6th Advanced Course on Knee Surgery

January 31st – February 5th, 2016 Val d'Isère - France

Partial Osteochondral Fractures of the Condyles

(Osteochondral Defects)

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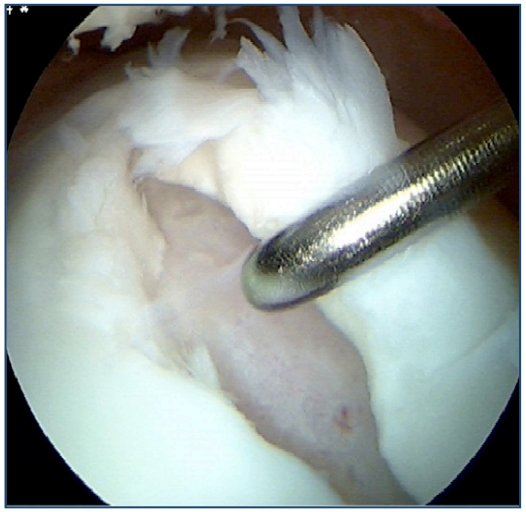
ASPETAR سبيتار

3 February 2016

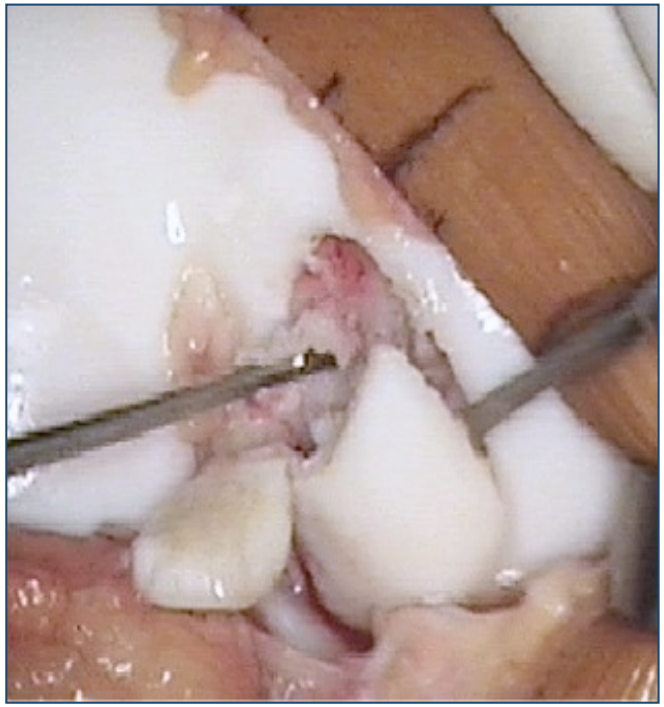
Val d'Isère, France

Treatment Options for Osteochondral Fractures

Decision Making ?



- Primary Repair (ORIF vs AARIF)
- Fixation Options: screws, pins, sutures
- Augmentation: BMP, Stem Cells, PRP, Fibrin Glue
- Cartilage Repair: Marrow Stimulation 1st or 2nd generation
- Cartilage Regeneration: Scaffolds, Matrix, Cells (autologous vs. allogenic)
- Bone Replacements: autograft, allograft, synthetic
- Bone and Cartilage: Scaffolds, OATS (auto, allograft)



Treatment of Knee Osteochondral Fractures

Treatment of osteochondral fractures of the knee: a meta-analysis of available scientific evidence. Kuhle J; Angele P; Balcarek P; Eichinger M; Feucht M; Haasper C; Alexander G; Jung T; Lill H; Marquass B; Osti M; Rosenberger R; Salzmann G; Steinwachs M; Voigt C; Vogt S; Zeichen J; Niemeyer P:. Int Orthop (Germany), Dec 2013, 37(12) p2385-94.

- Although traumatic osteochondral fractures of the knee represent a common pathology of the knee joint, there is no general agreement concerning specific treatment
- Of possible 1,226 articles, only 19 studies met criterion and had clinical follow-up of 638 patients.
- All articles (n = 19) identified represent case series (evidence-based medicine level IV)
- Studies had average 33 pts, 46 month follow up and used 6 different scoring systems, success rate 83%.
- Significant lack of scientific evidence, No valid conclusions for any specific treatment algorithm

Demographics of OCD

The demographics and epidemiology of osteochondritis dissecans of the knee in children and adolescents. Kessler JI; Nikizad H; Shea KG; Jacobs JC; Bebchuk JD; Weiss JM: Am J Sports Med, Feb 2014, 42(2) p320-6

- A retrospective chart review of over 1 million patient records ages 2-19 yrs
- 192 patients with 206 OCD lesions of the knee identified.

- MFC- 63.6%
- LFC- 32.5%
- Patella 1.5%, Trochlea 2%
- 50.0% Right; 42.7% Left
- 7.3% Bilateral

- 11.2 per 100,000 Ages 12-19
- 6.8 per 100,000 Ages 6-11
- None 5 yrs or less
- Incidence:15.4 Males vs 3.3 Females per 100,000 patients

- Male patients had 3.8 times a greater risk of OCD of the knee than female patients ($P < .001$; 95% CI, 2.71-5.41).
- Blacks highest odds ratio of OCD of the knee compared with all other ethnic groups.

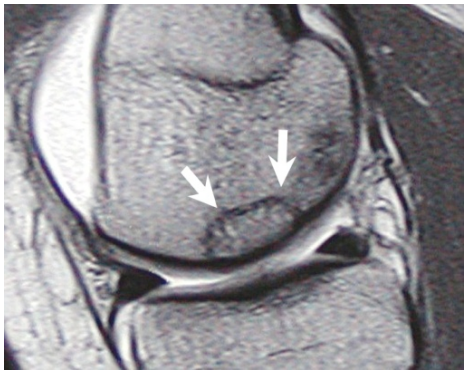
Osteochondral Fractures

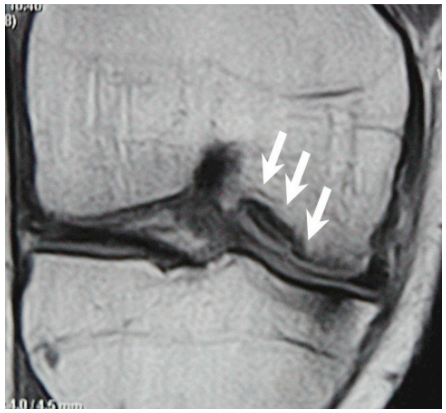
Fundamental Issues

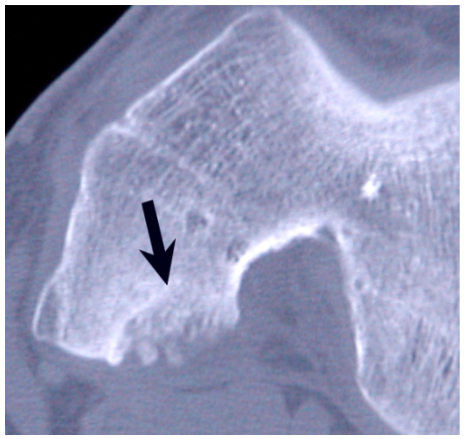
1. Bone lesion,
   Cartilage intact

2. Bone lesion,
   Cartilage
   Disrupted, may or
   may not be
   reparable

3. Bone deficit,
   Cartilage <u>not</u>
   reparable

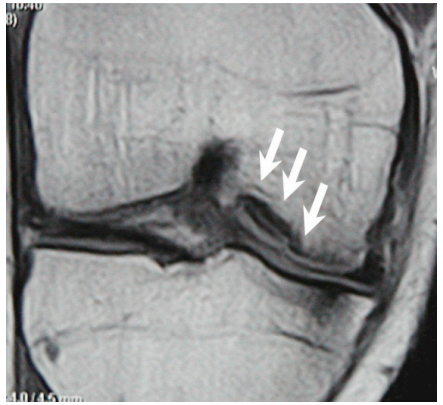




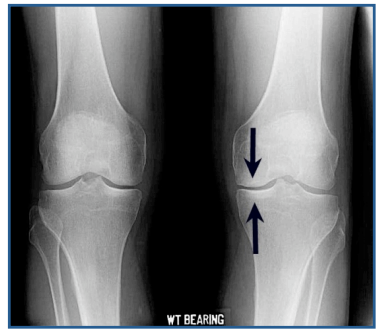


Osteochondral Fracture Treatment

Is there Salvageable native cartilage on fracture or lesion?



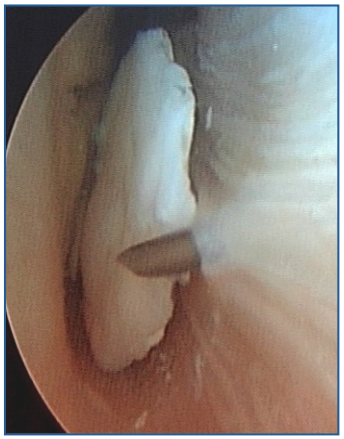
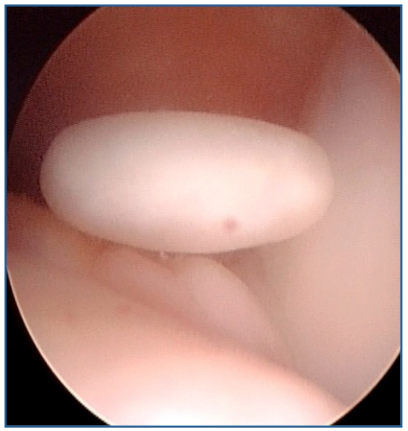
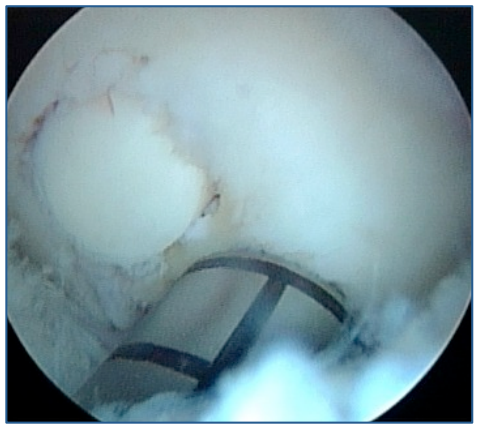
- Does any part or all of the fracture have viable articular cartilage ?
- Assess on MRI, Radiographs, Arthroscopic Evaluation
- Try to *retain native cartilage* by any means necessary
- Repair, Stabilize, Augment to re-establish congruity of articular surface
- Evaluate the need to correct any Malalignment or Maltracking



Osteochondral Fracture Treatment

Arthroscopic Staging/Assessment

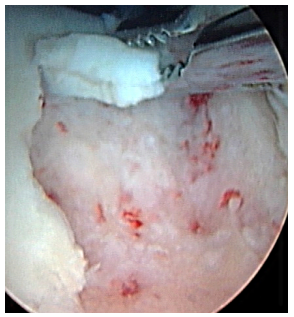
- Assess Fracture, bone bed, articular surfaces
- Is Loose body viable to repair ?
- Can it be repaired? Single stage
- Restore articular surface
- If Yes Proceed with Arthroscopic or Open Reduction and Internal Fixation
- Mini-Open gives better control of articular surface

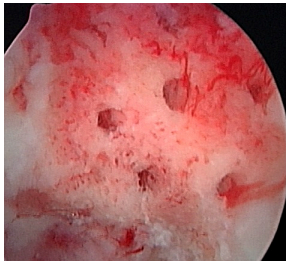




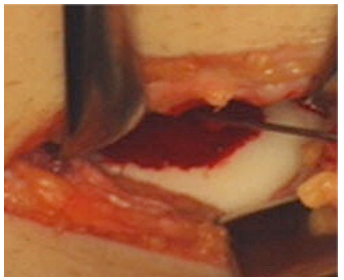

Osteochondral Fracture Treatment

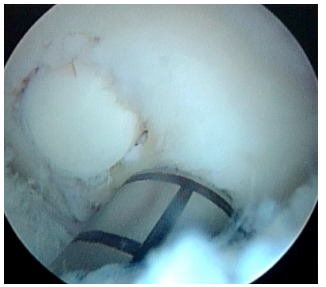
Arthroscopic Treatment

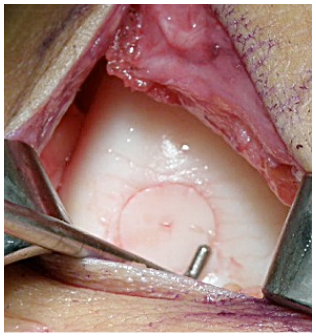
- Marrow stimulation (for small defects < 2.5 cm^2)
  - Augmentation if appropriate
- Edge debridement, Chondroplasty, MSCs
- Arthroscopic Stabilization: Darts, Screws (absorbable vs metal)
- Avoid Prominence of Fixation; Plan for removal and counsel patient
- OATS autograft (usually prefer mini-open for this option)
- If not reparable or immediately treatable, plan for second stage procedure
  - Chondral Biopsy, OATS, Allograft
  - Scaffold, Matrix

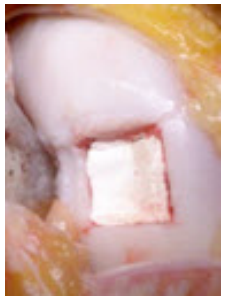












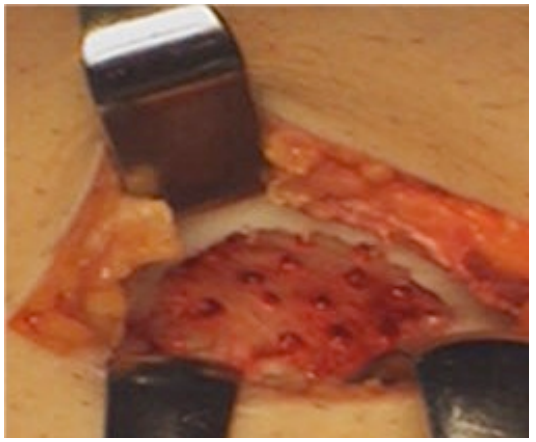
Treatment with Microfracture

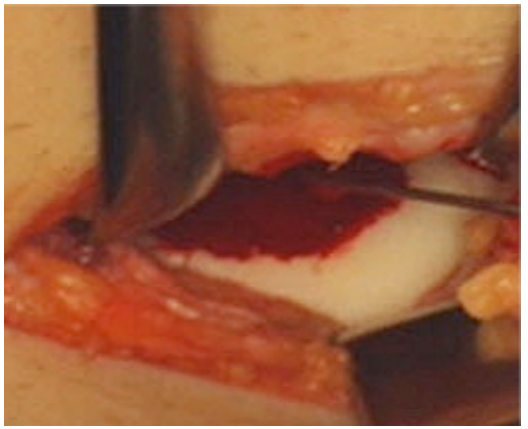
Clinical Efficacy of the Microfracture Technique for Articular Cartilage Repair in the Knee: An Evidence-Based Systematic Analysis. Mithoefer K, McAdams T, Williams R, Kreuz PC, Mandelbaum BR: Am J Sports Med October 2009 37 2053-2063;

- Twenty-eight studies describing 3122 patients were included in the review.
- Factors affecting clinical outcome: Defect fill on MR; Macroscopic repair cartilage quality positively affected long-term failure rate; Histologic repair tissue quality remained inconclusive
- Systematic analysis shows that microfracture provides effective short-term functional improvement of knee function but insufficient data are available on its long-term results.
- Shortcomings of the technique include limited hyaline repair tissue, variable repair cartilage volume, and possible functional deterioration.

Smart Scaffolds for Cell Recruitment
Marrow Stimulation Augmentation

- **BST-Cargel** (Piramal, Canada)
- Chitosan-glycerol phosphate-based scaffold designed to stabilize marrow clot and prevent clot retraction
- Peripheral whole blood is added immediately before implantation resulting in adhesion and polymerization
- **Significant better MRI-appearances with the BST-Cargel vs MFX in a 2 year's follow up.**
- **BST CarGel: EU Class III device, Not in US**



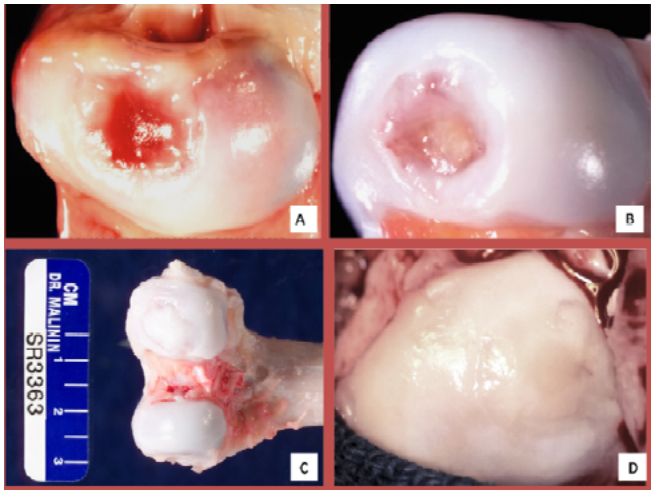


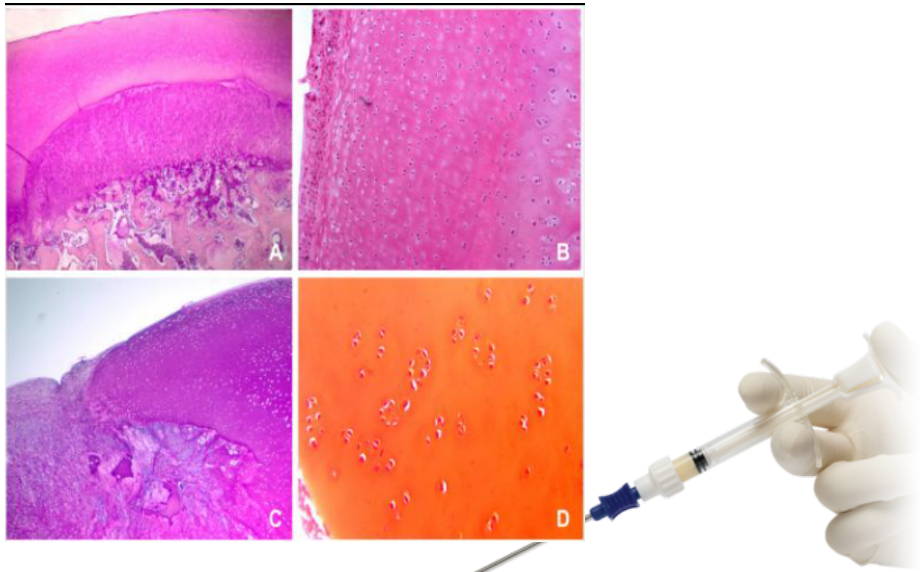
Novel scaffold-based BST-CarGel treatment results in superior cartilage repair compared with microfracture in a randomized controlled trial. Stanish WD, McCormack R, Forriol F, Mohtadi N, Pelet S, Desnoyers J, Restrepo A, Shive MS. J Bone Joint Surg Am. 2013 Sep 18;95(18):1640-50

Smart Scaffolds for Cell Recruitment Marrow Stimulation Augmentation

BioCartilage: (Arthrex) Micronized Cartilage Matrix

- Allograft Cartilage (ECM- Col, GAG, Growth Factors)
- Cartilage is dehydrated than micronized- Freeze dried (Particle size 100-300microns), Fibrin Glue
- It provides a scaffold over the MFX- disappears over time





It is based upon the principle of the chitosan based scaffold (Shrimp Exoskeleton)

Arthroscopic Treatment Unstable OCD/ Osteochondral Fractures

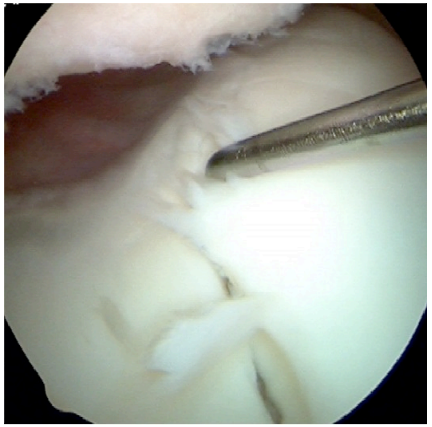
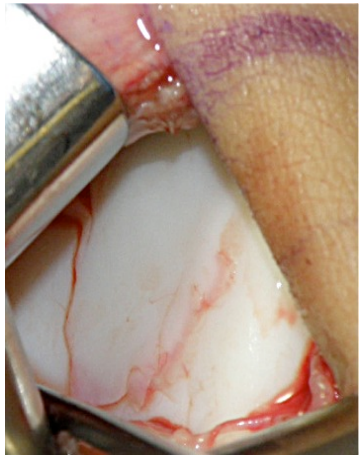
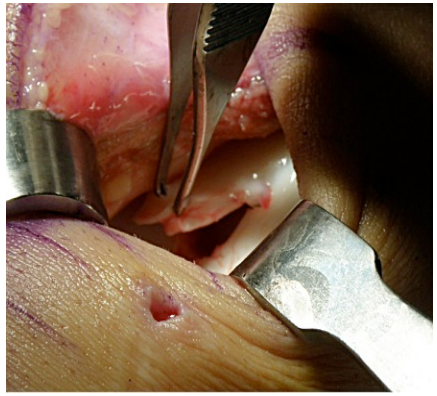
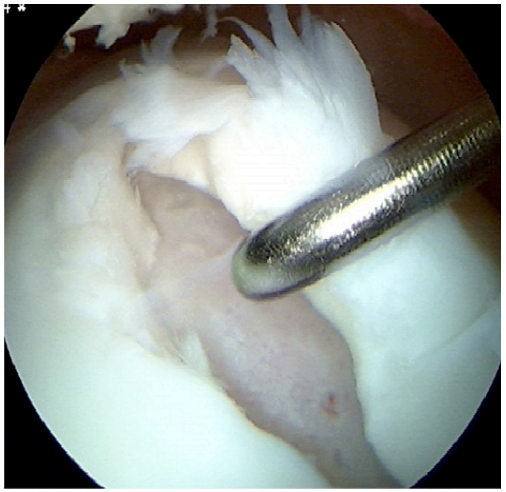
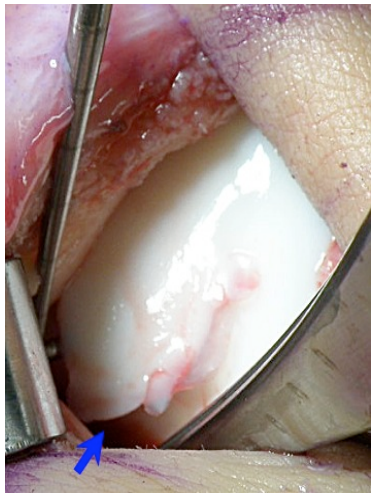
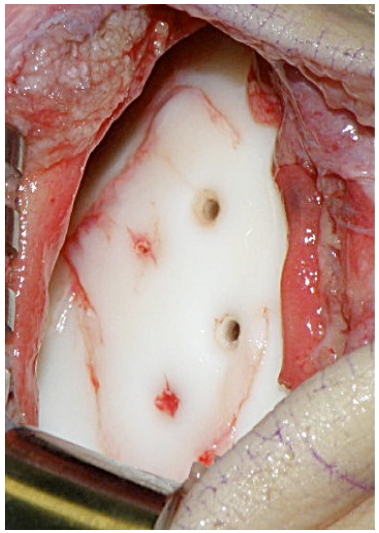
Arthroscopic Fixation of Osteochondritis Dissecans of the Knee: Clinical, Magnetic Resonance Imaging, and Arthroscopic Follow-up .
Makino A, Muscolo DL, Puigdevall M, Costa-Paz M, Ayerza M, MD. Am L Sports Med 2005, 33:1499-1504.

- Unstable OCD treated with Arthroscopic Herbert Screws, followed average 50 months, Level IV study
- Hardware removed @ average 100 days post fixation
- 14 of 15 knees showed stable surface with healing of osteochondral fragment by MRI
- Lysholm score improved from a mean of 79 preoperatively to 97 postoperatively.
- Correlation of MRI healing, Arthroscopic healing with good clinical outcomes

Osteochondral Fracture Treatment

Open Cartilage Preservation: Trochlea

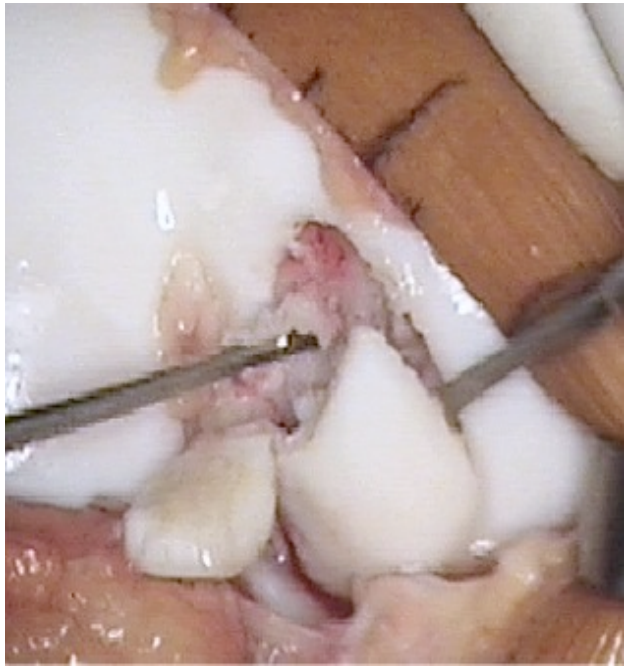
- Minimally open technique, absorbable Darts
- Augment with BMP, Stem cells, Fibrin Glue seal

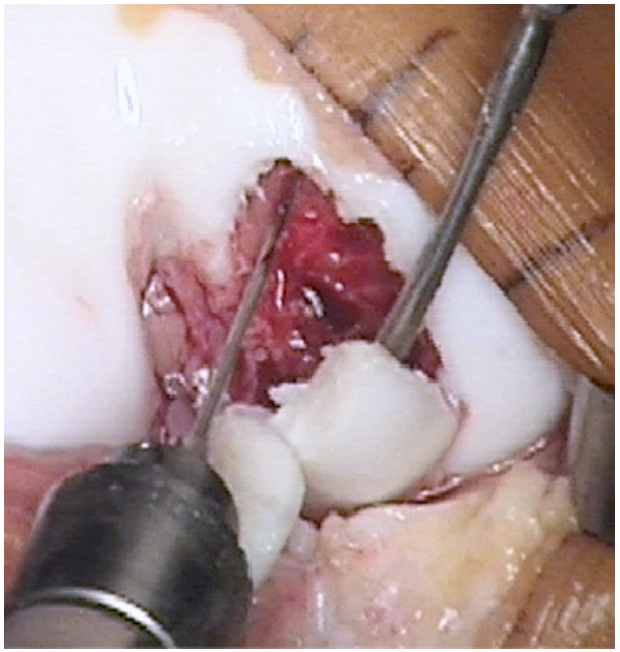







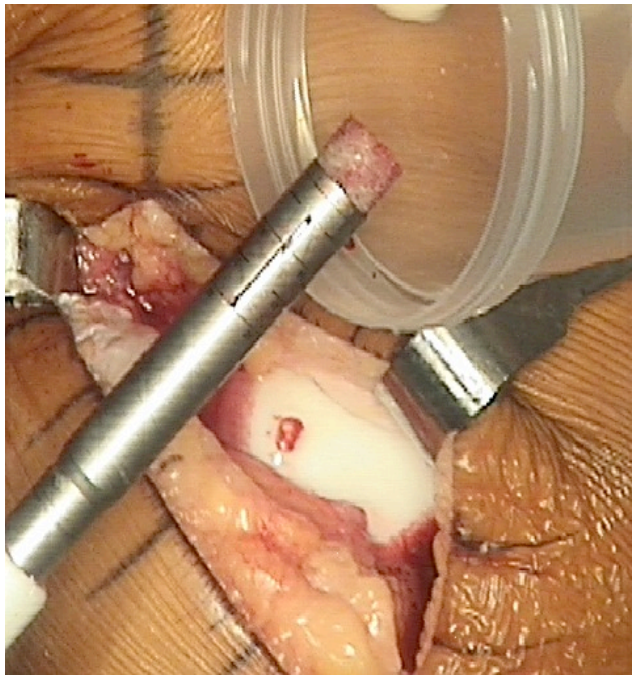
Osteochondral Fracture Treatment

Open Cartilage Preservation: Femoral Condyle

- Save Cartilage at all costs!
- Bone Graft (Autograft), Augment



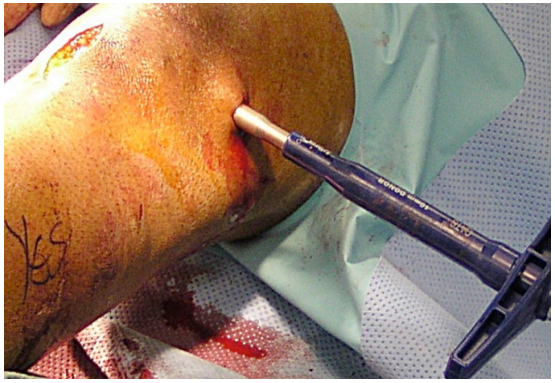


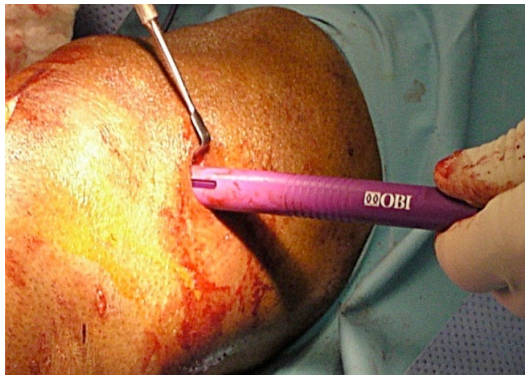


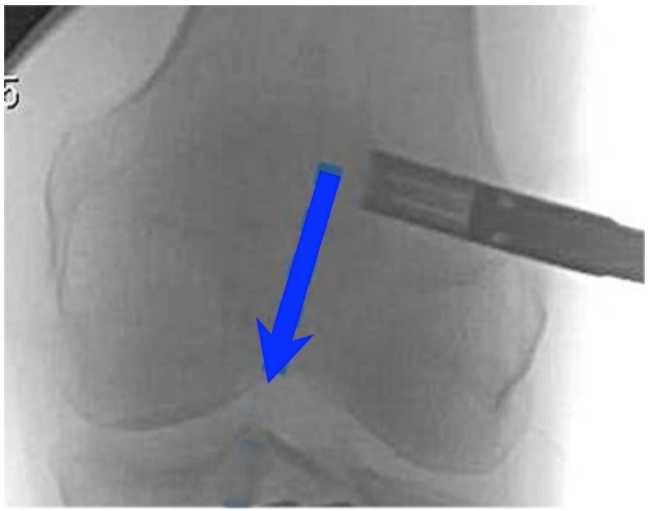
Osteochondral Fracture Treatment

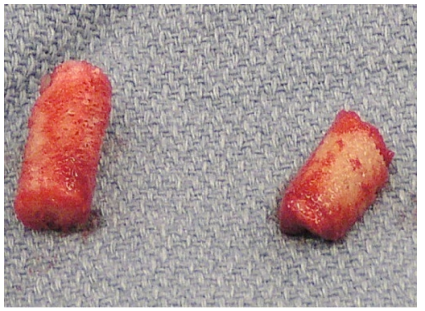
Autologous Bone Graft Harvest from Femoral Condyle

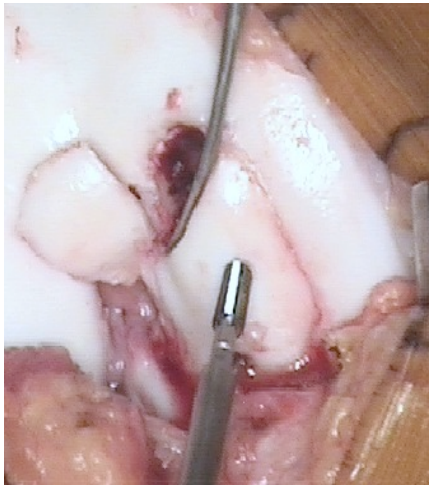
- OATS harvester from femoral condyle (tibia) for autologous cancellous bone
- Back fill harvest site with allograft or bone graft substitute







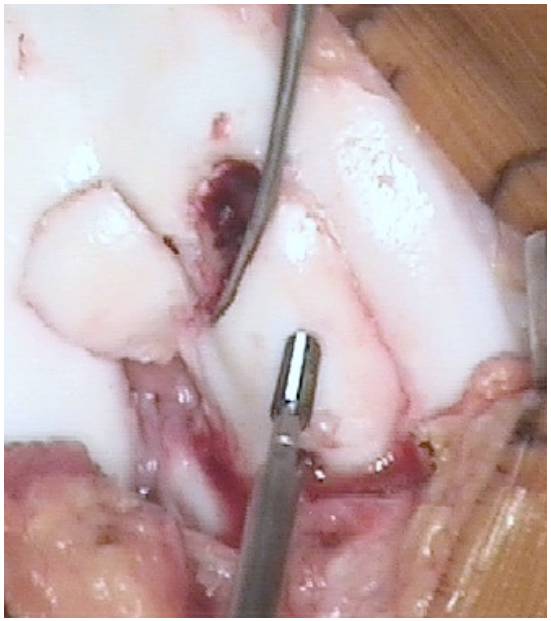


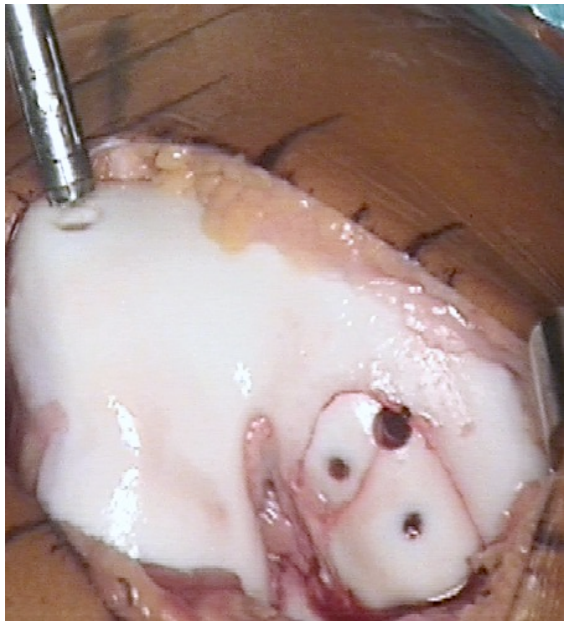


Osteochondral Fracture Treatment

Open Cartilage Preservation: Femoral Condyle

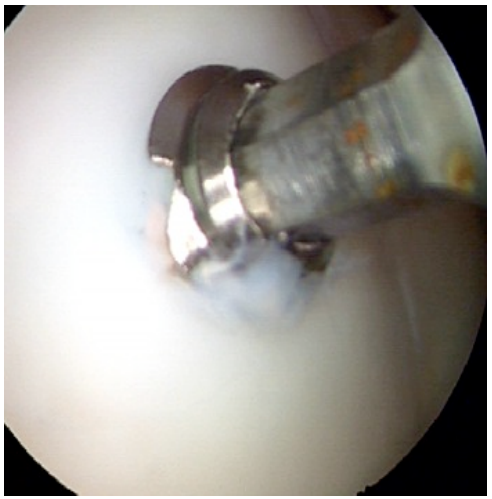
- Stabilize, Bone Graft, Augment

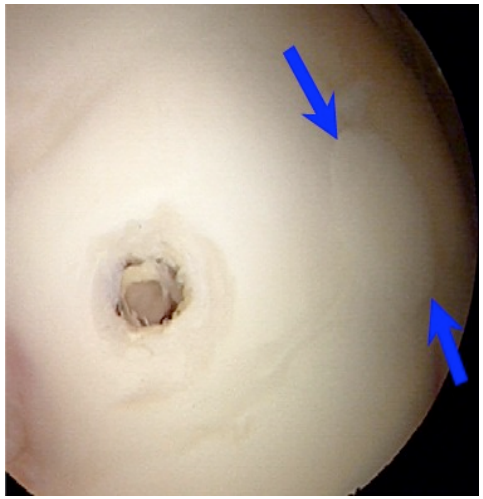


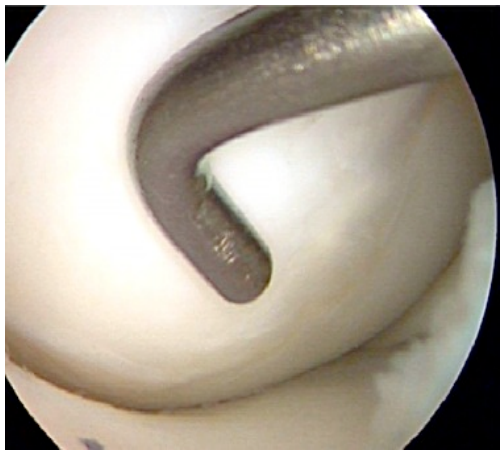


Hardware Removal

@ 4 Mos.



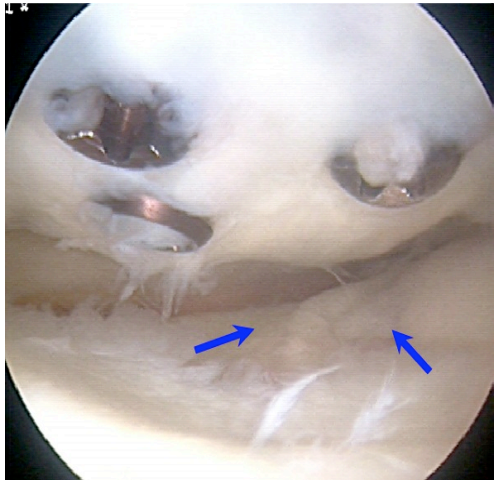




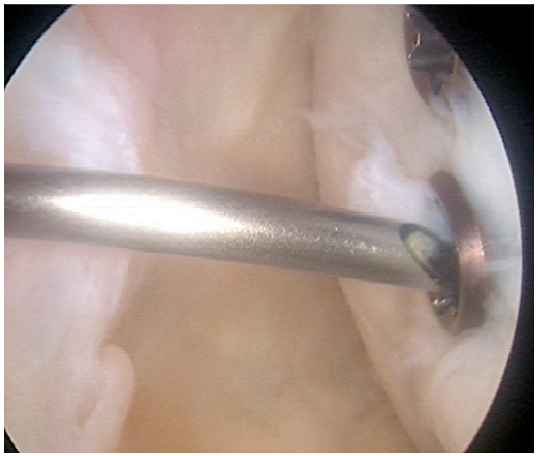
Osteochondral Fracture Treatment

Open Cartilage Preservation: Hardware Removal

- Plan on Hardware Removal in Pre-operative Counseling
- Avoid damage to opposing articular surface

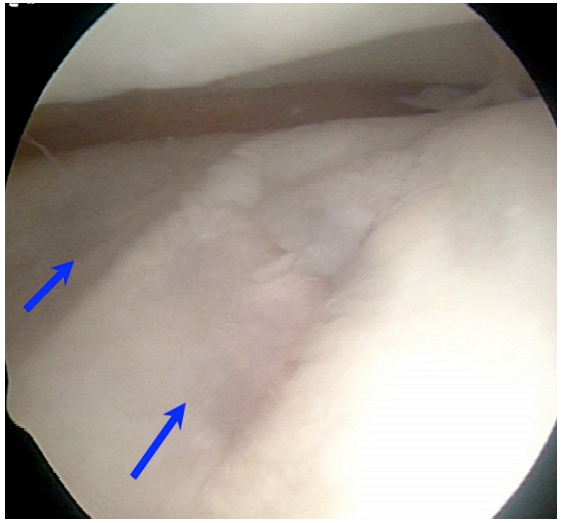


Damage to tibial plateau

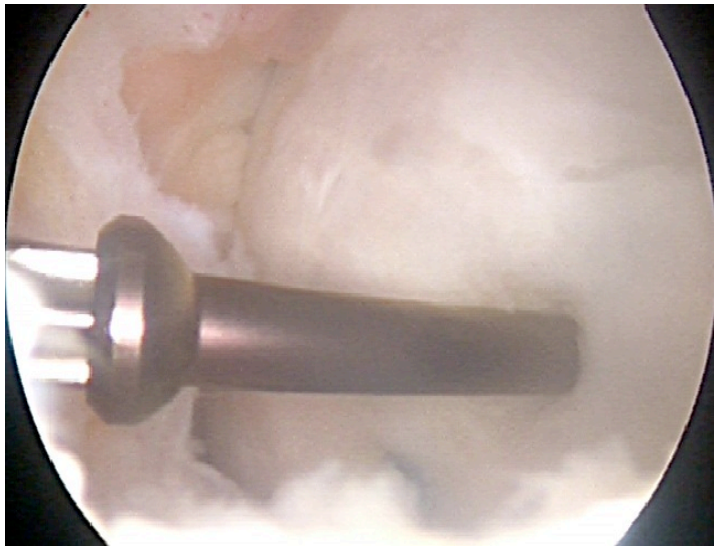


Portal track; free up screw head

Preop: get the correct screwdriver



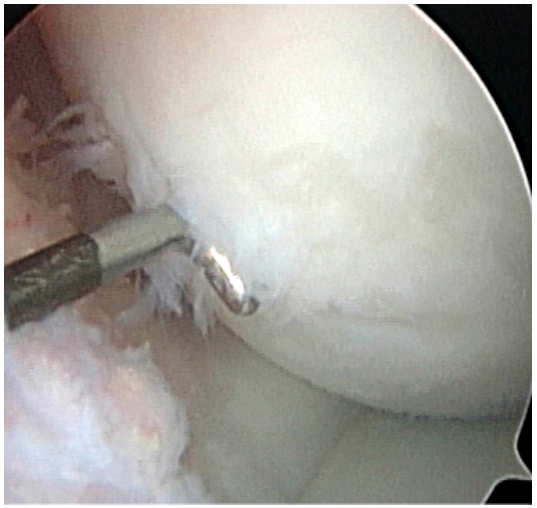
Damage to trochlea



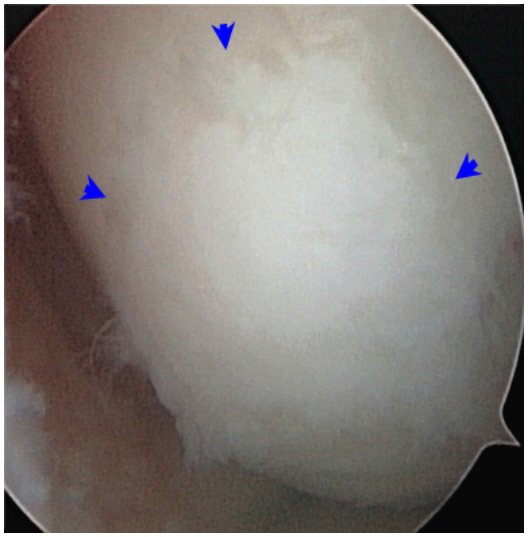
Articular Cartilage OCD/OCF Treatment

Open Cartilage Preservation: OATS

- Intact or partially attached articular cartilage and unstable OCD bone
- Preserve cartilage while healing bone
- Can replace areas of damaged cartilage



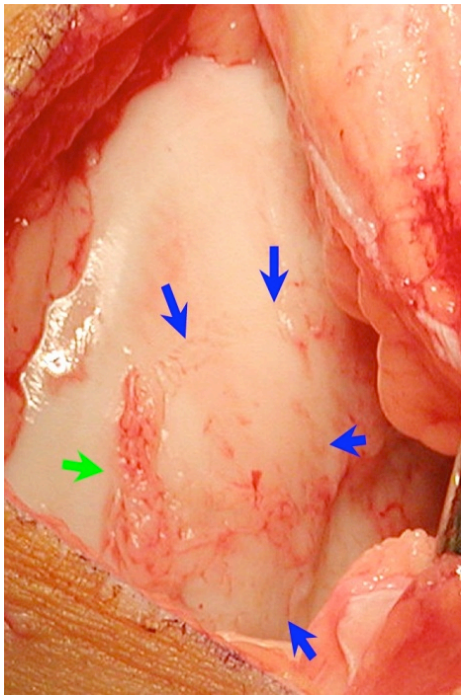
Native Cartilage still better than regenerated cartilage

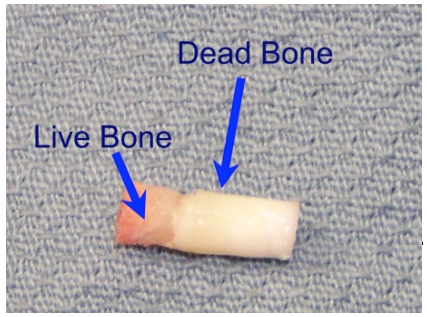


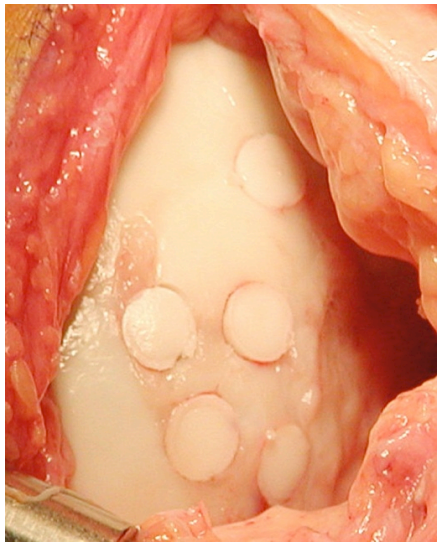
Articular Cartilage OCD/OCF Treatment

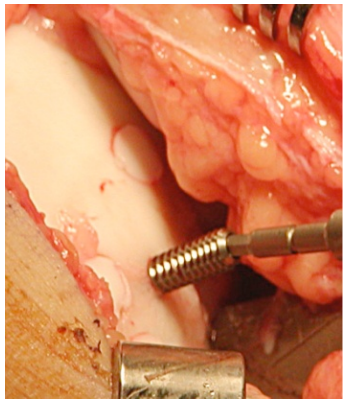
Open Cartilage Preservation: OATS

- Stabilize w/ 3-5 OAT Autograft plugs (6 to 8 mm in size) and internal fixation (temporary or absorbable)









3 years post-op

Articular Cartilage OCD/OCF Treatment

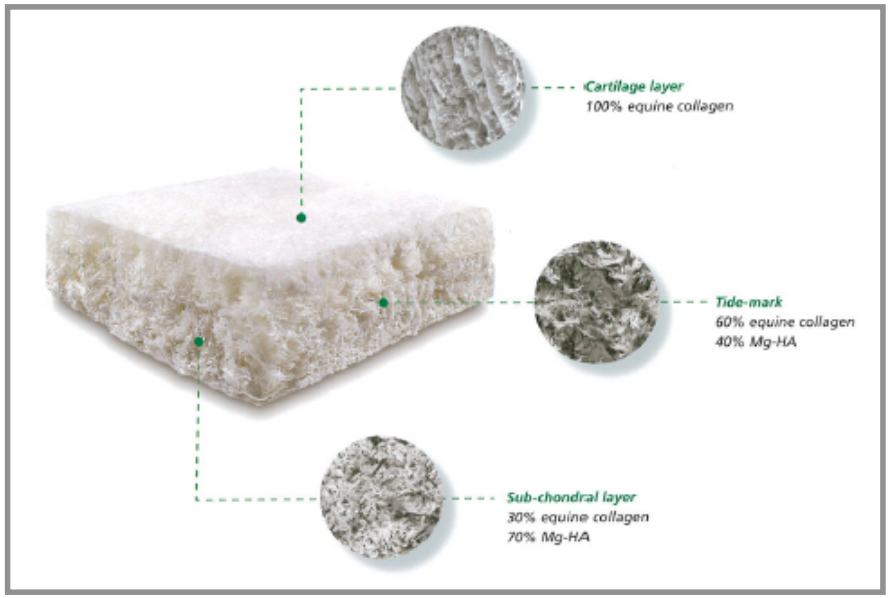
No Salvageable native cartilage on fragment and no bony deficiency

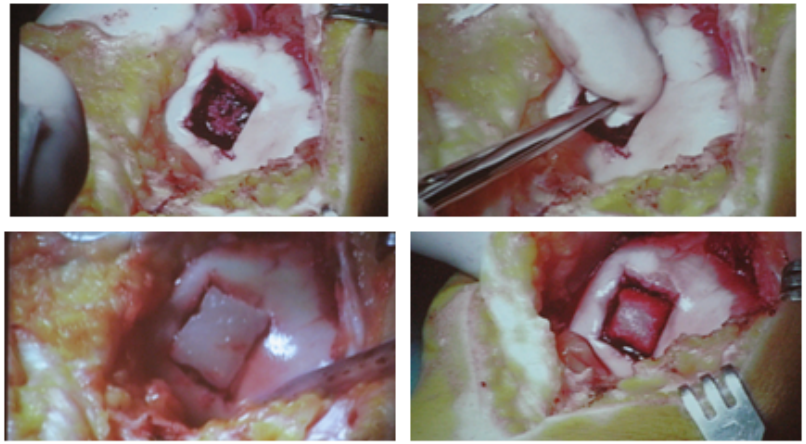
- Predominant Articular Cartilage Lesion
- Smaller deficits may be amenable to marrow stimulation/scaffold (< 2.5 cm^2)
- Treatment with advanced biologic cartilage repair techniques:
  Autologous Chondrocyte Implantation (ACI)
  - Arthroscopic assessment of lesion(s)
  - Chondral Biopsy for cell culture
- Scaffolds, Allograft Cartilage (deNovo)

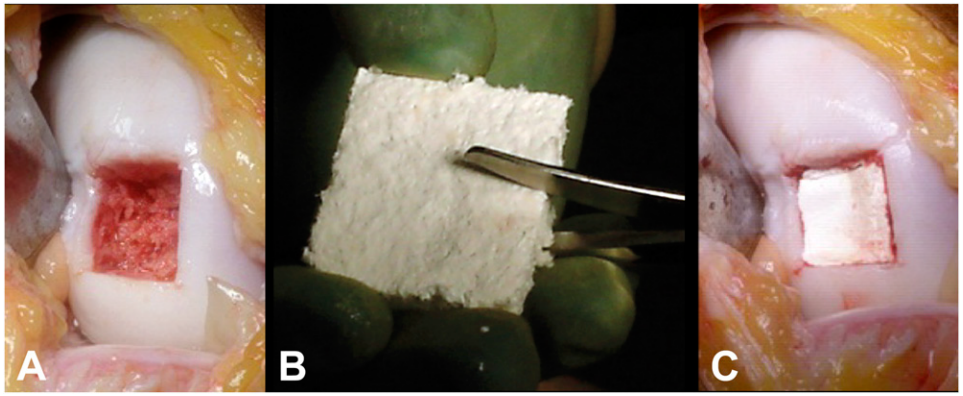
Advanced Biologic Cartilage Repair Techniques

Deep osteochondral filling scaffold

- **Maio Regen** (Fin-Ceramica, Italy)
- tri-layered Type 1 collagen implant with varying levels of hydroxyapatite and magnesium. Press Fit
- MRI shows good defect filling and implant integration but also **inhomogeneous regenerated tissue and subchondral bone changes in most patients at both 1 and 2 years**
- AJSM, 2013







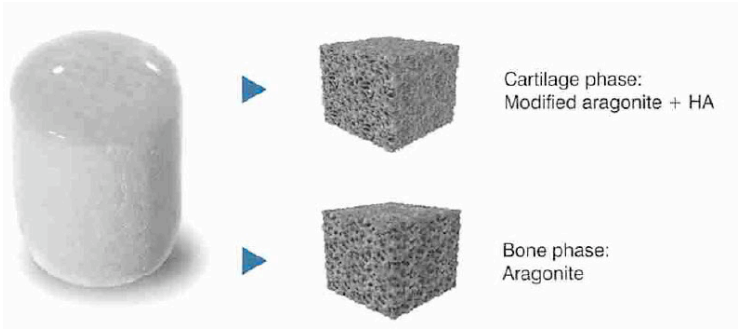
Case courtesy Mats Brittberg MD

Advanced Biologic Cartilage Repair Techniques

Smart Scaffolds for Cell Recruitment

- **Agili-C** is single stage press fit bi-phasic implant for hyaline cartilage and bone regeneration
- Bone phase is calcium carbonate; cartilage phase modified aragonite and HA

Sheep



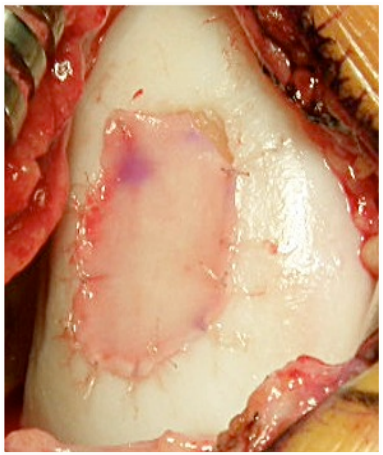
CartiHeal
Regenerating Cartilage, Naturally.

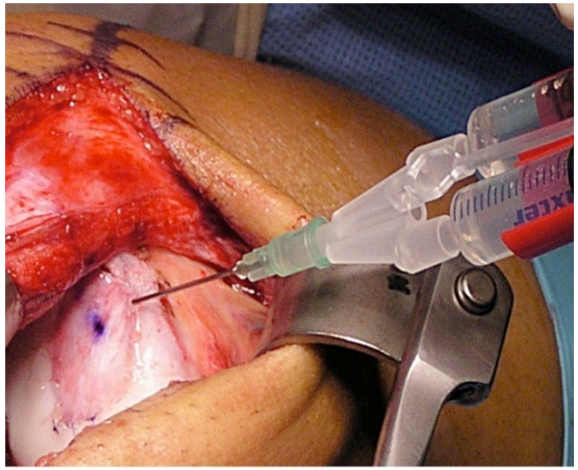
Human

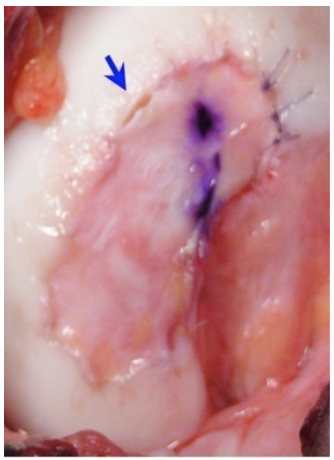
Articular Cartilage OCF/OCD Treatment

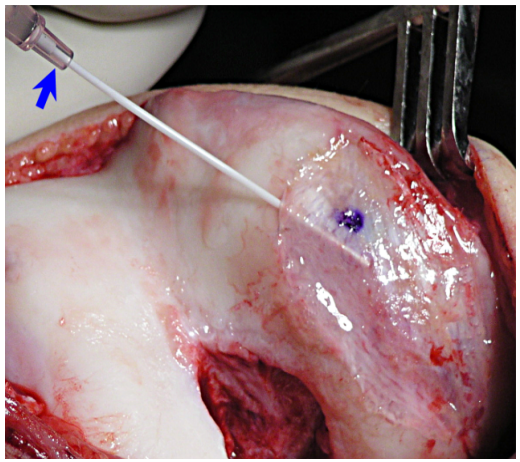
Open Cartilage Reconstruction: Autologous Chondrocyte Implantation (ACI)

- Secure membrane cover, water tight seal for cells









Articular Cartilage OCF/OCD Treatment

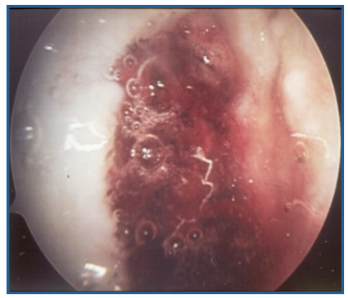
Arthroscopic Cartilage Reconstruction: Hyalograft ACI

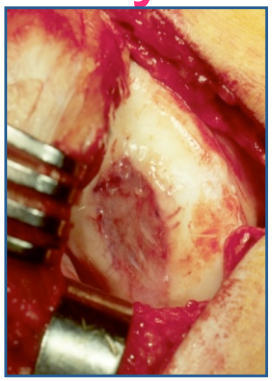
- ACI alternative done by arthroscopy
- Chondrocyte seeded on hyalyronic acid scaffold Hyalograft/Hycel
- Scaffold implanted slightly below the surrounding cartilage surface and sealed with Fibrin Glue

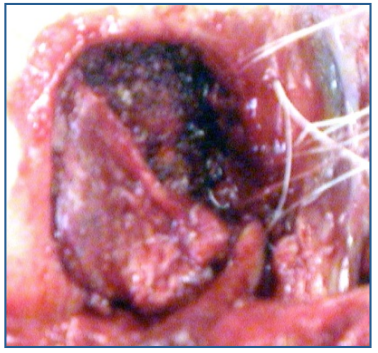
Case courtesy Mats Brittberg MD

Articular Cartilage OCF/OCD Treatment

No Salvageable native cartilage, Bone Deficiency





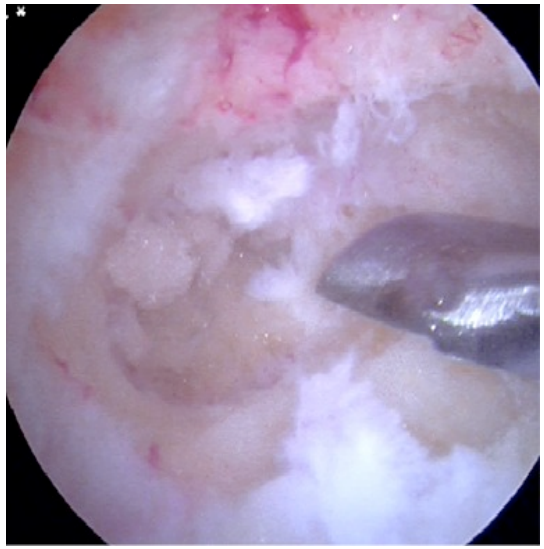


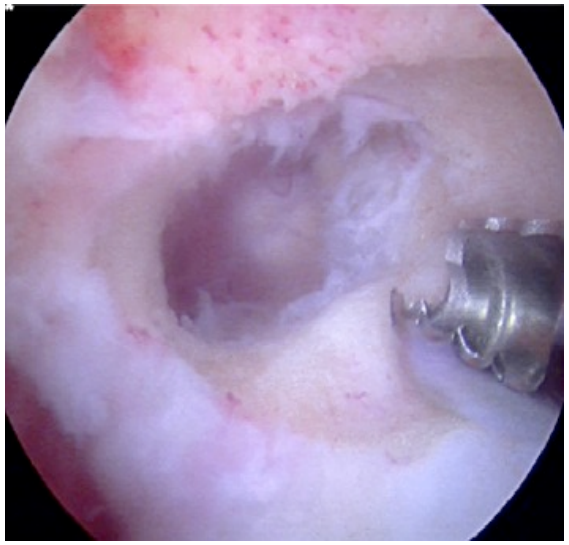
- Bone Deficiency ≥ 7-8 mm
- Defect will require treatment bone deficiency:
  - Bone Grafting and Staged ACI
  - Single staged ACI with "Sandwich technique"
  - Osteochondral Autograft (only for smaller lesion needing no more than two plugs)
  - Osteochondral Allograft (benefit of treating both bone and cartilage loss), no size limitation

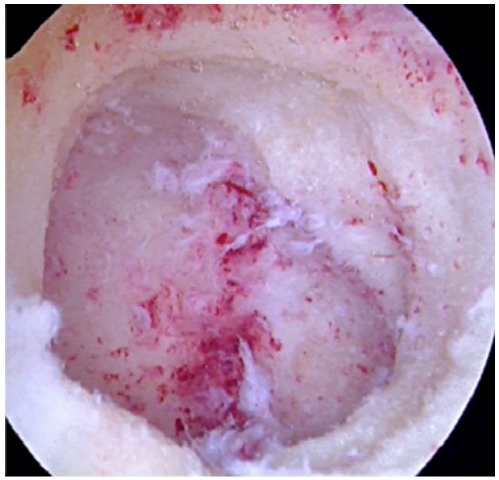
Articular Cartilage OCD Treatment

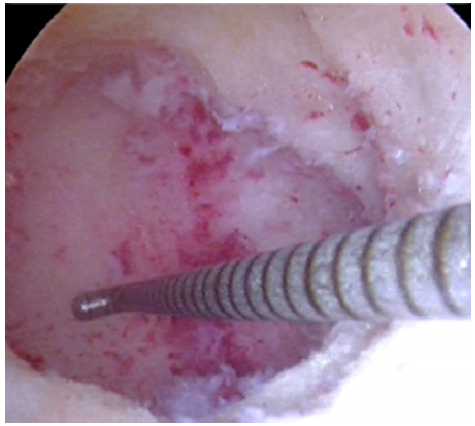
Arthroscopic Bone Grafting

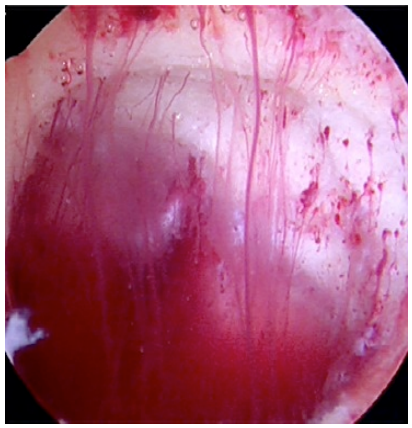
- Bone Deficiency ≥ 7-8 mm

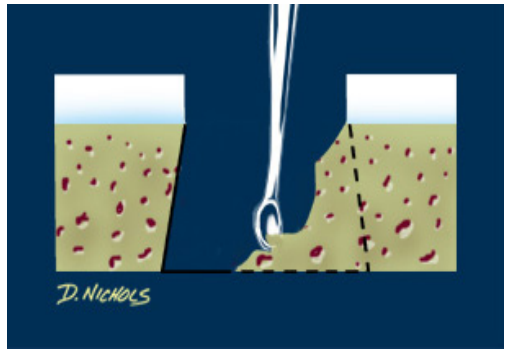








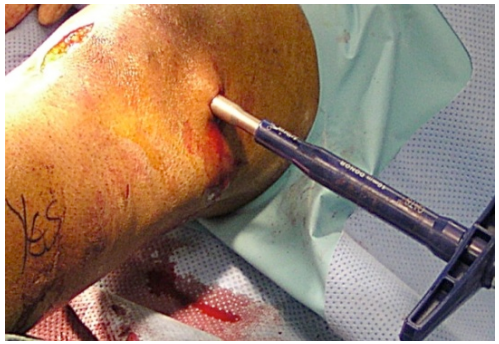
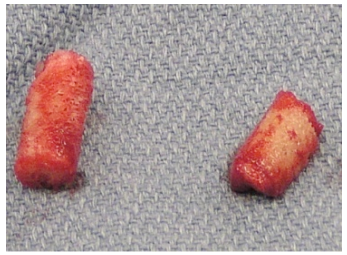
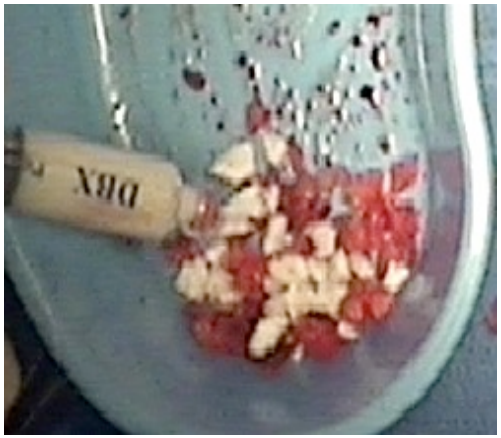


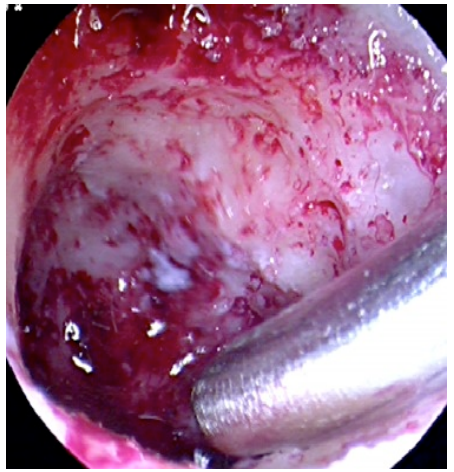
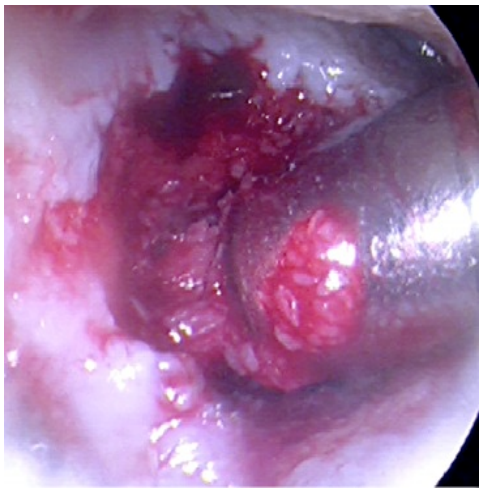


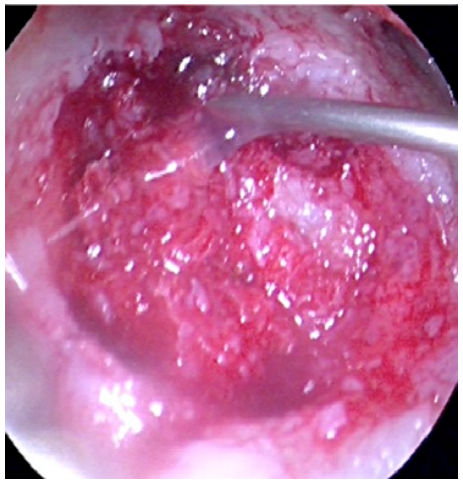
Articular Cartilage OCD Treatment

Arthroscopic Bone Grafting

- Bone Graft (Auto and Allograft) to level of subchondral bone, seal with Fibrin

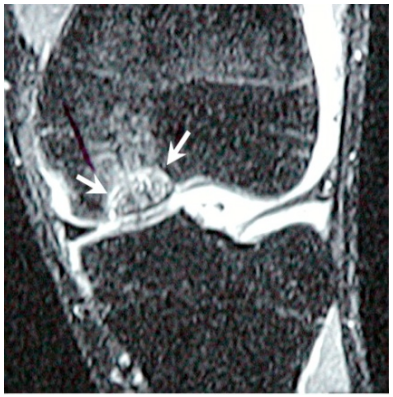




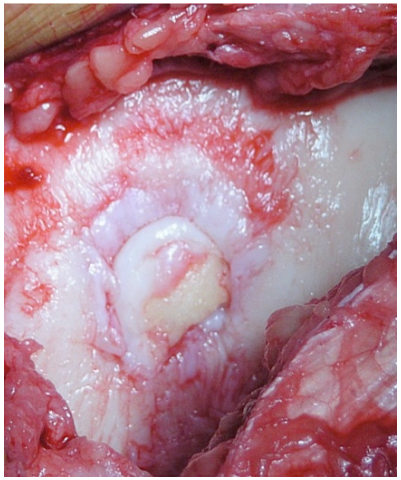
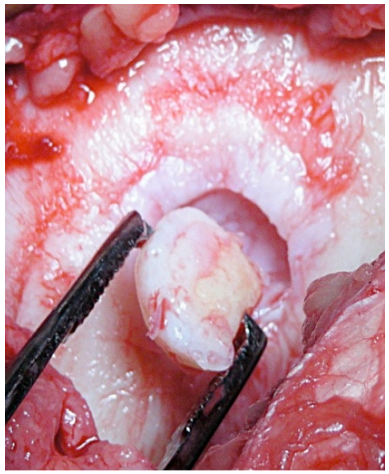
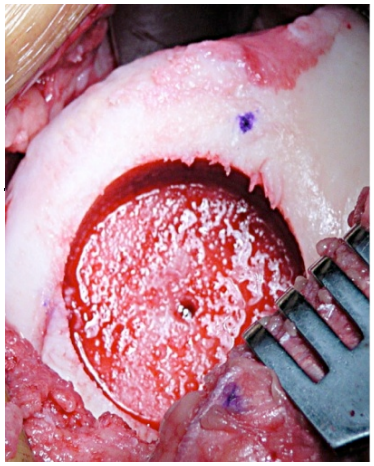
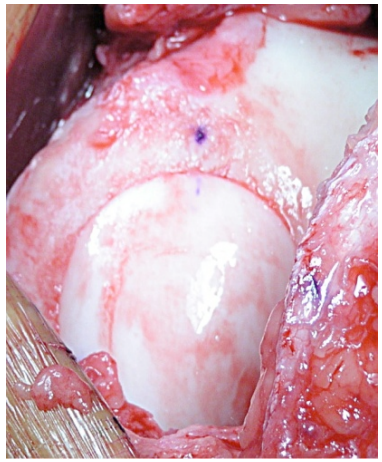
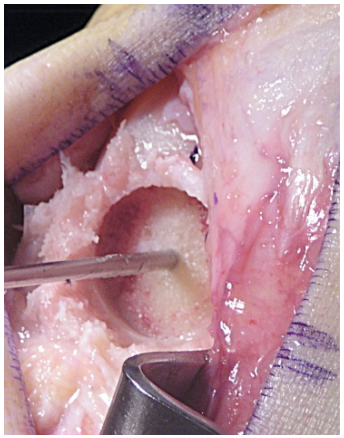
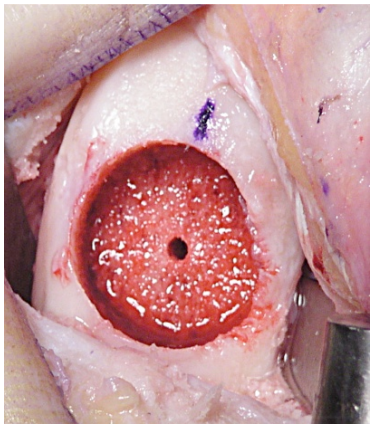
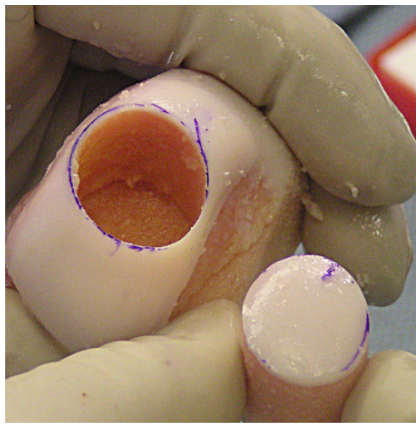
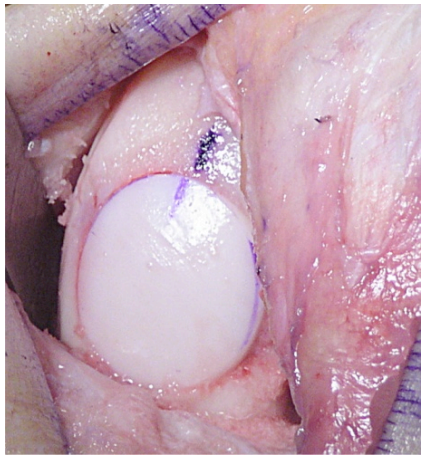



Articular Cartilage OCD Treatment

Open Cartilage Replacement
Osteochondral Allograft



- Significant Bone Loss, Treats both bone and cartilage deficiency

Treatment with Fresh Osteochondral Allografts

Do fresh osteochondral allografts successfully treat femoral condyle lesions? Levy YD; Gortz S; Pulido PA; McCauley JC; Bugbee WD: Clin Orthop Relat Res, Jan 2013, 471(1) p231-7

- 122 patients (129 knees) who underwent osteochondral allograft transplantation of the femoral condyle. Mean age was 33 yrs, 53% male. Median F/U 13.4 yrs.
- Sixty-one knees (47%) underwent reoperations. Thirty-one knees (24%) failed at a mean of 7.2 years. Survivorship was 82% at 10 years, 74% at 15 years, and 66% at 20 years.
- Age of more than 30 years at time of surgery and having two or more previous surgeries for the operated knee were associated with allograft failure.

Treatment Options for Osteochondral Fractures (OCD)

Summary

- Preserve patient articular cartilage first and foremost; error on the side of repair.
- Evaluate for any concomitant malalignment and treat aggressively
- Treat bone involvement in OCF/OCD with as little damage as possible to articular cartilage
- Use Autologous bone graft
- Cautious of Hardware, Plan to remove
- Don’t hesitate to stage treatment, always do what is best to preserve native cartilage

Merci
Molte Grazie
Danke Schön
Thank You