

Treatment of Osteochondral Lesions of the Knee

Lance LeClere, MD

CDR MC USNR

Associate Professor of Orthopaedic Surgery

Vanderbilt University Medical Center





Acknowledgements

Maj Travis Dekker, US Air Force

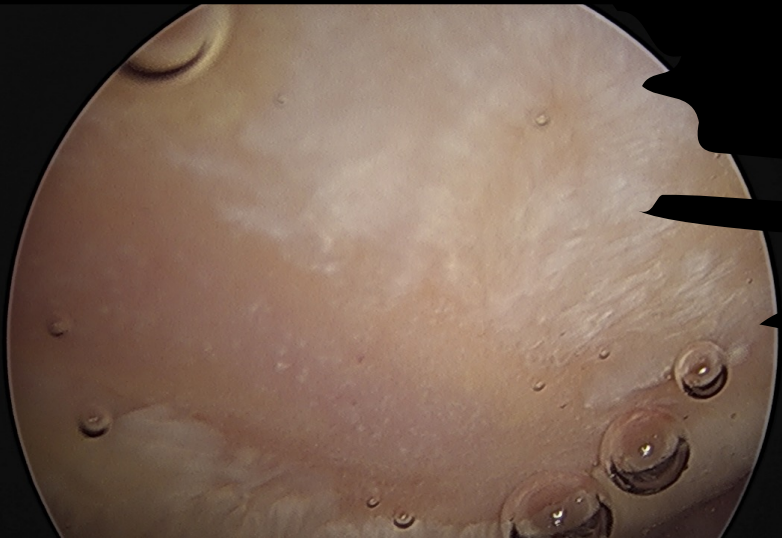
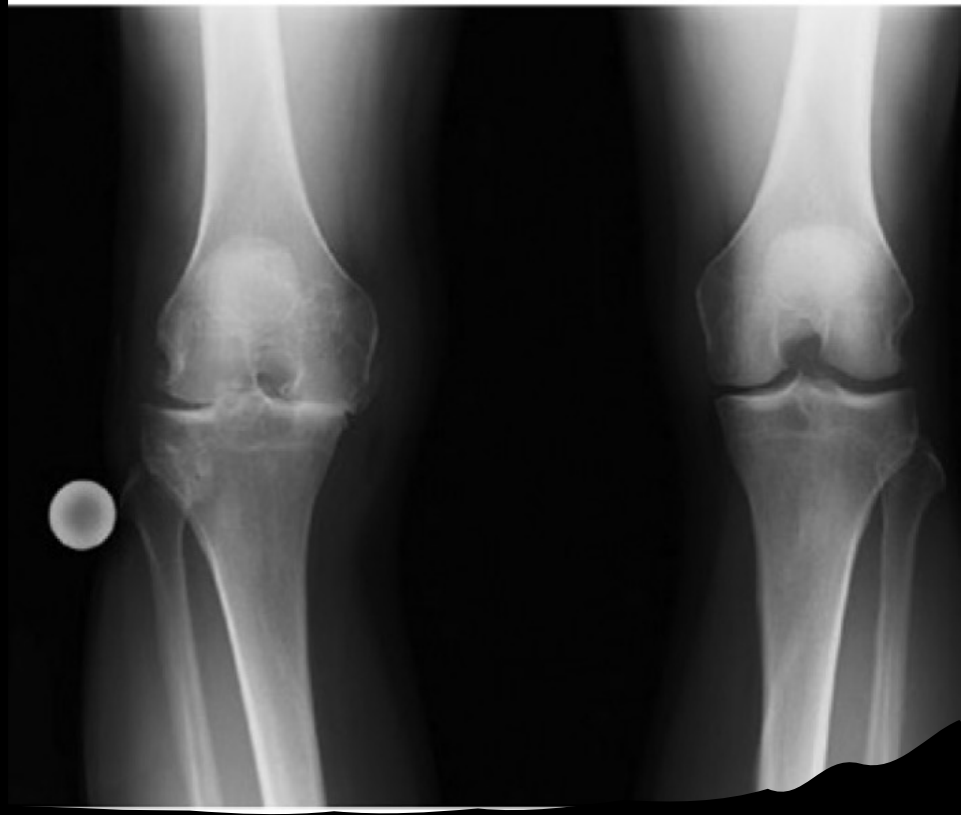
Disclosures

- No relevant disclosures

Fundamentals...



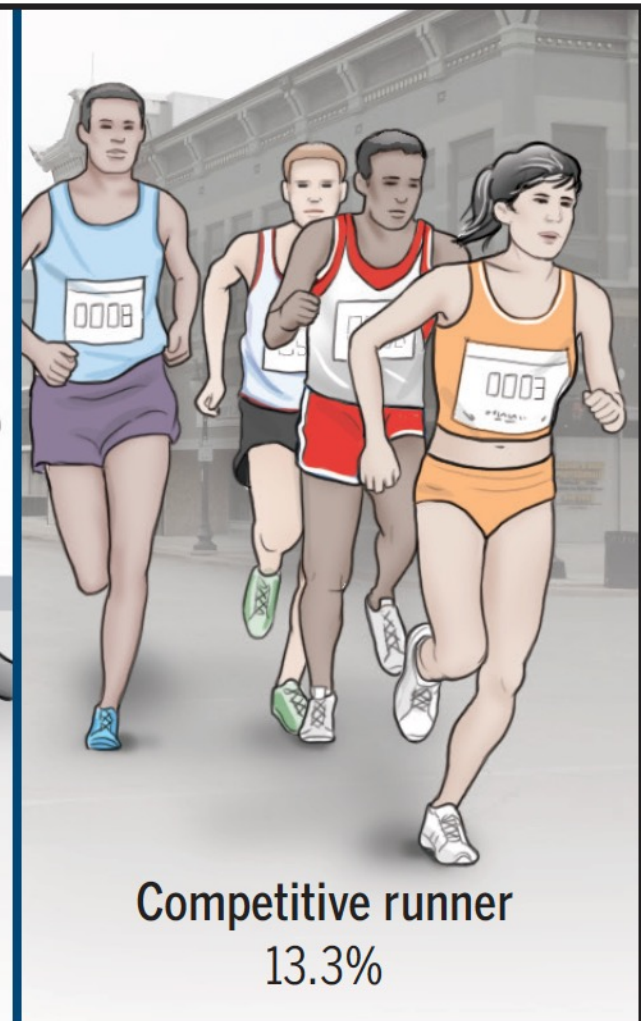
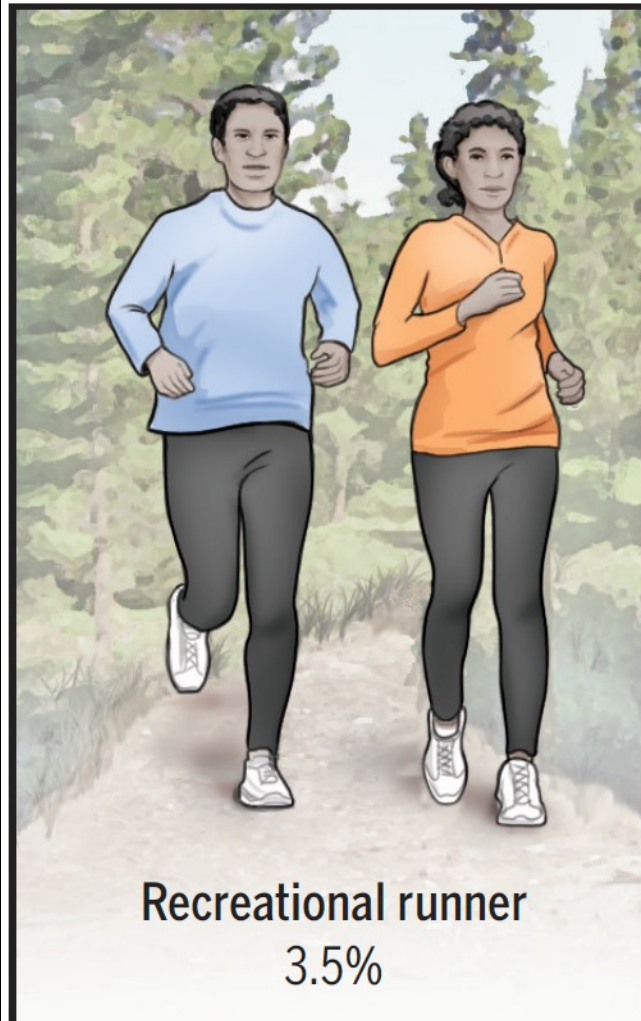
Hang on... We must be doing something wrong...
How does the saying go again?



Focal Cartilage Injury—
What it isn't...

Running and Osteoarthritis

ERIYADU ALFENTODN-CELI MD MSc PhD14 • KRISTIAN SAMUELSSON MD MSc PhD5 • VOLKED MUSAHI MD PhD6



running competitively and more sedentary, nonrunning individuals. While

low quality or most of the evidence, the small number of studies for some comparisons, the potentially high risk of bias

Running and Knee Osteoarthritis

A Systematic Review and Meta-analysis

Kate A. Timmins,^{*} PhD, Richard D. Leech,^{*} MSc,
Mark E. Batt,^{*†} MB BChir, DM, FFSEM, and Kimberley L. Edwards,^{*‡§} PhD
Investigation performed at the University of Nottingham, Nottingham, UK

The American Journal of Sports Medicine, Vol. 45, No. 6

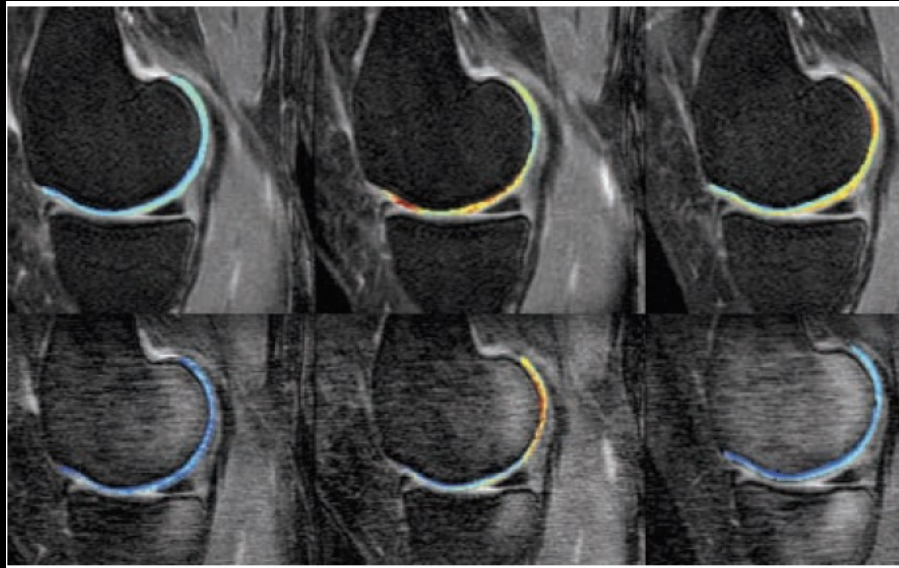
From this evidence, it is not possible to conclude whether running was associated with a diagnosis of knee OA, and studies offered differing conclusions. Nor was there evidence to support a difference in radiographic or other imaging markers between runners and controls,

High-Field Magnetic Resonance Imaging Assessment of Articular Cartilage Before and After Marathon Running

Does Long-Distance Running Lead to Cartilage Damage?

Anthony C. Luke,^{*†} MD, MPH, Christoph Stehling,^{‡§} MD, Robert Stahl,^{‡||} MD, Xiaojuan Li,[‡] PhD,
Terry Kay,^{†¶} Stephen Takamoto,[†] PhD, Benjamin Ma,[†] MD, Sharmilla Majumdar,[‡] PhD, and
Thomas Link,[‡] MD

The American Journal of Sports Medicine, Vol. 38, No. 11

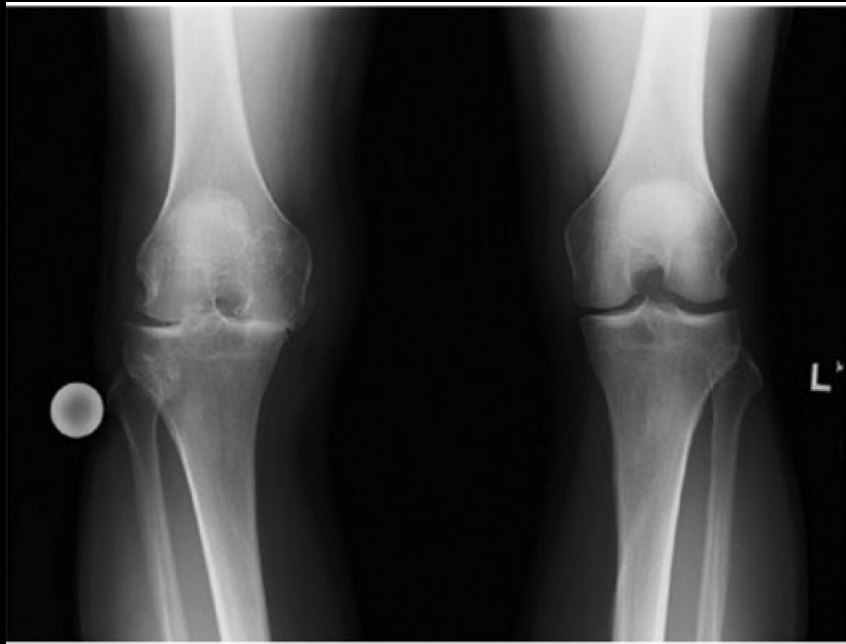


Now What?

Nonoperative Treatment Approach to Knee Osteoarthritis in the Master Athlete

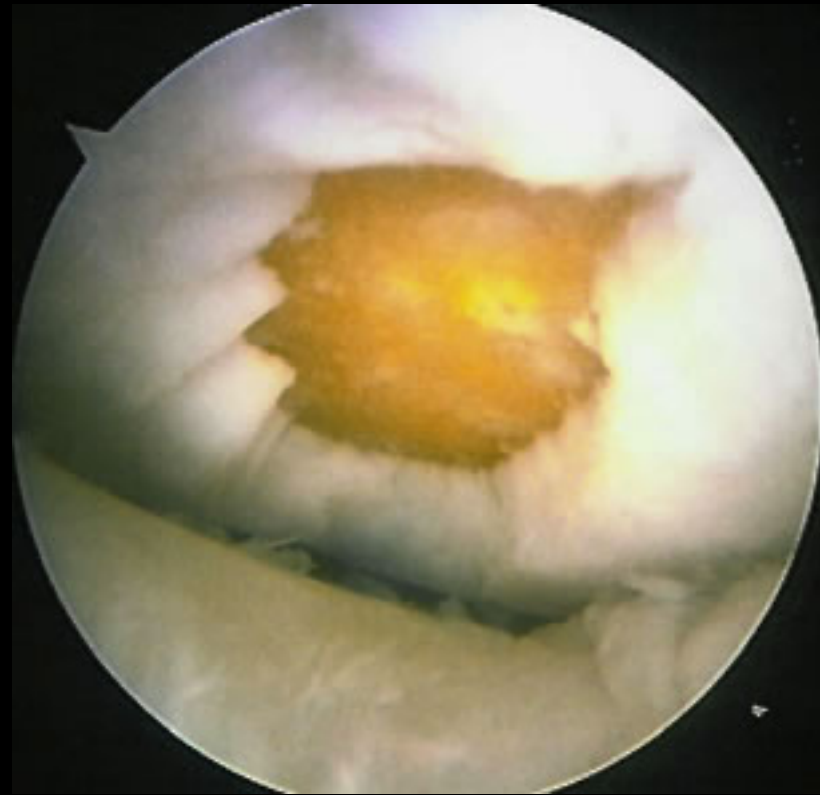
Joel B. Huleatt, MD,[†] Kevin J. Campbell, BS,[†] and Robert F. LaPrade, MD, PhD*[‡]

SPORTS HEALTH vol. 6 • no. 1 Jan • Feb 2014

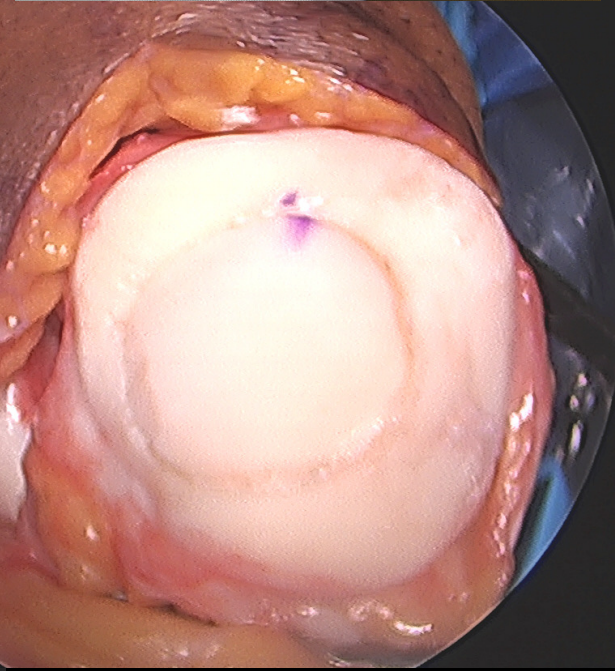
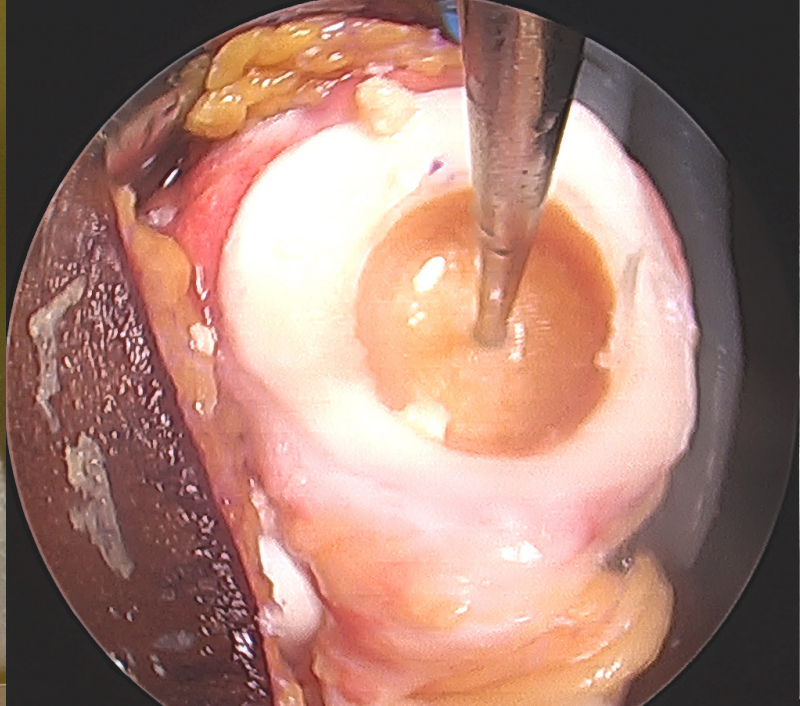
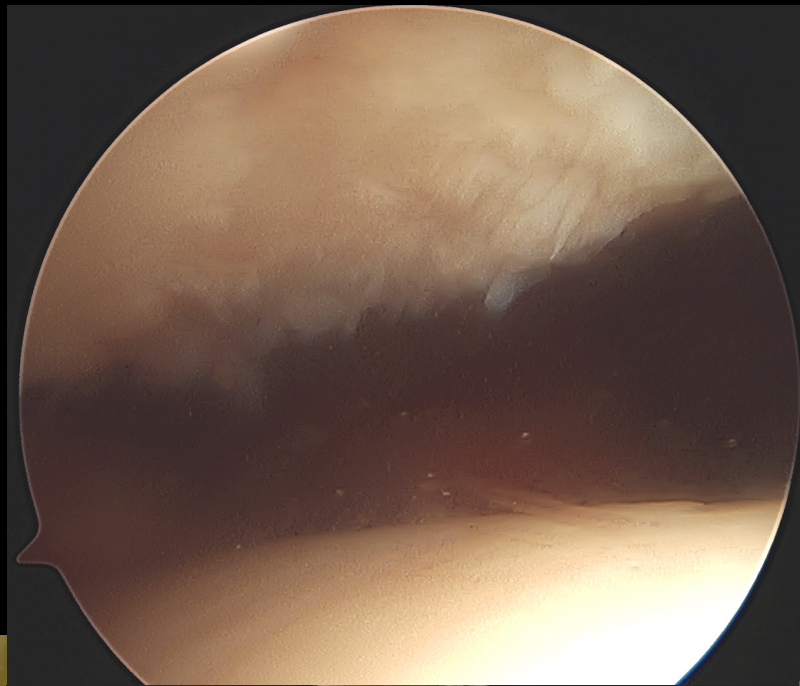


- “With evidence on the side of running in slowing the development and/or progression of knee OA, there appears little reason for physicians to discourage running in this population.”

Focal Chondral Lesion



Case 1



Treatment Options

Non Op Tx

Chondroplasty

Microfracture

Chondrocyte Implantation

Osteochondral Graft

HTO

Partial Replacement

Total Knee

A





Weight Loss/Optimal Body Weight

1 kg of weight loss = 4x decrease in force across the knee

Bracing



Oral/topical NSAIDs



Physical Therapy

Med Sci Sports Exerc. 2010 November ; 42(11): 2081–2088. doi:10.1249/MSS.0b013e3181dd902e.

The Effect of Quadriceps Strength and Proprioception on Risk for Knee Osteoarthritis

Neil A. Segal, MD, MS¹, Natalie A. Glass, MA¹, David T. Felson, MD, MPH², Michael Hurley, PT, PhD³, Mei Yang, DsC², Michael Nevitt, PhD⁴, Cora E. Lewis, MD, MSPH⁵, and James C. Torner, PhD¹

¹University of Iowa, Iowa City, IA

²Boston University, Boston, MA

³King's College London, London, UK

⁴University of California at San Francisco, San Francisco, CA

⁵University of Alabama at Birmingham, Birmingham, AL.

The Ottawa panel clinical practice guidelines for the management of knee osteoarthritis. Part two: strengthening exercise programs

Clinical Rehabilitation
2017, Vol. 31(5) 596–611
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DOI: 10.1177/0269215517691084
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Lucie Brosseau¹, Jade Taki², Brigit Desjardins³, Odette Thevenot³, Marlene Fransen⁴, George A Wells⁵, Aline Mizusaki Imoto⁶, Karine Toupin-April⁷, Marie Westby⁸, Inmaculada C Álvarez Gallardo⁹, Wendy Gifford¹⁰, Lucie Laferrière¹¹, Prinon Rahman¹², Laurianne Loew¹³, Gino De Angelis¹³, Sabrina Cavallo¹³, Shirin Mehdi Shallwani¹³, Ala' Aburub¹³, Kim L Bennell¹⁴, Martin Van der Esch¹⁵, Milena Simic¹⁶, Sara McConnell¹⁷, Alison Harmer¹⁸, Glen P Kenny¹⁹, Gail Paterson²⁰, Jean-Philippe Regnaud²¹, Marie-Martine Lefevre-Colau²² and Linda McLean²³

Benefits of Resistance Training with Blood Flow Restriction in Knee Osteoarthritis

RODRIGO BRANCO FERRAZ¹, BRUNO GUALANO^{1,2}, REYNALDO RODRIGUES², CECI OBARA KURIMORI², RICARDO FULLER², FERNANDA RODRIGUES LIMA², ANA LÚCIA DE SÁ-PINTO², and HAMILTON ROSCHEL^{1,2}

¹Applied Physiology and Nutrition Research Group - School of Physical Education and Sport, University of São Paulo, SP, BRAZIL; and ²Rheumatology Division; Faculdade de Medicina FMUSP, Universidade de Sao Paulo, Sao Paulo, SP, BR, University of São Paulo, SP, BRAZIL

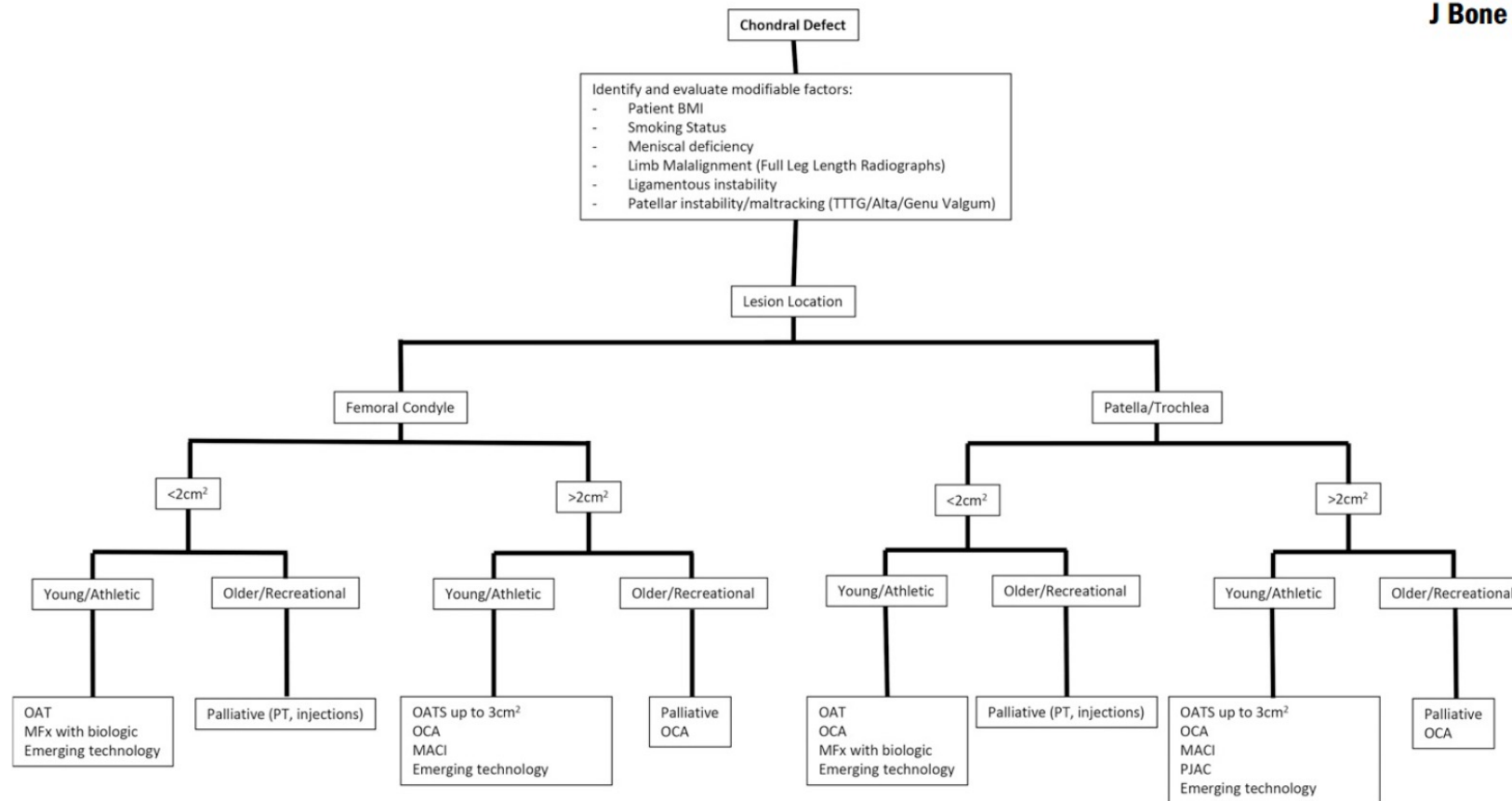


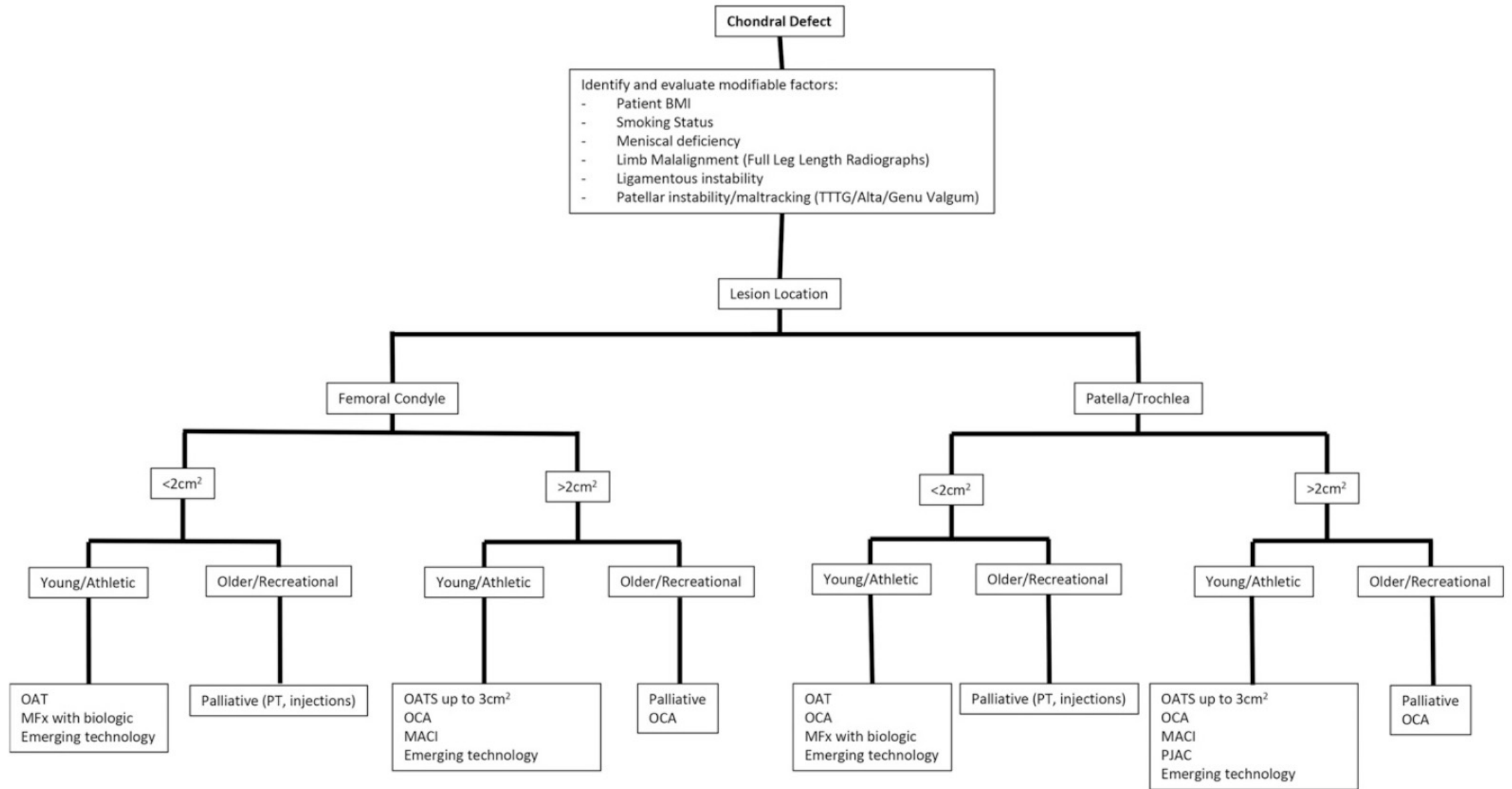
CURRENT CONCEPTS REVIEW

Chondral Lesions of the Knee: An Evidence-Based Approach

MAJ Travis J. Dekker, MD, USAF, MC, Zachary S. Aman, MS, BA, Nicholas N. DePhillipo, PhD, MS, ATC, CSCS, LT COL
Jonathan F. Dickens, MD, USA, MC, Adam W. Anz, MD, and Robert F. LaPrade, MD, PhD

J Bone Joint Surg Am. 2021;103:629-45



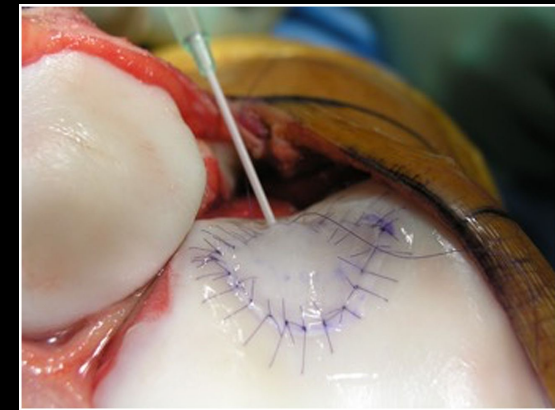


Results?

Arthroscopic Arthritis Options Are On the Horizon

Arthroscopy: The Journal of Arthroscopic and Related Surgery, Vol 31, No 3 (March), 2015: pp 389-392

Time and time again, with long term
follow up:
~67% good/excellent results



-Patient BMI

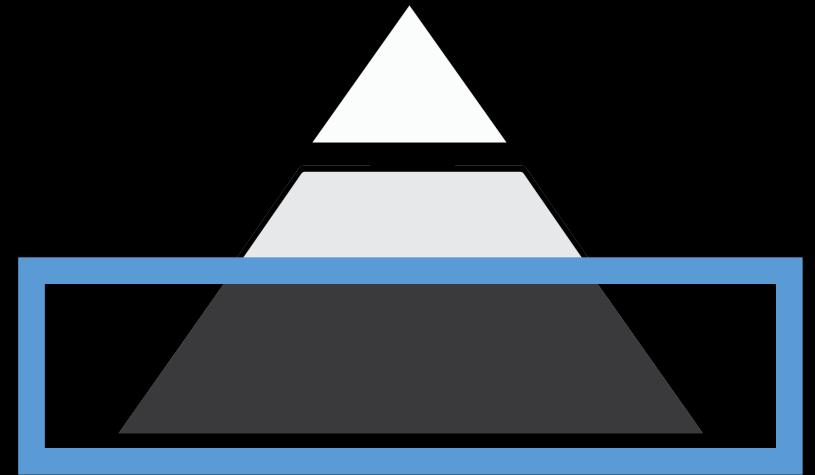
-Smoking Status

-Meniscal deficiency

-Limb Malalignment

-Ligamentous instability

-Patellar instability/maltracking (TTTG/Alta/Genu Valgum)



Published in final edited form as:


Osteoarthritis Cartilage. 2014 July ; 22(7): 912–917. doi:10.1016/j.joca.2014.05.013.

Influences of Alignment and Obesity on Knee Joint Loading in Osteoarthritic Gait

Stephen P. Messier^{1,2}, Mackenzie Pater¹, Daniel P. Beavers³, Claudine Legault³, Richard F. Loeser⁴, David J. Hunter⁵, and Paul DeVita⁶

Osteochondral Allograft Transplantation of the Knee in Patients with an Elevated Body Mass Index

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2019, Vol. 10(2) 214–221
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DOI: 10.1177/1947603518754630
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Dean Wang¹ , Brian J. Rebolledo², David M. Dare¹, Mollyann D. Pais¹, Matthew R. Cohn¹, Kristofer J. Jones³, and Riley J. Williams III¹

Knee joint forces: prediction, measurement, and significance

Darryl D. D’Lima¹, Benjamin J. Fregly², Shantanu Patil¹, Nikolai Steklov¹, and Clifford W. Colwell Jr.¹

¹Scripps Health, Shiley Center for Orthopaedic Research and Education at Scripps Clinic, USA

²University of Florida, Dept of Mechanical & Aerospace Engineering, USA

Clinical Outcomes After Microfracture of the Knee

Midterm Follow-up

Alexander E. Weber,^{*,†} MD, Philip H. Locker,[‡] MD, Erik N. Mayer,[†] BS, Gregory L. Cvetanovich,[‡] MD, Annemarie K. Tilton,[‡] MD, Brandon J. Erickson,[‡] MD, Adam B. Yanke,[‡] MD, and Brian J. Cole,[‡] MD, MBA

Investigation performed at the Department of Orthopedic Surgery, Rush University Medical Center, Chicago, Illinois, USA

Do Outcomes of Osteochondral Allograft Transplantation Differ Based on Age and Sex?

A Comparative Matched Group Analysis

Rachel M. Frank,^{*,†} MD, Eric J. Cotter,[‡] BS, Simon Lee,[‡] MD, MPH, Sarah Poland,[‡] BS, and Brian J. Cole,[‡] MD, MBA

Investigation performed at Rush University Medical Center, Chicago, Illinois, USA

Patient BMI

- Recommendation: weight loss until BMI <30 kg/m²

Smoking Status

Effects of Autogenous Bone Marrow Aspirate Concentrate on Radiographic Integration of Femoral Condylar Osteochondral Allografts

Lasun O. Oladeji,* MD, MS, James P. Stannard,** MD, Cristi R. Cook,** DVM, MS, Mauricio Kfuri,* MD, PhD, Brett D. Crist,* MD, Matthew J. Smith,* MD, and James L. Cook,** DVM, PhD

Investigation performed at the Department of Orthopaedic Surgery, University of Missouri School of Medicine, Columbia, Missouri, USA; and the Thompson Laboratory for Regenerative Orthopaedics, Missouri Orthopaedic Institute, University of Missouri, Columbia, Missouri, USA

The Effect of Smoking on Ligament and Cartilage Surgery in the Knee



A Systematic Review

Praveen Kanneganti,* MD, Joshua D. Harris,* MD, Robert H. Brophy,[†] MD, James L. Carey,[†] MD, MPH, Christian Lattermann,[‡] MD, and David C. Flanigan,[¶] MD
Investigation performed at The Ohio State University Sports Medicine Center, Columbus, Ohio

- Recommendation: nicotine usage is a contraindication for cartilage restoration

The Effect of Smoking on the Outcome of Matrix-Based Autologous Chondrocyte Implantation: Data from the German Cartilage Registry

Volker M. Betz, MD¹ Martin Holzgruber, MD¹ Johanna Simon, MD¹ Felix Uhlemann, MD¹ Philipp Niemeyer, MD^{2,3} Peter E. Müller, MD¹ Thomas R. Niethammer, MD¹

THE JOURNAL OF BONE AND JOINT SURGERY, BRITISH VOLUME
Volume 91-B, Issue 12, December 1, 2009, Pages 1575-1578
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<https://doi.org/10.1302/0301-620X.91B12.22878>



■ KNEE

Does smoking influence outcome after autologous chondrocyte implantation? A CASE-CONTROLLED STUDY

- P. K. Jaiswal, MRCS¹, Academic Clinical Fellow
- S. Macmill, MRCS¹, Clinical Research Fellow
- G. Bentley, ChM, FRCS¹, Professor of Orthopaedics
- R. W. J. Carrington, FRCS(Orth)¹, Consultant Orthopaedic Surgeon
- J. A. Skinner, FRCS(Orth)¹, Consultant Orthopaedic Surgeon
- T. W. R. Briggs, FRCS¹, Consultant Orthopaedic Surgeon

Meniscal Allograft Transplantation in the Sheep Knee

Evaluation of Chondroprotective Effects

Bryan T. Kelly,^{*†} MD, Hollis G. Potter,[†] MD, Xiang-Hua Deng,[†] MD, Andrew D. Pearle,[†] MD, A. Simon Turner,[‡] BVSc, MS, Russell F. Warren,[†] MD, and Scott A. Rodeo,[†] MD
From the [†]Hospital for Special Surgery, New York, New York, and [‡]Colorado State University, Fort Collins, Colorado

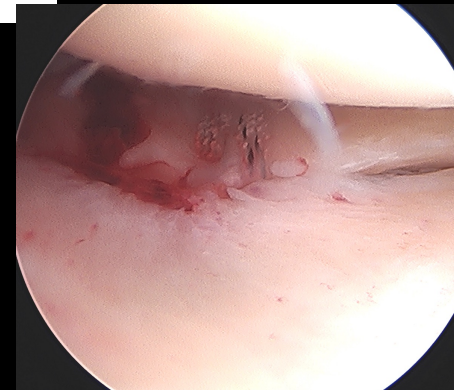
Rate of Knee Cartilage Loss After Partial Meniscectomy

FLAVIA M. CICUTTINI, ANDREW FORBES, WANG YUANYUAN, GLEN RUSH, and STEPHEN L. STUCKEY

Save the meniscus – Clinical outcomes of meniscectomy versus meniscal repair

Wen Qiang Lee[Ⓞ], Jonathan Zhi-Wei Gan
and Denny Tjiauw Tjoen Lie

Journal of Orthopaedic Surgery
27(2) 1–6
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Meniscal Deficiency

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<https://doi.org/10.1302/0301-620X.88B12.18140>



REVIEW ARTICLE

The consequences of meniscectomy

- I. D. McDermott, MB BS, MS, FRCS(Tr & Orth)¹, Consultant Orthopaedic Surgeon, Honorary Associate Professor
- A. A. Amis, DSc(Eng), FIMechE², Professor of Orthopaedic Biomechanics Mechanical Engineering

Partial meniscectomy is associated with increased risk of incident radiographic osteoarthritis and worsening cartilage damage in the following year

Frank W. Roemer^{1,2}, C. Kent Kwok³, Michael J. Hannon⁴, David J. Hunter⁵, Felix Eckstein⁶, Jason Grago⁴, Robert M. Boudreau⁷, Martin Englund⁸, and Ali Guermazi¹

Limb Malalignment

Comparison of Autologous Chondrocyte Implantation and Osteochondral Allograft Transplantation of the Knee in a Large Insurance Database: Reoperation Rate, Complications, and Cost Analysis

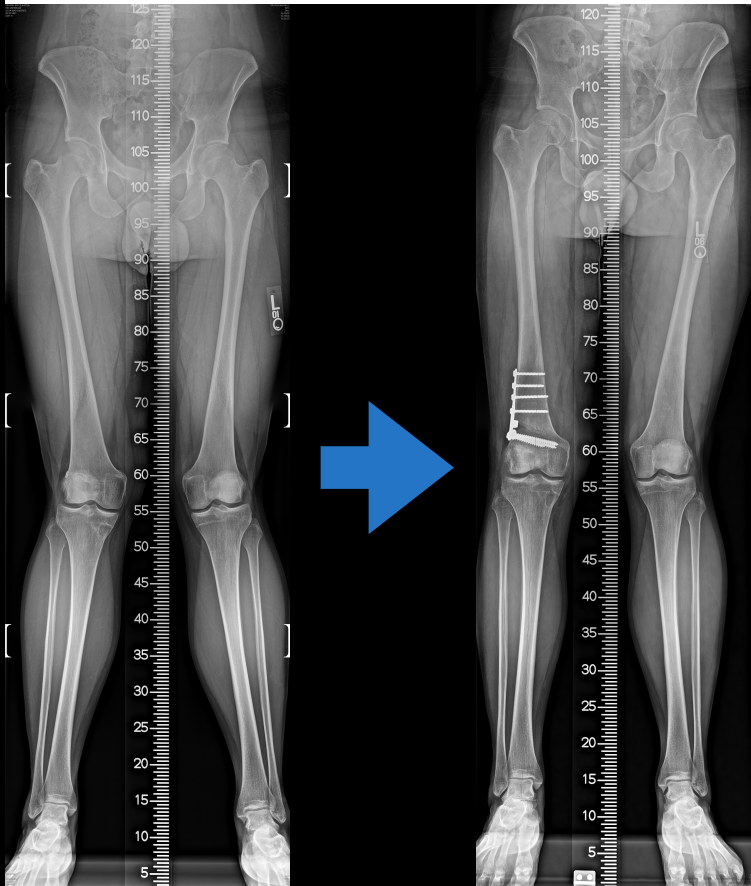
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DOI: 10.1177/1947603520967065
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Kyle R. Sochacki¹, Kunal Varshneya¹, Jacob G. Calcei¹,
Marc R. Safran¹, Geoffrey D. Abrams¹, Joseph Donahue¹,
Constance Chu¹, and Seth L. Sherman¹

Cartilage repair procedures associated with high tibial osteotomy in varus knees: Clinical results at 11 years' follow-up

A. Ferruzzi, R. Buda, M. Cavallo*, A. Timoncini, S. Natali, S. Giannini

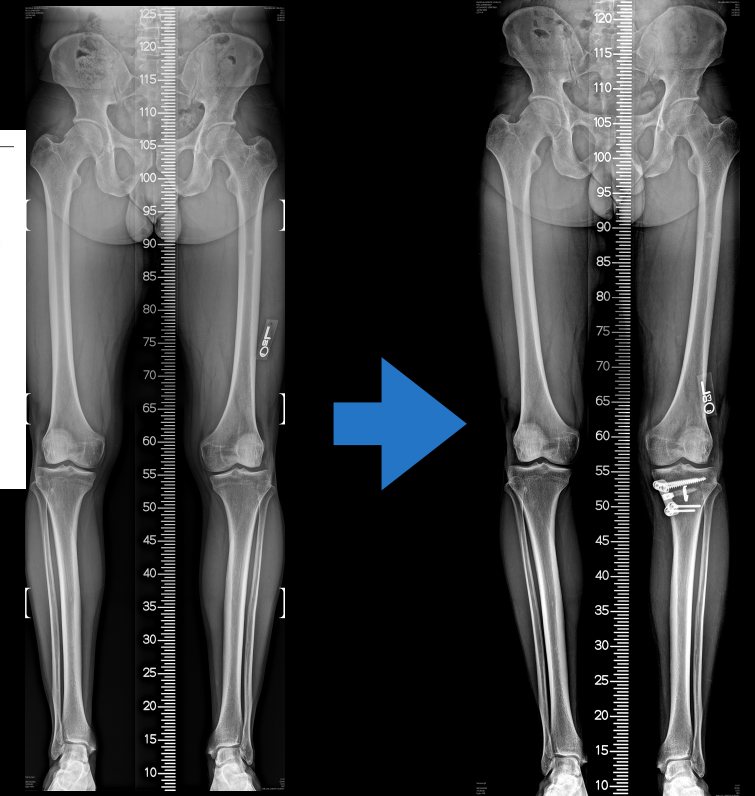
1st Clinic of Orthopaedics and Traumatology, Istituto Ortopedico Rizzoli, via G.C. Pupilli 1, 40136 Bologna, Italy



Concomitant Osteotomy Reduces Risk of Reoperation Following Cartilage Restoration Procedures of the Knee: A Matched Cohort Analysis

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Jacob G. Calcei¹, Kunal Varshneya², Kyle R. Sochacki³, Marc R. Safran²,
Geoffrey D. Abrams², and Seth L. Sherman²



Ligamentous instability

Intermediate- to Long-Term Results of Combined Anterior Cruciate Ligament Reconstruction and Autologous Chondrocyte Implantation

Lt Col Andrew N. Pike,*† MD, Tim Bryant,‡ RN, Takahiro Ogura,‡ MD, and Tom Minas,‡ MD
Investigation performed at Department of Orthopaedic Surgery, Cartilage Repair Center, Brigham and Women's Hospital, Chestnut Hill, Massachusetts, USA

KNEE

Meniscal and articular cartilage lesions in the anterior cruciate ligament-deficient knee: correlation between time from injury and knee scores

Sotirios Michalitsis · Mariana Vlychou ·
Konstantinos N. Malizos · Paschal Thriskos ·
Michael E. Hantes

Systematic Review With Video Illustration

Anterior Cruciate Ligament Reconstruction and Concomitant Articular Cartilage Injury: Incidence and Treatment

Robert H. Brophy, M.D., David Zeltser, M.D., Rick W. Wright, M.D., and David Flanigan, M.D.

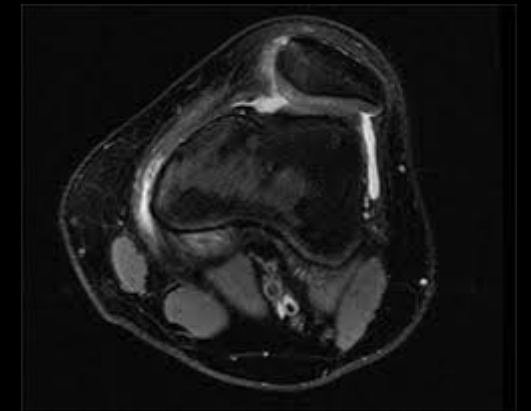
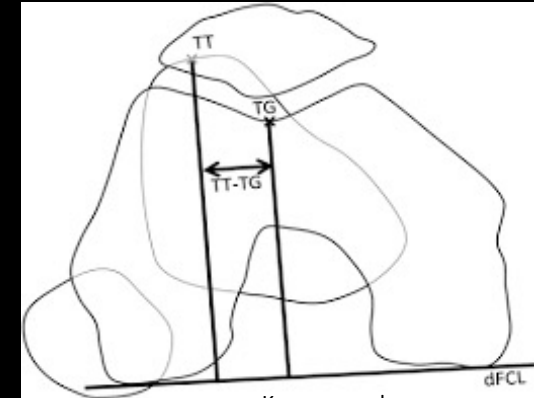
Similar Outcomes After Osteochondral Allograft Transplantation in Anterior Cruciate Ligament-Intact and -Reconstructed Knees: A Comparative Matched-Group Analysis With Minimum 2-Year Follow-Up

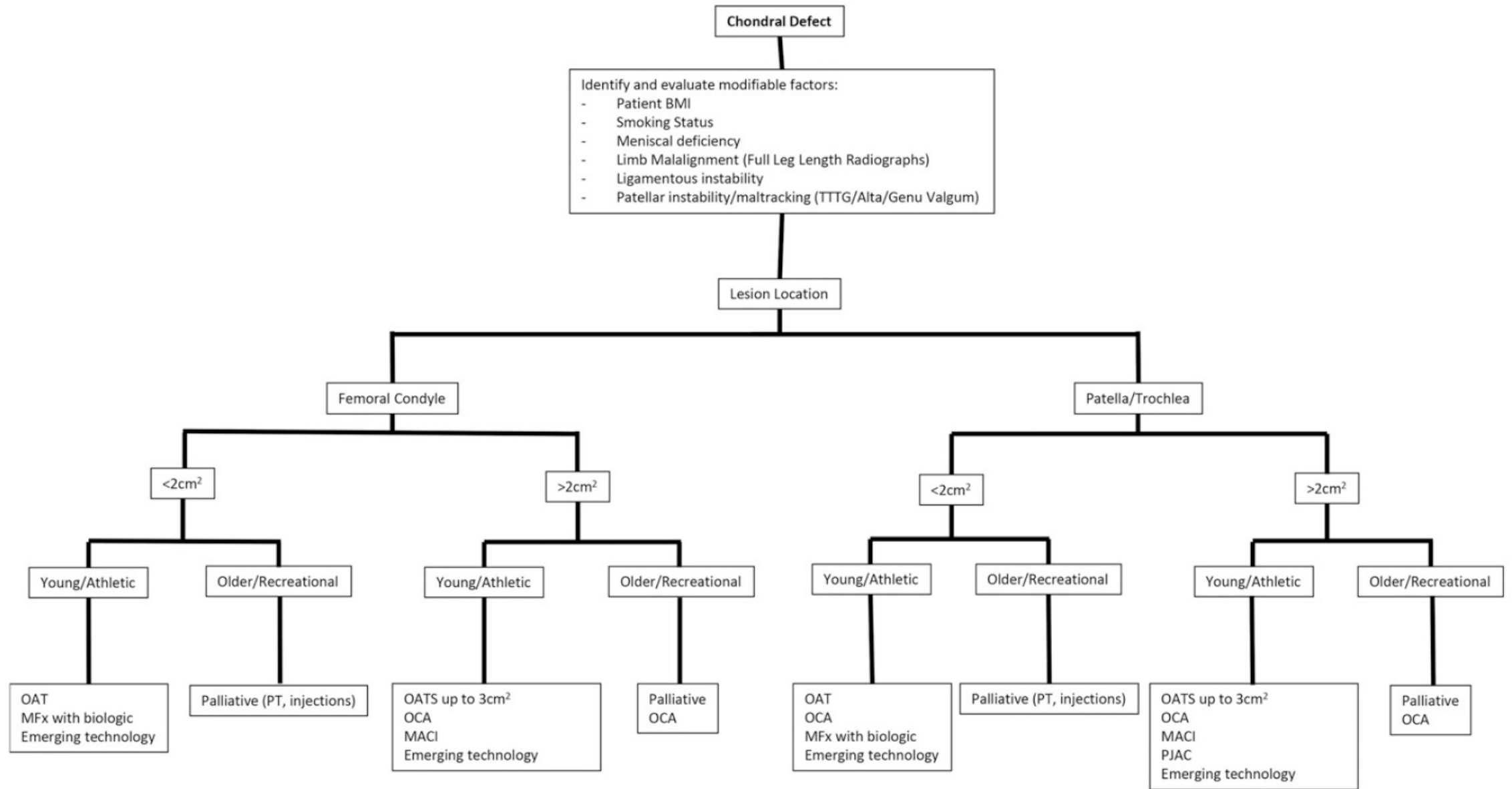
Dean Wang, M.D., Claire D. Eliasberg, M.D., Tim Wang, M.D., Ryan R. Fader, M.D.,
Francesca R. Coxe, B.S., Mollyann D. Pais, B.S., and Riley J. Williams III, M.D.



Recommendation: address all pathology and stabilize the knee to prevent further degeneration

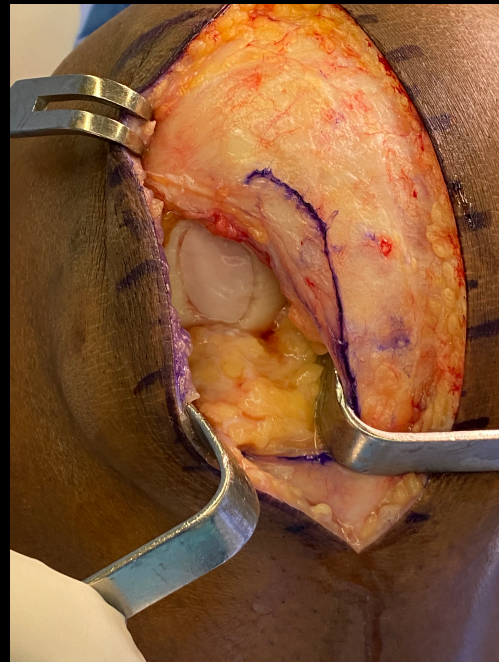
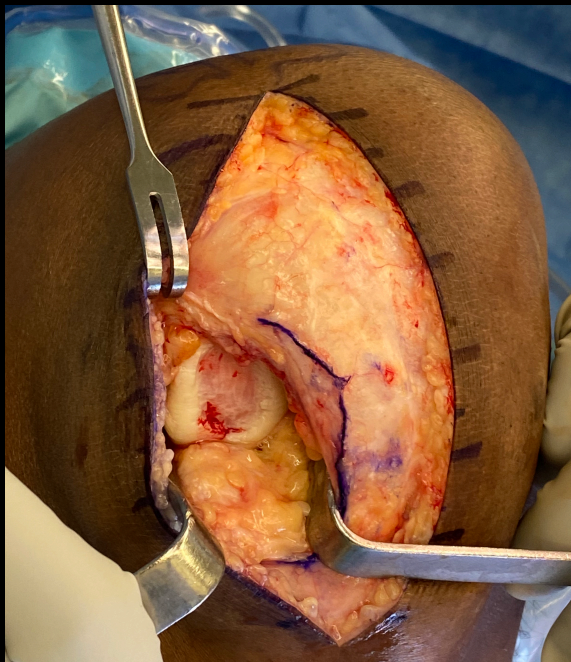
Patellar instability/maltracking



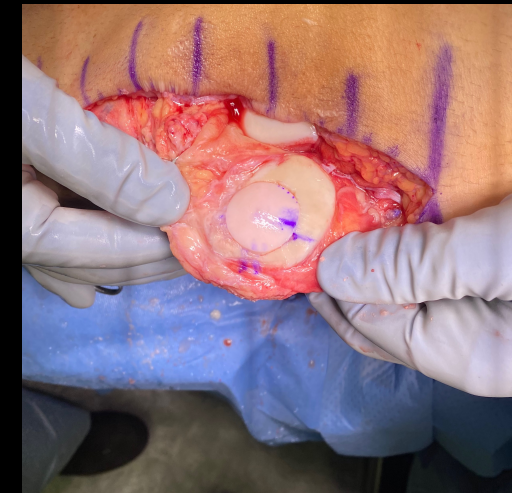
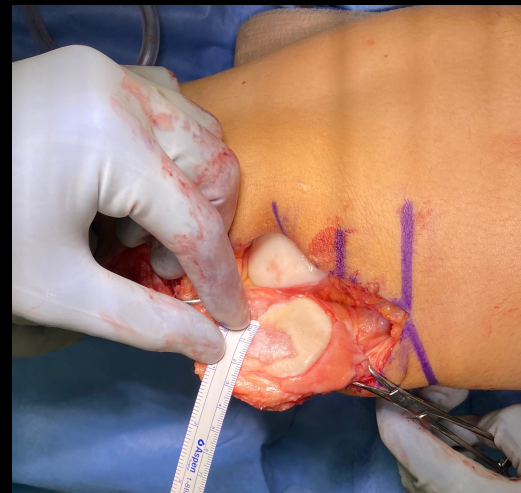


Lesion Location

Femoral Condyle




Patellofemoral Joint



**Preoperative Measurement of
Cartilage Defects by MRI
Underestimates Lesion Size**

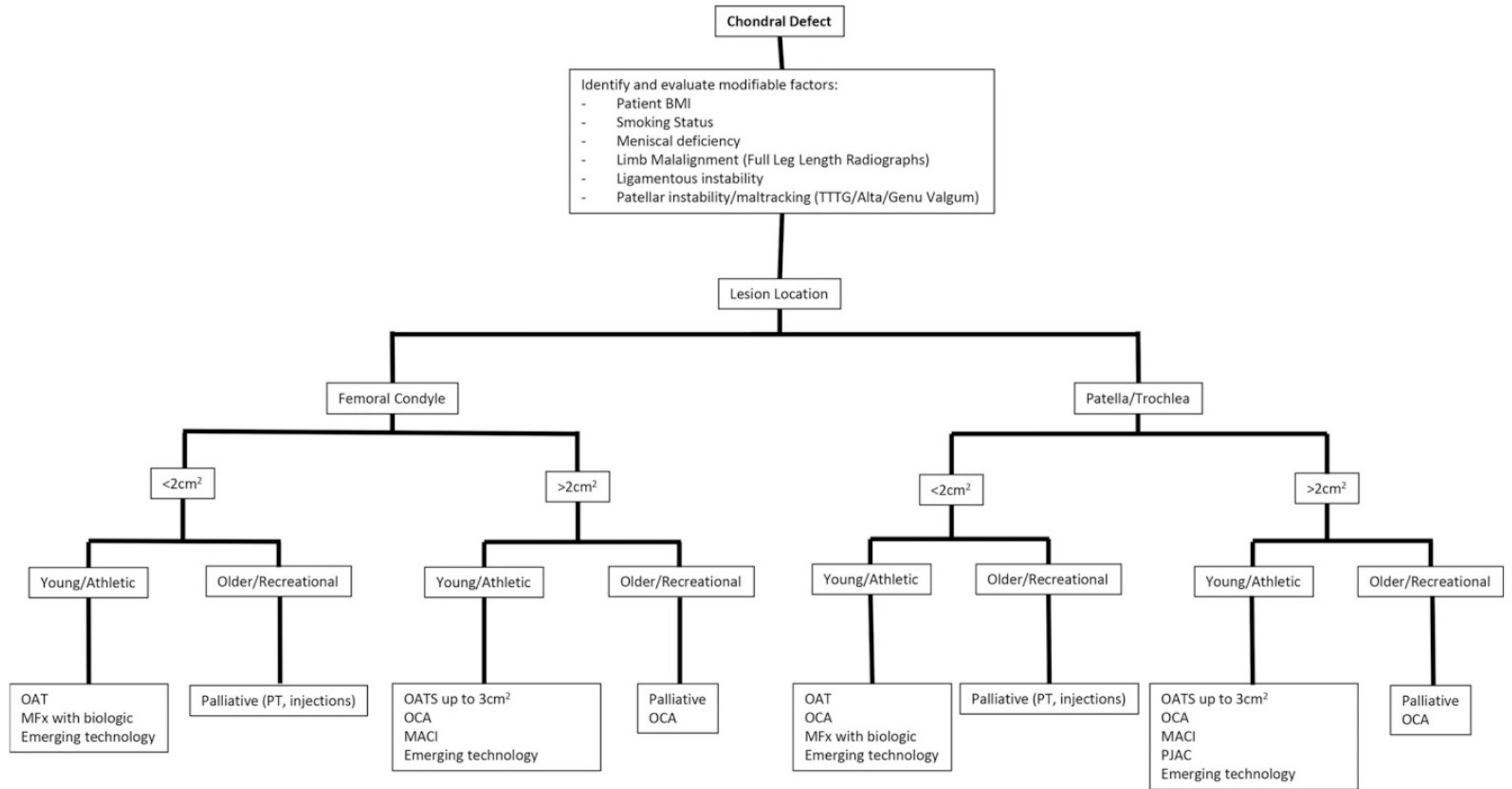
**Andreas H. Gomoll¹, Hiroshi Yoshioka², Atsuya Watanabe³,
John C. Dunn¹, and Tom Minas¹**

Cartilage
2(4) 389-393
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DOI: 10.1177/1947603510397534
http://cart.sagepub.com


**The Importance of Staging Arthroscopy for
Chondral Defects of the Knee**

Hytham S. Salem, MD¹ Zaira S. Chaudhry, MPH¹ Ludovico Lucenti, MD² Bradford S. Tucker, MD¹
Kevin B. Freedman, MD¹

Recommendation: size matters so get it right.
Cartilage as a primary procedure = staged arthroscopy



Step 4

Patient specific treatment

Young/Active

Old/Sedentary



Treatment Options

Non Op Tx

Chondroplasty

Microfracture

Chondrocyte Implantation

Osteochondral Graft

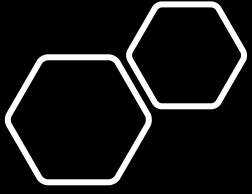
HTO

Partial Replacement

Total Knee

A





Microfracture

- Recommendation: lesions less than 1cm². Drill >6mm depth.

Knee Surgery, Sports Traumatology, Arthroscopy (2020) 28:670–706
<https://doi.org/10.1007/s00167-019-05359-9>

KNEE



Microfracture for cartilage repair in the knee: a systematic review of the contemporary literature

Patrick Orth^{1,2} · Liang Gao¹ · Henning Madry^{1,2}

Received: 5 December 2018 / Accepted: 11 January 2019 / Published online: 18 January 2019
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Review

Microfracture Versus Drilling of Articular Cartilage Defects

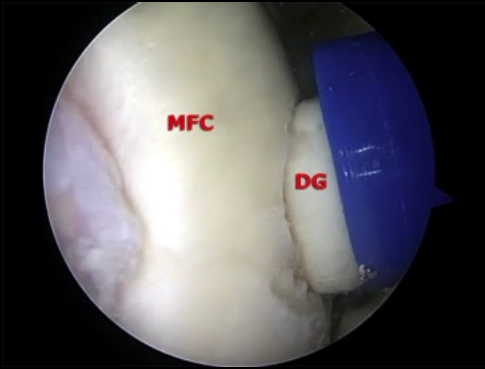
A Systematic Review of the Basic Science Evidence

Matthew J. Kraeutler,^{*†} MD, Gianna M. Aliberti,[‡] BA, Anthony J. Scillia,^{†§} MD, Eric C. McCarty,^{||} MD, and Mary K. Mulcahey,[‡] MD

Investigation performed at St. Joseph's University Medical Center, Department of Orthopaedic Surgery, Paterson, New Jersey, USA



Osteochondral Autograft Transfer



REVIEW ARTICLE

Osteochondral Autograft Transplantation: A Review of the Surgical Technique and Outcomes

Dustin L. Richter, MD, John A. Tanksley, MD, and Mark D. Miller, MD

Accelerated Return to Play Following Osteochondral Autograft Plug Transfer (OATS)

C. Jan Gilmore, MD, Christopher T. Cosgrove, MS, Brian Werner, MD, Matthew Lawrence Lyons, MD, Eric W. Carson, MD, Mark D. Miller, MD, Stephen F. Brockmeier, MD, David R. Diduch, MD
University of Virginia, Charlottesville, VA, USA

Systematic Review

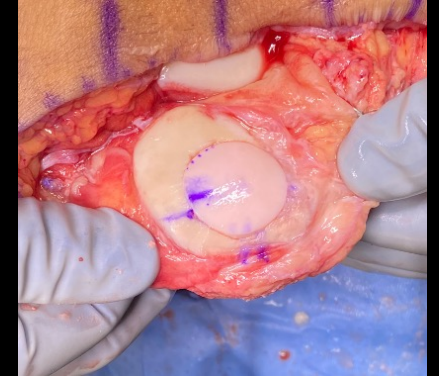
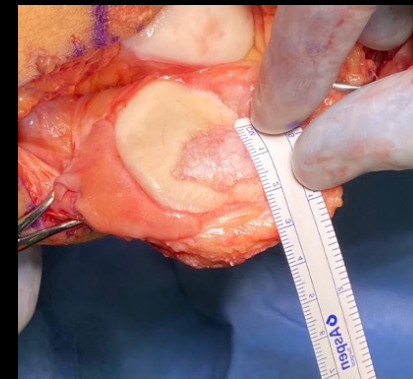
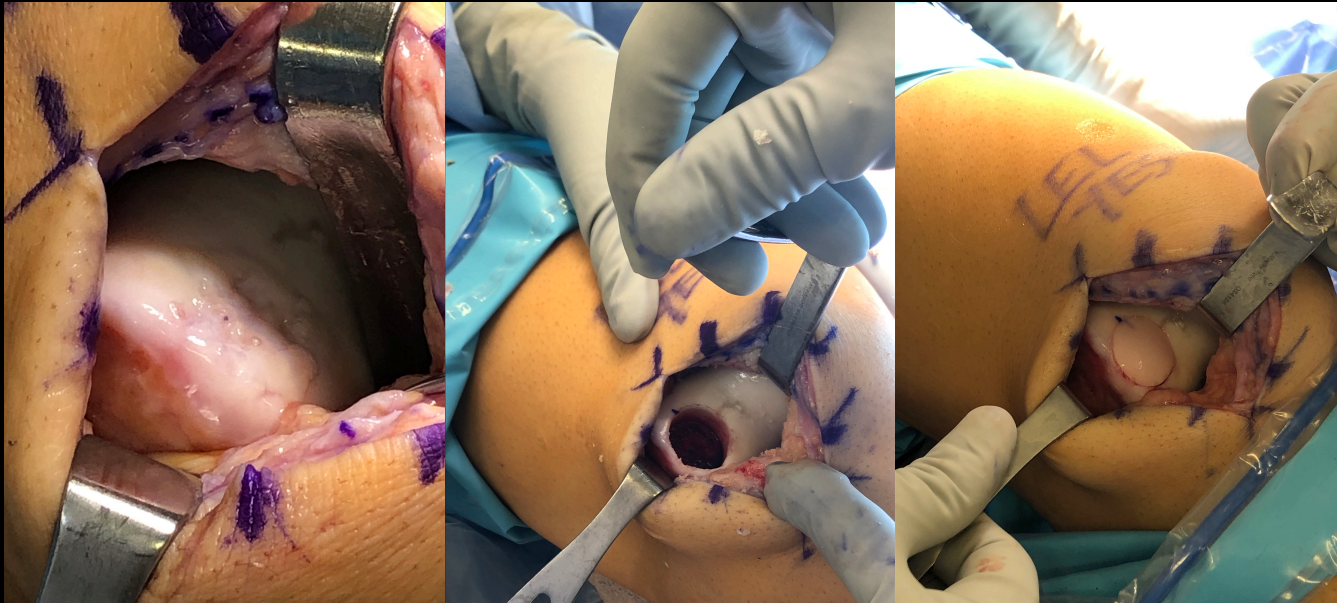
Systematic Review of Autogenous Osteochondral Transplant Outcomes



T. Sean Lynch, M.D., Ronak M. Patel, M.D., Alex Benedick, B.S., Nirav H. Amin, M.D., Morgan H. Jones, M.D., and Anthony Miniaci, M.D.

Recommendation: active and high demand patients with time constraint to get back to duty.

Osteochondral Allograft



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

CME

A Systematic Review

Osteochondral Allograft Transplantation CME in the Patellofemoral Joint

A Systematic Review

Jorge Chahla,^{*†} MD, PhD, Matthew C. Sweet,[‡] MD, Kelechi R. Okoroha,[†] MD,
Benedict U. Nwachukwu,[†] MD, MBA, Betina Hinckel,[§] MD, Jack Farr,^{||} MD,
Adam B. Yanke,[†] MD, PhD, William D. Bugbee,[¶] MD, and Brian J. Cole,[†] MD, MBA
Investigation performed at Rush University Hospital, Chicago, Illinois, USA

Return to an Athletic Lifestyle After Osteochondral Allograft Transplantation of the Knee

James S. Shaha,^{*†} MD, Jay B. Cook,[†] MD, Douglas J. Rowles,[†] MD, Craig R. Bottoni,[†] MD, Steven H. Shaha,[‡] PhD, DBA, and John M. Tokish,[†] MD
Investigation performed at the Tripler Army Medical Center, Honolulu, Hawaii

The American Journal of Sports Medicine, Vol. 41, No. 9

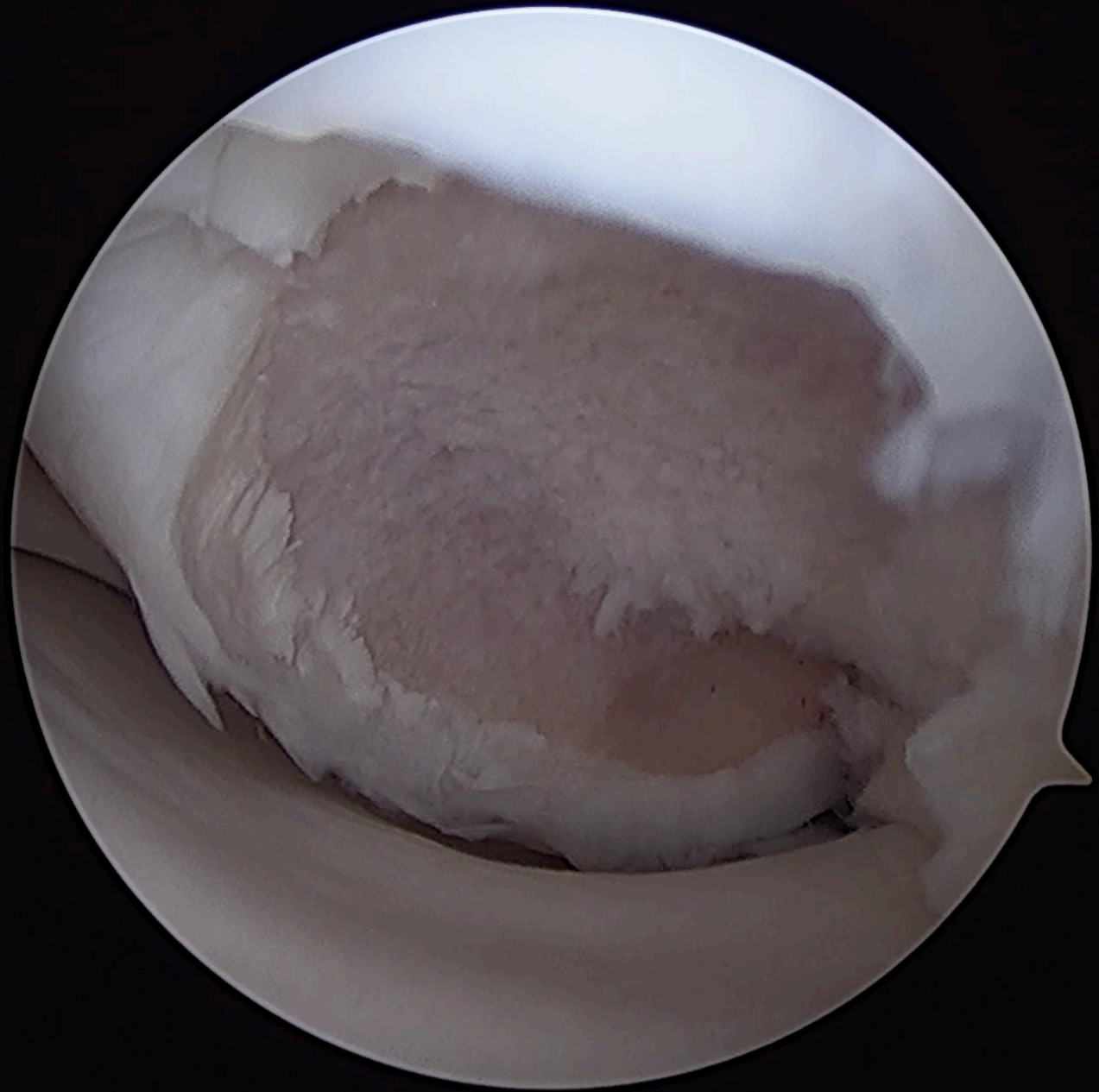
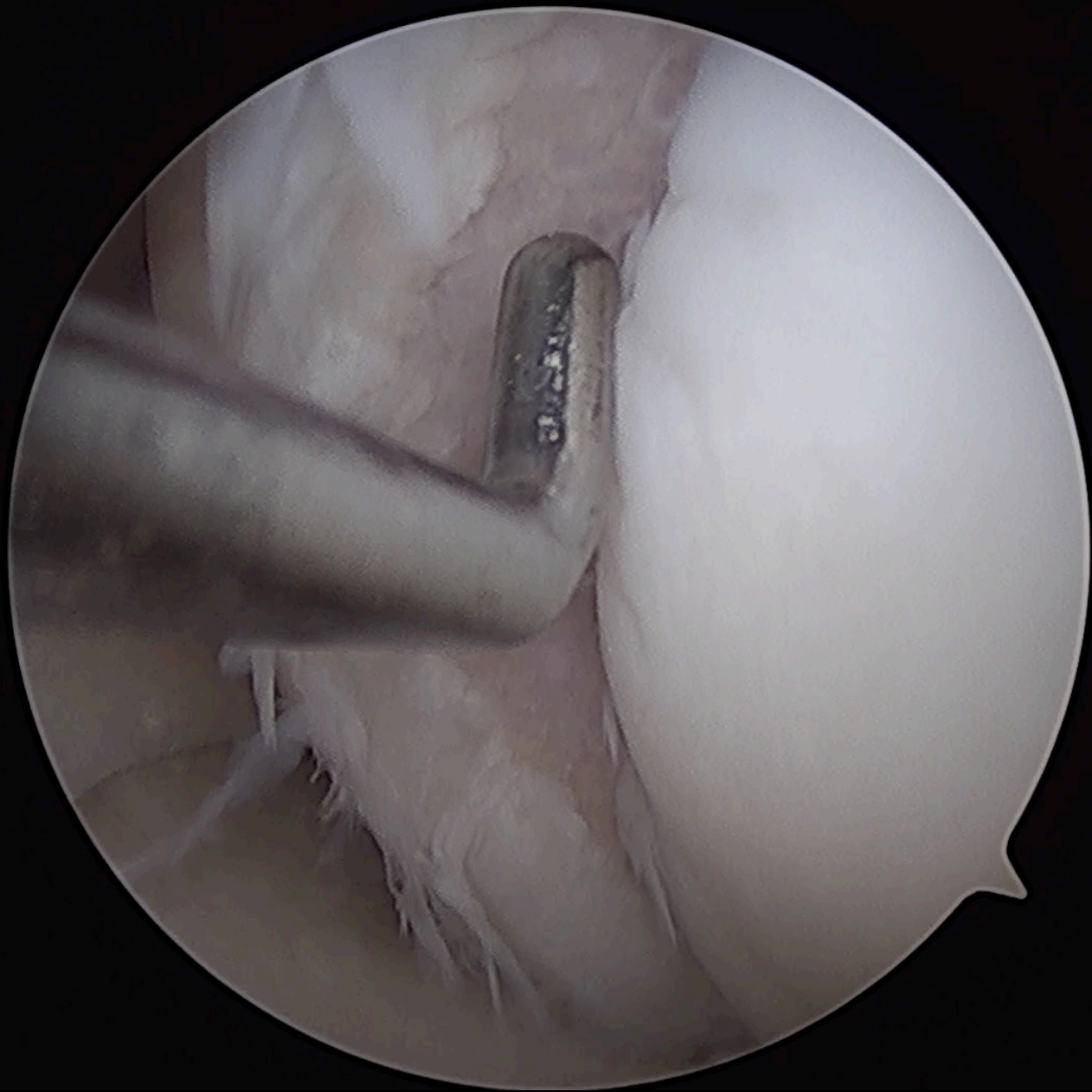
Outcomes in Isolated OATS Procedures ^a						
	All Isolated OATS Procedures (n = 27)	Full Duty (n = 9)	Limited Duty (n = 6)	No Return (n = 12)	Statistical Significance	P Value
Time to follow-up, y	3.48 ± 1.86	3.99 ± 3.06	4.60 ± 2.84	2.55 ± 2.32		
SANE	59.87 ± 10.08	78.57 ± 11.07	63.00 ± 13.51	44.29 ± 19.88	F, L > N	.002
KOOS total	252.40 ± 43.09	346.71 ± 66.81	222.60 ± 71.18	196.57 ± 52.09	F > L, N	.010
KOOS subscales						
Symptoms	47.47 ± 9.18	56.14 ± 16.89	39.40 ± 13.69	45.00 ± 9.93		
Pain	61.67 ± 9.92	80.43 ± 12.69	60.60 ± 18.35	48.14 ± 12.71	F > N	.002
Activities of daily living	71.45 ± 9.97	91.43 ± 8.26	65.80 ± 16.24	59.29 ± 19.48	F > L, N	.029
Sports and recreation	37.08 ± 13.53	64.29 ± 22.07	29.00 ± 15.57	20.71 ± 22.07	F > L, N	.026
Quality of life	34.73 ± 11.23	54.43 ± 24.70	27.80 ± 11.34	23.43 ± 13.48	F > L, N	.015

Biologics

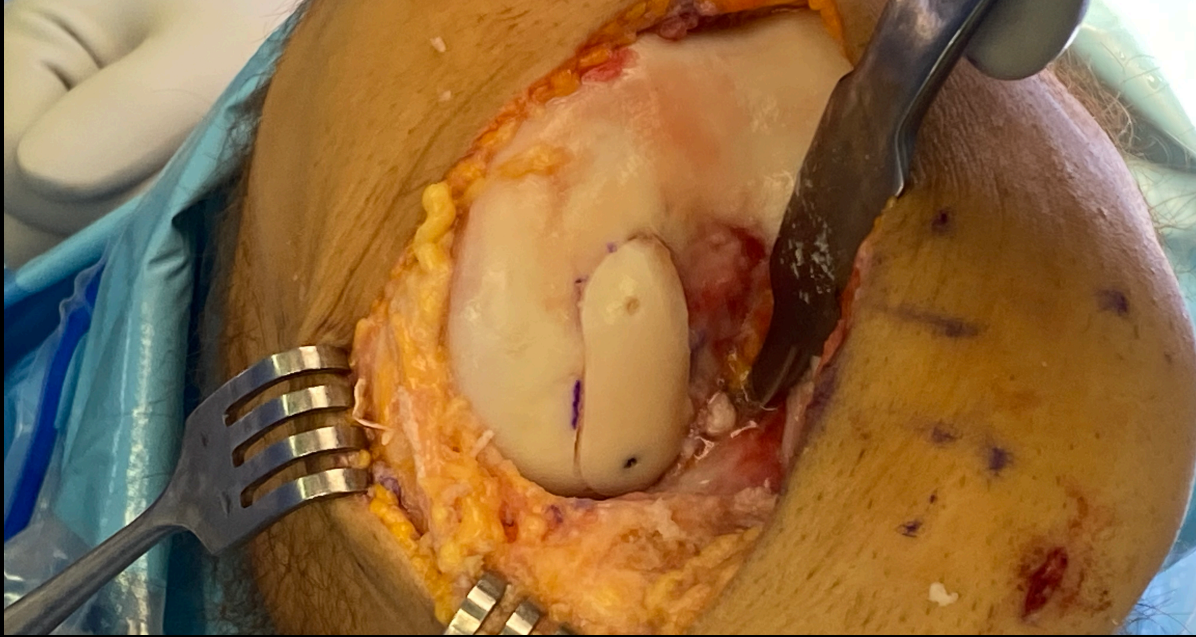


Fig. 1

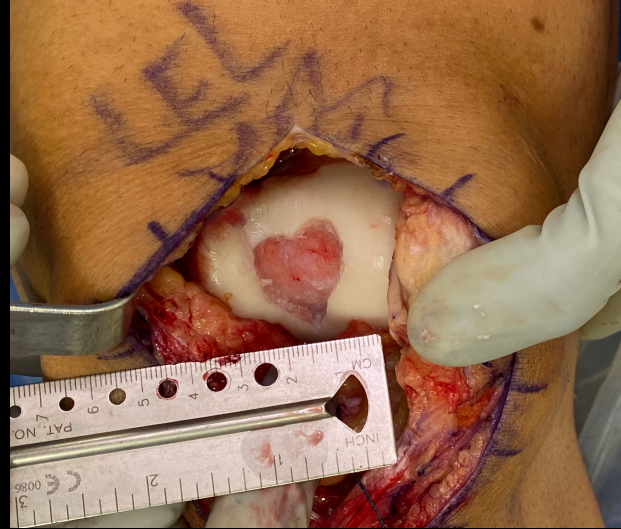
With the patient in a lateral decubitus position, bone marrow aspirate for concentration is harvested from the posterior superior iliac spine in between the inner and outer tables of the iliac crest. The BMC can be later used to augment chondral procedures.







Autologous Chondrocyte Implantation



Autologous Chondrocyte Implantation and Osteochondral Allograft Transplantation Render Comparable Outcomes in the Setting of Failed Marrow Stimulation

Andrew J. Riff,^{*} MD, Hailey P. Huddleston,[†] BS, Brian J. Cole,[†] MD, MBA, and Adam B. Yanke,^{††} MD, PhD
Investigation performed at Rush University Medical Center, Chicago, Illinois, USA

Autologous Chondrocyte Implantation and Anteromedialization for Isolated Patellar Articular Cartilage Lesions

5- to 11-Year Follow-up

Scott D. Gillogly,^{*†} MD, and Ryan M. Arnold,[‡] MD
Investigation performed at the Atlanta Sports Medicine and Orthopaedic Center, Atlanta, Georgia, USA

Autologous Chondrocyte Implantation for Bipolar Chondral Lesions in the Patellofemoral Compartment

Clinical Outcomes at a Mean 9 Years' Follow-up

Takahiro Ogura,^{*†} MD, Tim Bryant,^{**‡} BSN, RN, Gergo Merkely,^{*§} MD, and Tom Minas,^{**||} MD, MS
Investigation performed at the Cartilage Repair Center, Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, USA

Recommendation: with comparable results to OCA, do what you're best at. In the setting of subchondral bone pathology= OCA.

Activity-Related Outcomes of Articular Cartilage Surgery: A Systematic Review

Cartilage
4(3) 193–203

**Peter N. Chalmers, MD¹, Hari Vigneswaran, BS¹,
Joshua D. Harris, MD¹, and Brian J. Cole, MD, MBA¹**

- Activity scores better for ACI and OATS
- Faster Return to Sports with Microfracture
- Highest reoperation rate with ACI

Conclusions?

- Nothing is perfect
- Most are pretty good
- Microfracture is easiest, with quickest recovery
- Most are moving away from microfracture
- Structural/biologic solution as a salvage