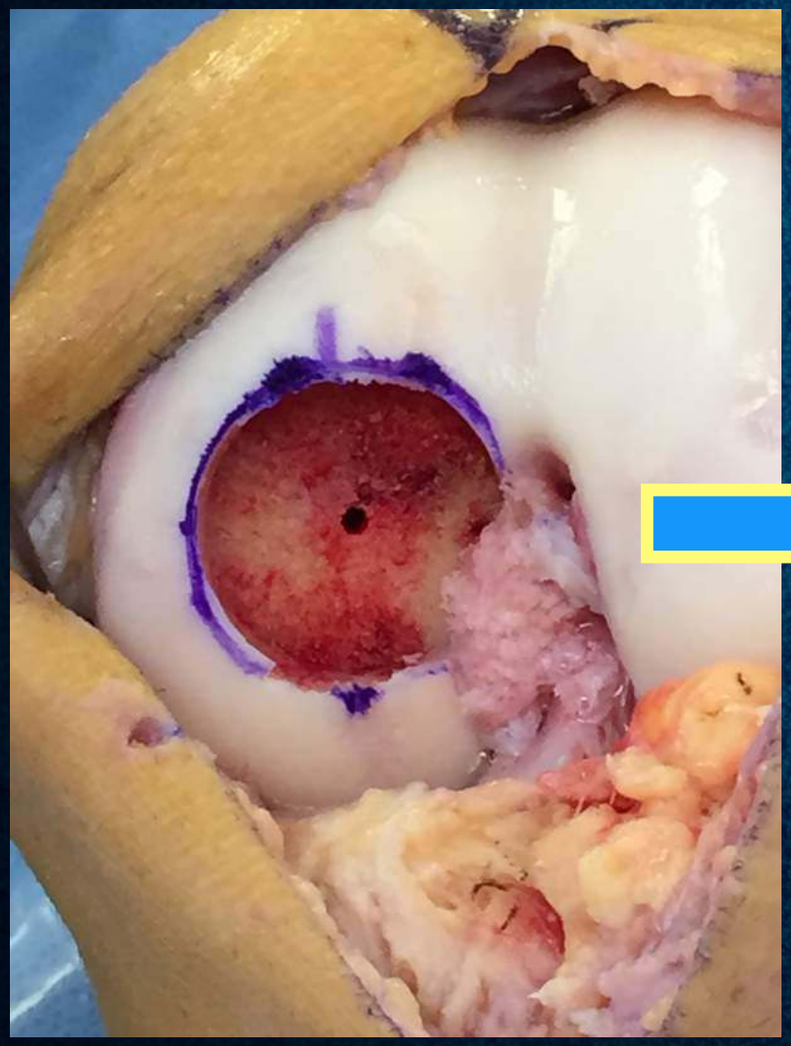
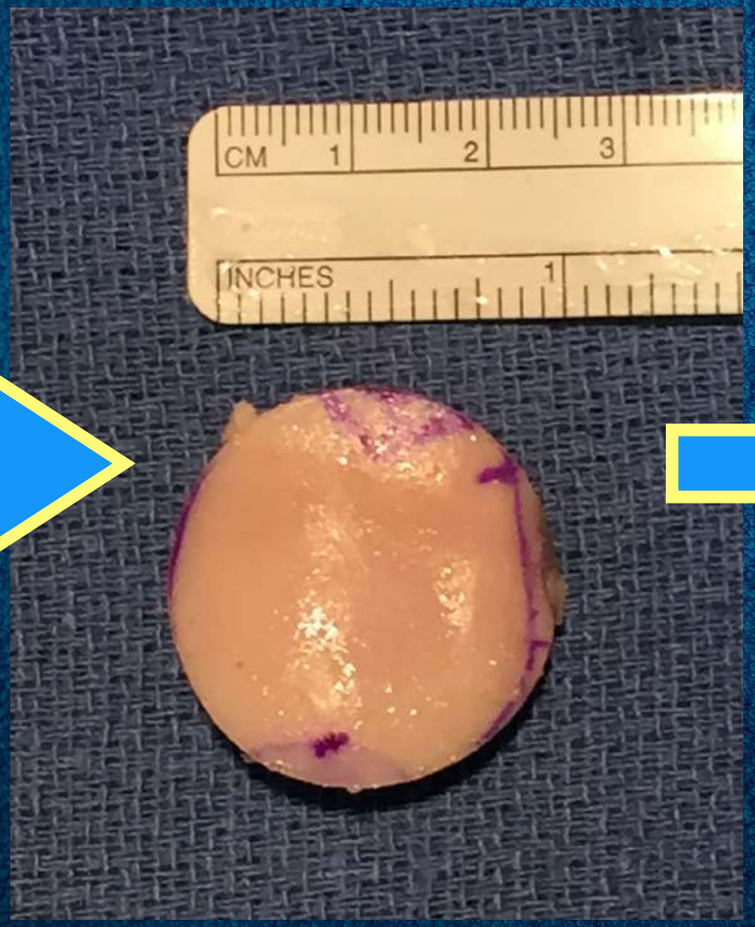
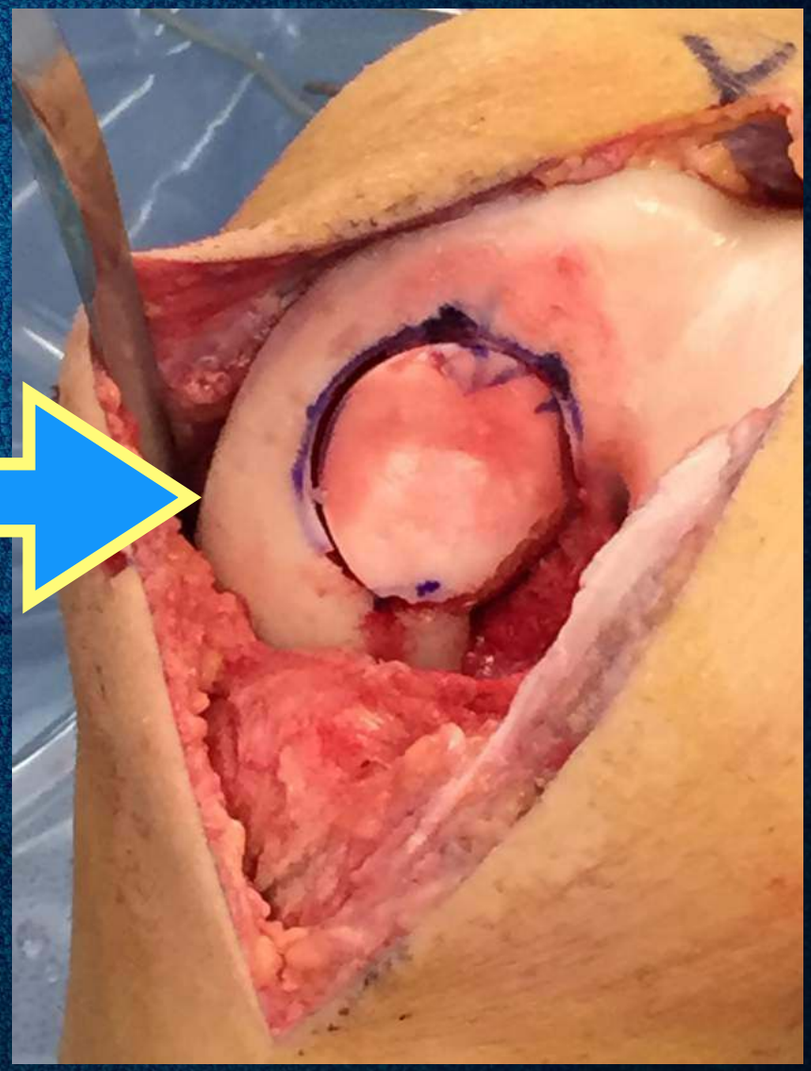
Transfer donor articular cartilage into the defect.







OC Allograft Procedure

- One step
- Fresh allograft
- Harvest large core of cartilage & bone
- Transfer core into defect
- Press fit
- Open procedure

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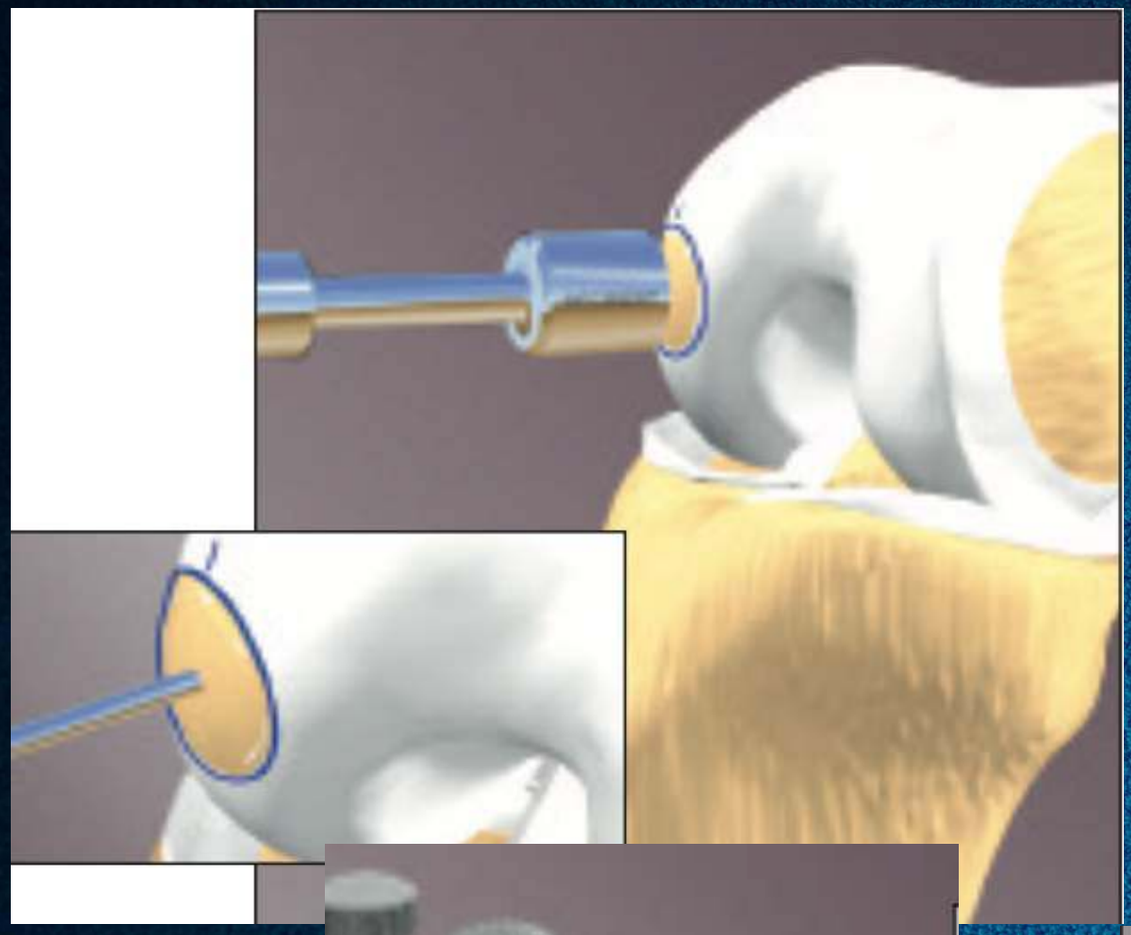

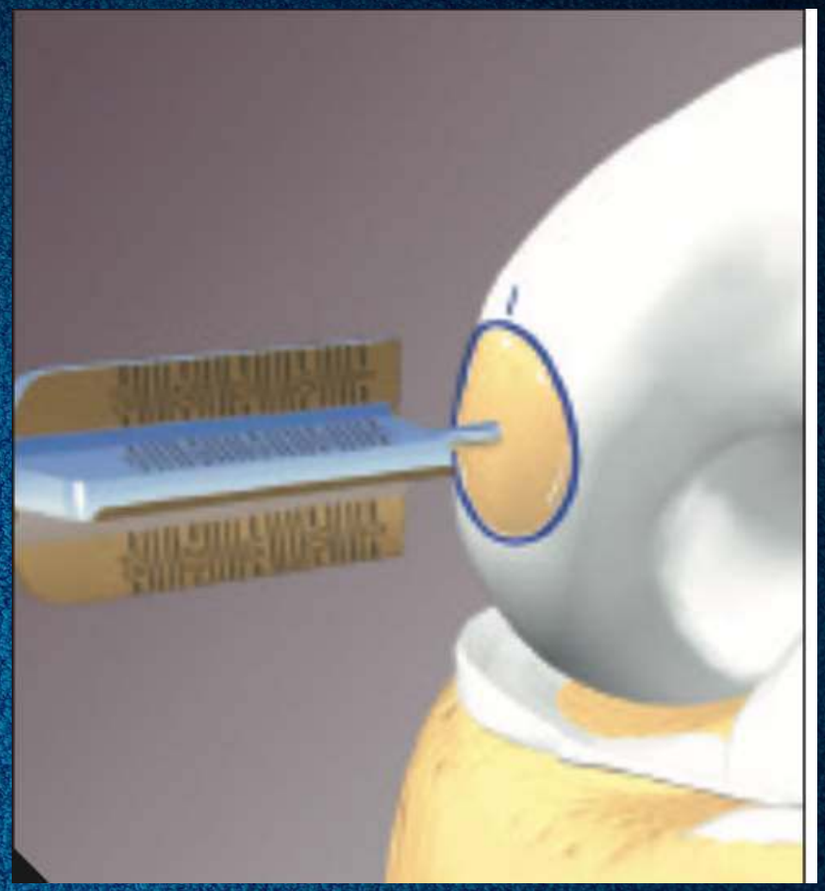

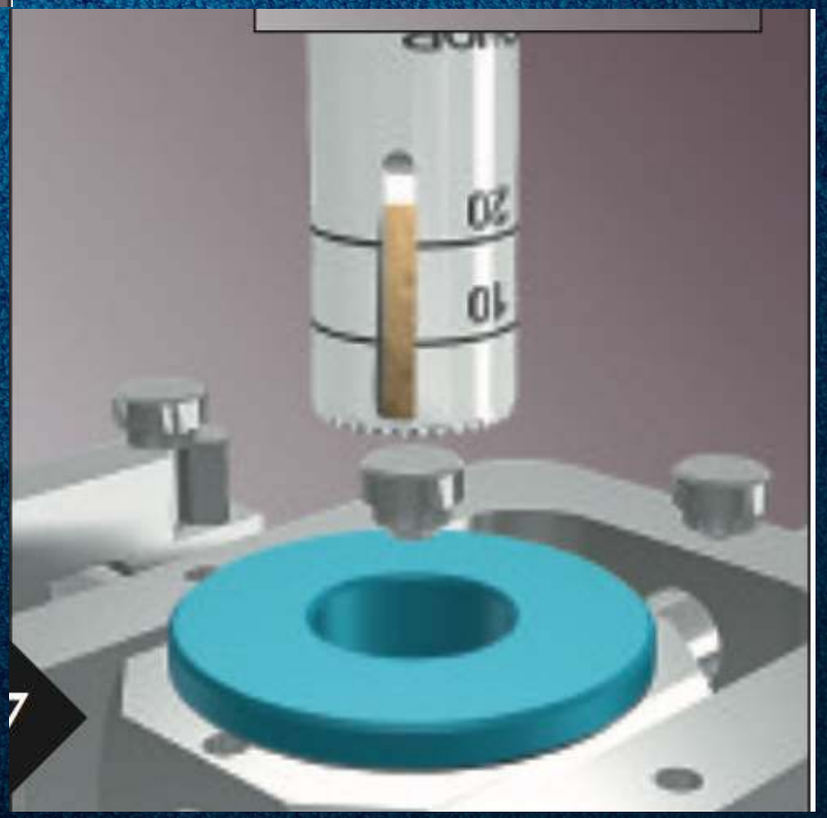
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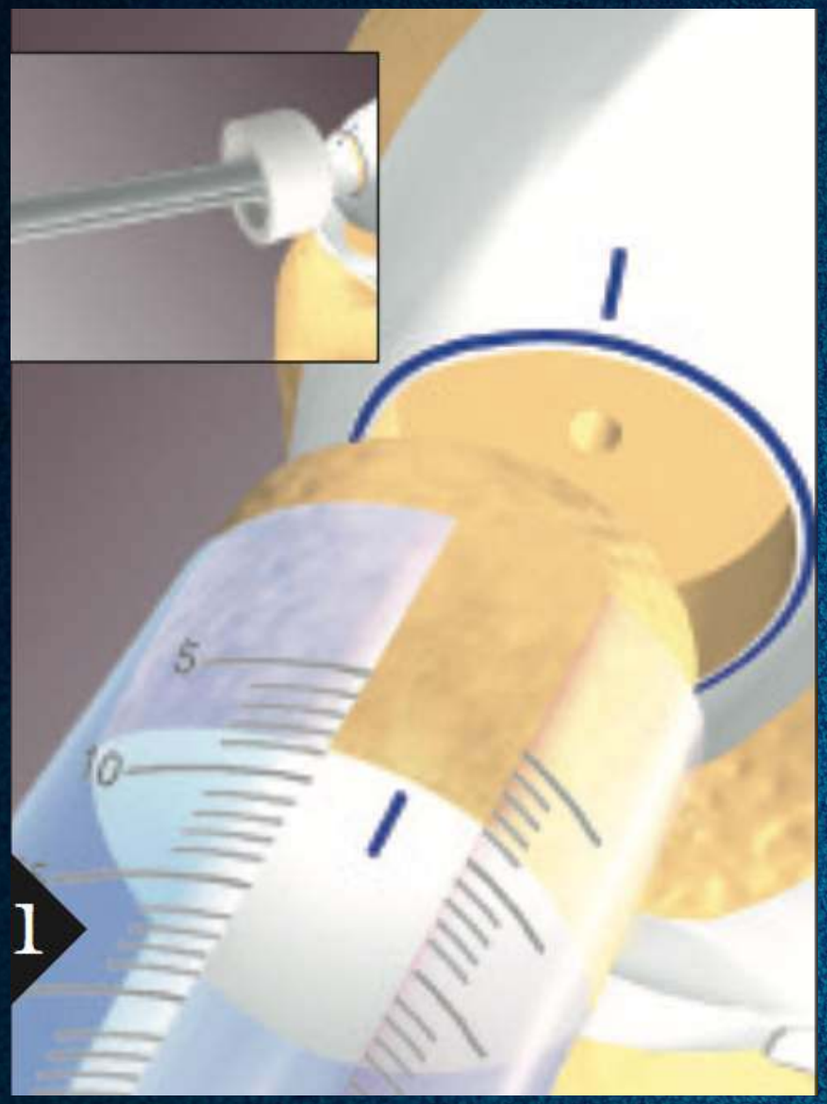

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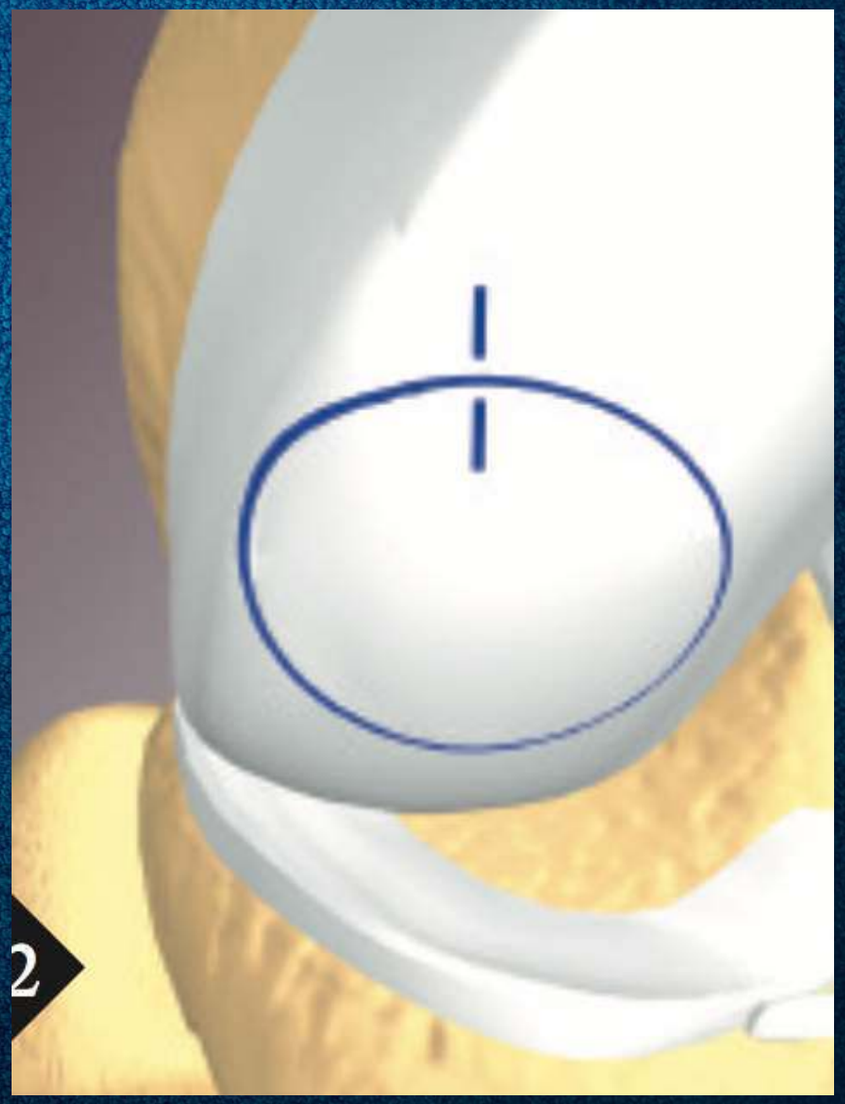

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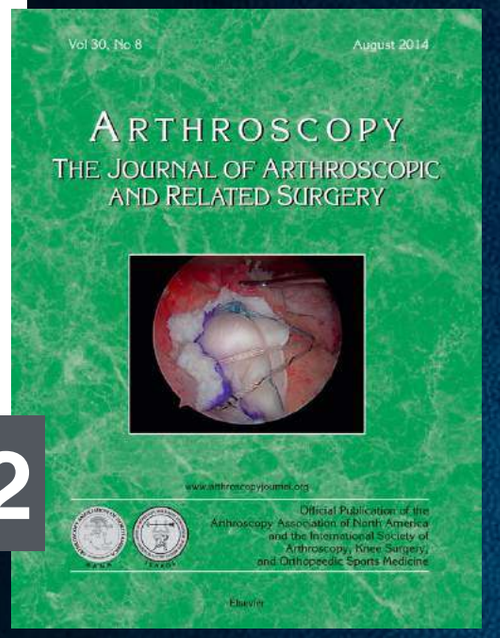
OC Allograft Good Results

- Davidson (AJSM, 2007)
- Emerson (AJSM, 2007)
- LaPrade (JBJS, 2009)
- Krych (AJSM, 2012)
- Shaha (AJSM, 2013)
- Tschon (Injury, 2017)
- Assenmacher (Arthroscopy, 2016)

Long-term Outcomes After Osteochondral Allograft: A Systematic Review at Long-term Follow-up of 12.3 Years

Andrew T. Assenmacher, M.D., Ayoosh Pareek, B.S., Patrick J. Reardon, B.S., Jeffrey A. Macalena, M.D., Michael J. Stuart, M.D., and Aaron J. Krych, M.D.



2012

- **Systematic review**
- **5 studies, 291 patients**
- **Average 12 year follow up**
- **75% success rate**

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Clinical Outcomes and Failure Rates of Osteochondral Allograft Transplantation in the Knee

A Systematic Review

Filippo Familiari,* MD, Mark E. Cinque,† BS, Jorge Chahla,† MD, PhD, Jonathan A. Godin,† MD, MBA, Morten Lykke Olesen,‡ MD, Gilbert Moatshe,†§‖ MD, and Robert F. LaPrade,†¶# MD, PhD

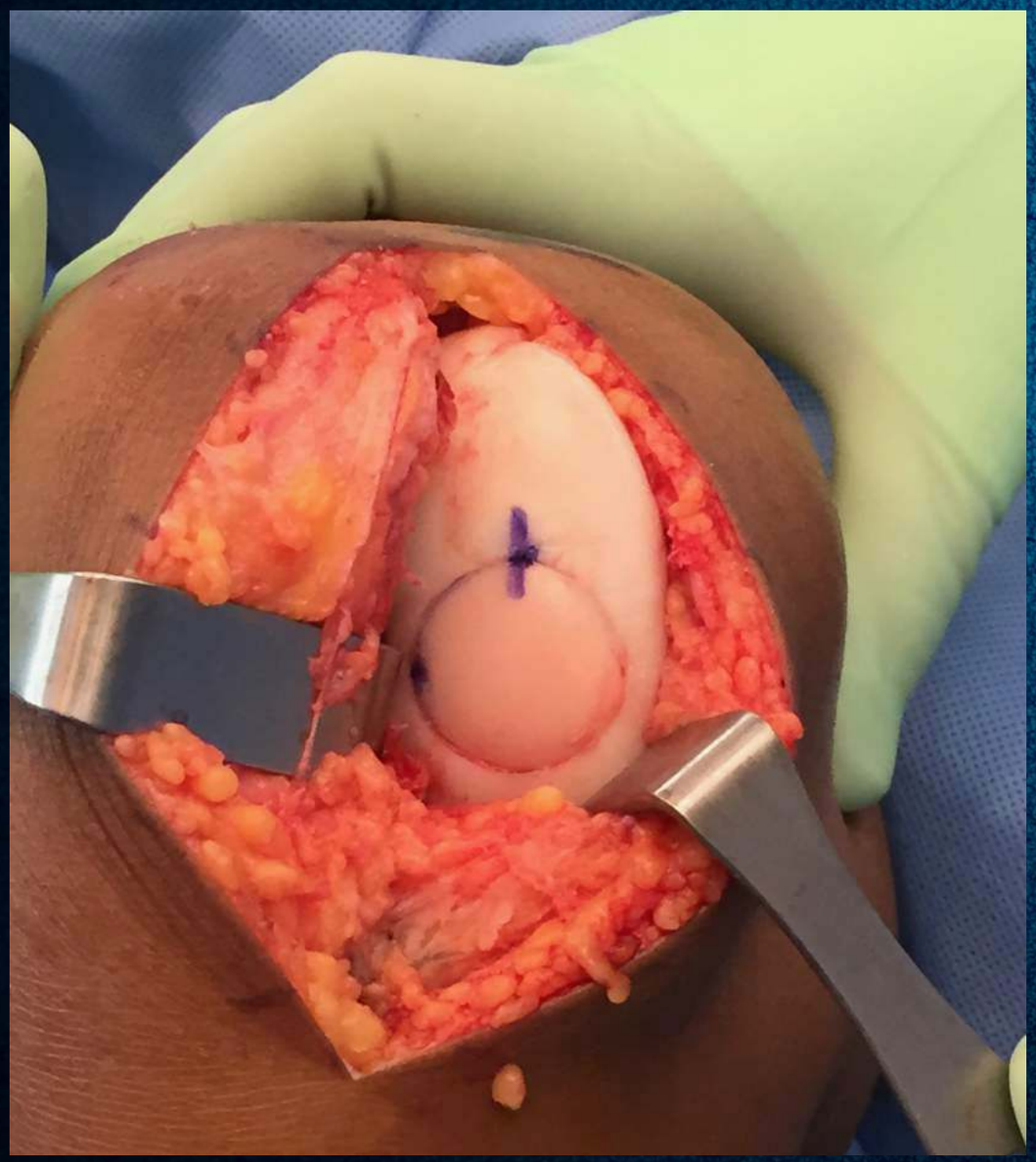
2018

- Systematic review
- 19 studies - 1,036 patients

Survival Rates

- *5 years - 87%*
- *10 years - 79%*
- *15 years - 73%*
- *20 years - 67%*

OC Allograft Positives



- No harvest site issues
- Allows for large grafts
- Hyaline cartilage transfer

OC Allograft Negatives

- Cell viability issues
- Donor anatomy matching necessary to replicate surface convexity
- Disease transmission issues
- Immunology

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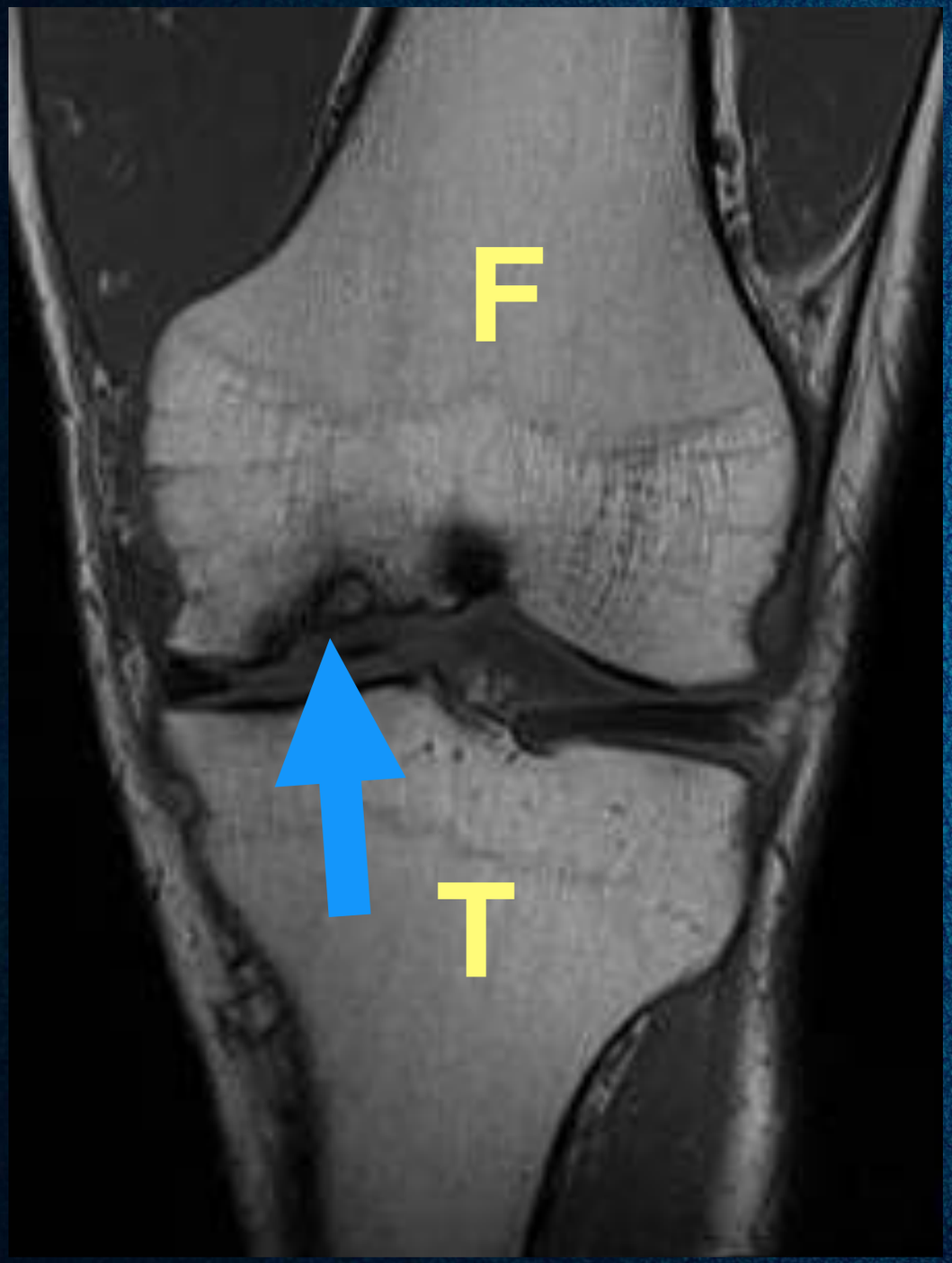
nter with long history knee pain & recent histor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Osteochondral Allograft Transplantatio

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these procedures stack up against eac

Quality comparison studies are lacking.

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Autologous Chondrocyte Implantation Compared with Microfracture in the Knee

A Randomized Trial

By Gunnar Knutsen, MD, Lars Engebretsen, MD, PhD, Tom C. Ludvigsen, MD,
[illegible]n Strand, MD,
[illegible]

2004

A Randomized Trial Comparing Autologous Chondrocyte Implantation with Microfracture

Findings at Five Years

By Gunnar Knutsen, MD, Jon Olav Drogset, MD, PhD, Lars Engebretsen, MD, PhD, Torbjørn Grøntvedt, MD, PhD, Vidar Isaksen, MD, Tom C. Ludvigsen, MD, Sally Roberts, PhD, Eirik Solheim, MD, PhD, Torbjørn Strand, MD, and Oddmund Johansen, MD, PhD

2007

- **Microfracture = ACI**
- **Biopsies - large amounts of fibrocartilage**

Autologous Chondrocyte Implantation and Osteochondral Cylinder Transplantation in Cartilage Repair of the Knee Joint

A Prospective, Comparative Trial

By U. Horas, MD, D. Pelinkovic, MD, G. Herr, DSc, T. Aigner, MD, and R. Schnettler, MD

2003

- ACI vs large cylinder OAT
- Slower recovery with ACI
- Equal results at 2 years
- ACI biopsies - fibrocartilage

Current Treatments of Isolated Articular Cartilage Lesions of the Knee Achieve Similar Outcomes

Hong-Chul Lim MD, PhD, Ji-Hoon Bae MD,
Sang-Heon Song MD, Young-Eun Park MD,
Seung-Ju Kim MD

2014

- MFx vs OAT vs ACI
- RCT level 2
- No differences in MRI or second look scopes at 1 year
- No differences in knee scores at 3 years minimum
- Only 58% follow-up

What about for athletes?

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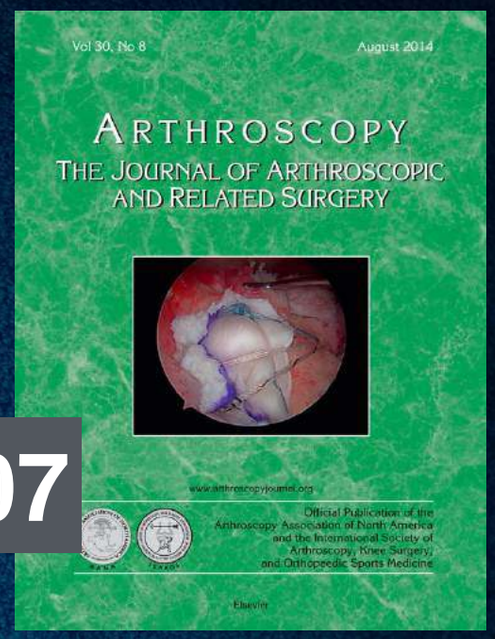
A Prospective Randomized Clinical Study of Mosaic Osteochondral Autologous Transplantation Versus Microfracture for the Treatment of Osteochondral Defects in the Knee Joint in Young Athletes

Rimtautas Gudas, M.D., Ph.D., Romas J. Kalesinskas, M.D., Vytautas Kimtys, M.D., Edgaras Stankevičius, M.D., Ph.D., Vytautas Toliušis, M.D., Giedrius Bernotavičius, M.D. and Alfredas Smailys, M.D., Ph.D.

2007



- **OAT vs Microfracture in competitive athletes**
- **RCT**
- **Better knee scores, MRI & histology for OAT**

Return to pre-injury sports level…
Microfracture - 52%
OAT - 93%

Activity Levels Are Higher After Osteochondral Autograft Transfer Mosaicplasty Than After Microfracture for Articular Cartilage Defects of the Knee

A Retrospective Comparative Study

Aaron J. Krych, MD, Heather W. Harnly, MD, Scott A. Rodeo, MD, and Riley J. Williams III, MD

2014

- **OAT vs Microfracture**
- **Retrospective**
- **Similar clinical scores**
- **Higher return to sports activities in OAT**

Articular Cartilage Treatment in High-Level Male Soccer Players

A Prospective Comparative Study of Arthroscopic Second-Generation Autologous Chondrocyte Implantation Versus Microfracture

Elizaveta Kon,*† MD, Giuseppe Filardo,† MD, Massimo Berruto,‡ MD, Francesco Benazzo,§ MD, Giacomo Zanon,§ MD, Stefano Della Villa,‖ MD, and Maurilio Marcacci,† MD

2014

- ACI vs Microfracture in soccer players
- Similar return to sports at 2 years
- Deterioration of results for microfracture
- Minimum 4 years & mean 7.5 years
- Soccer participation maintained in ACI

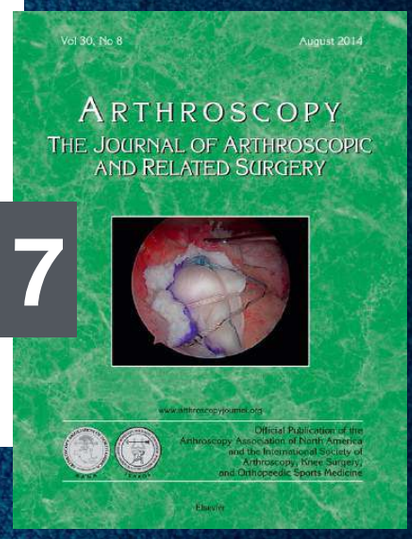
Return to Athletic Activity After Osteochondral Allograft Transplantation in the Knee

Aaron J. Krych,*† MD, Catherine M. Robertson,‡ MD,
Riley J. Williams III,§ MD, and the Cartilage Study Group§||

2012

Can Competitive Athletes Return to High-Level Play After Osteochondral Allograft Transplantation of the Knee?

Mark A. McCarthy, M.D., Maximilian A. Meyer, B.S., Alexander E. Weber
David M. Levy, M.D., Annemarie K. Tilton, M.D., Adam B. Yanke, M.D., and
Brian J. Cole, M.D., M.B.A.



2017

Return to pre-injury sports level…
77% & 79%

Lesion Location

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Lesion Location

Rank Order for Success

1. Femoral condyles
2. Patella
3. Tibial plateaus

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How is the procedure choice made?

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Articular Cartilage Defect Size

< or = 2 cm^2

- Microfracture
- OC autograft

> 2 cm^2

- OC allograft
- ACI

Adjunct Considerations

Femoral Condyle

- Ligament instability
- Meniscus deficiency
- Malalignment

Patella

- Malalignment
- Pressure offload

Other Factors

- Age
- Activity level
- Patient desires

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My Preferences

- 1 cm^2 - OC autograft
- > 1 cm^2 - OC allograft
- Will consider microfracture in teenagers for small lesions

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Summary

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- Challenging surgical problems
- Quality but imperfect options
- High level evidence studies are lacking
- Deep understanding and advanced skills are ne

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Thank You