

Decision Making for Cartilage Restoration: *Complex Algorithms for Difficult Problems*

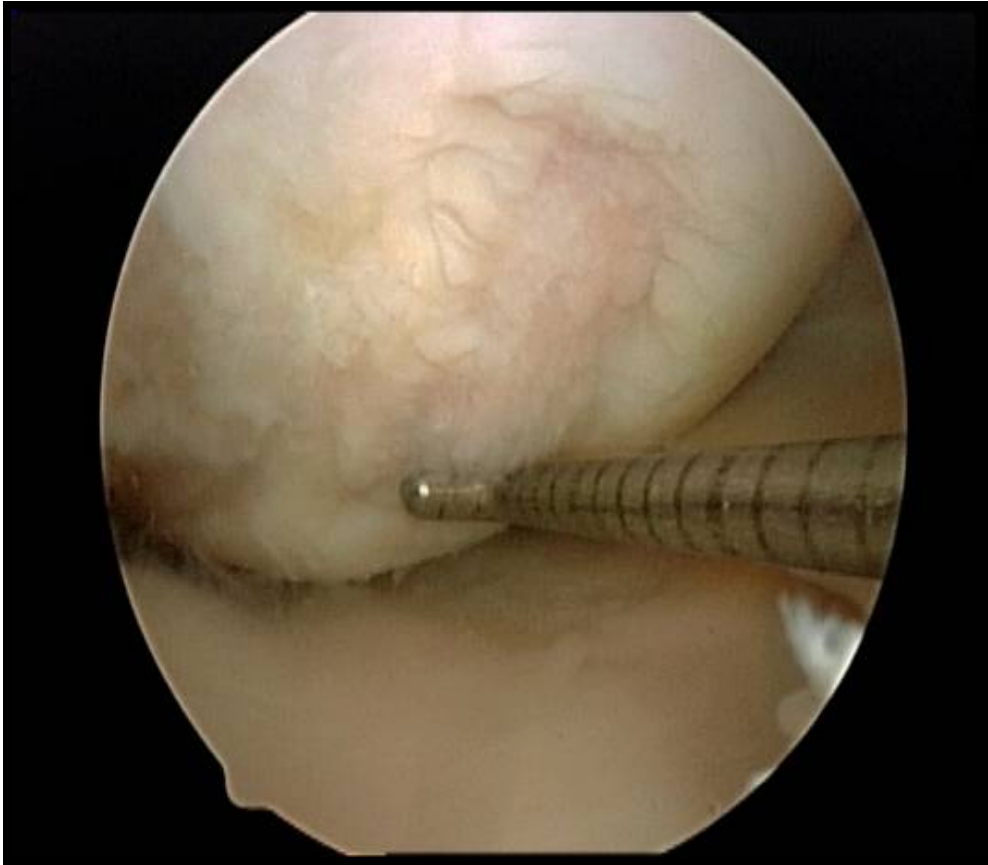
**Phil Davidson, MD
Heiden - Davidson Orthopaedics
Park City, UT**

**Articular Cartilage: State of the Art 2009
NYU Hospital for Joint Diseases**



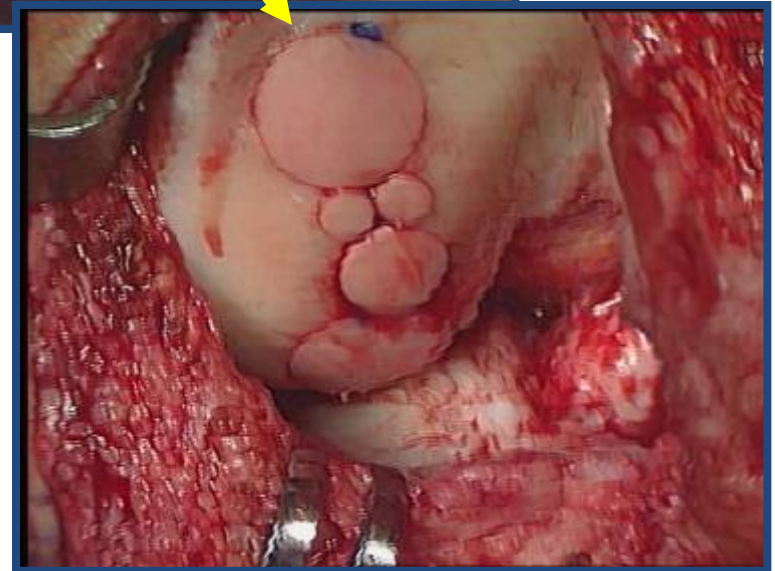
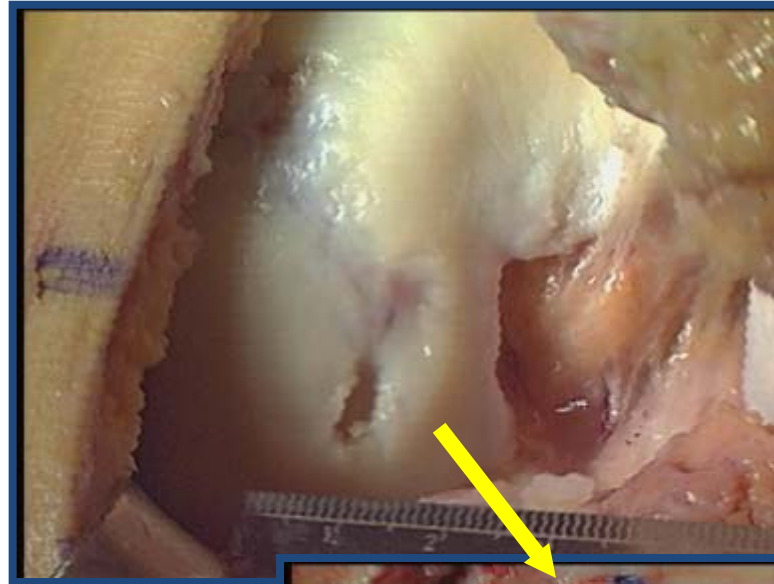
Cartilage Restoration & Joint Resurfacing

A wide realm between....

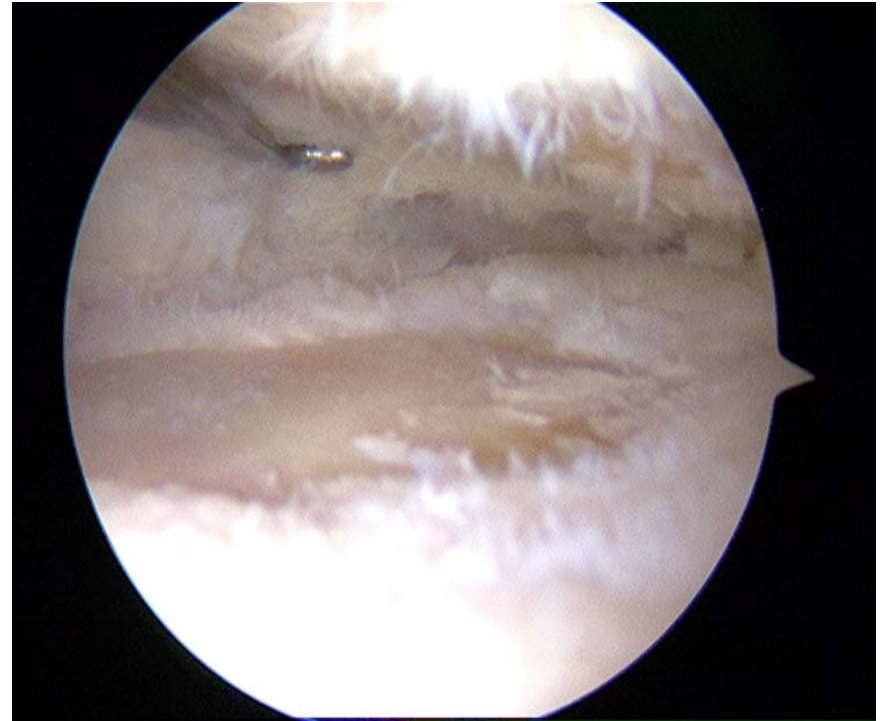
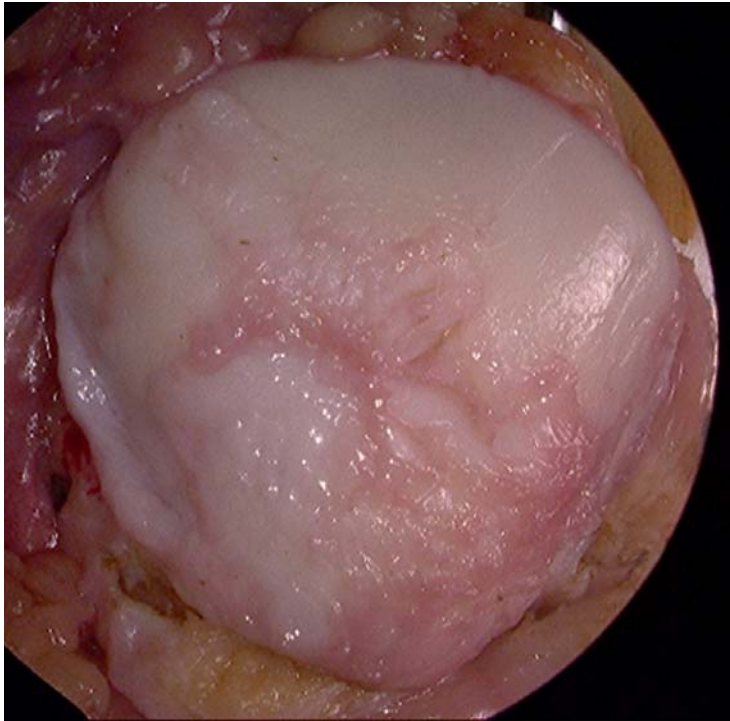


Goals: Cartilage Restoration and Joint Resurfacing

- Relieve pain
- Restore functional
- Improve Mechanics
- Long lasting
- Prevent or Limit Future Degenerative Changes

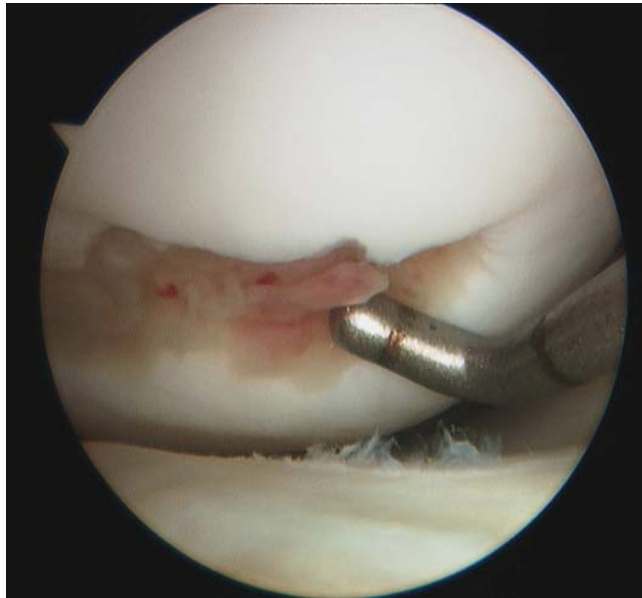
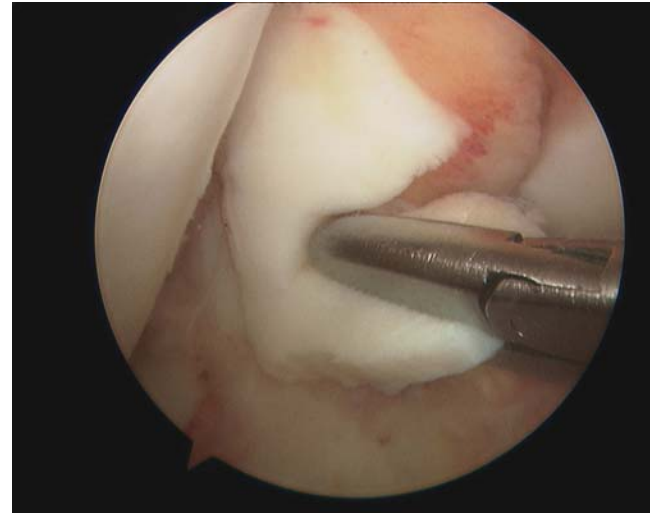


How do we systematically, scientifically and effectively get a handle on these challenging cases?



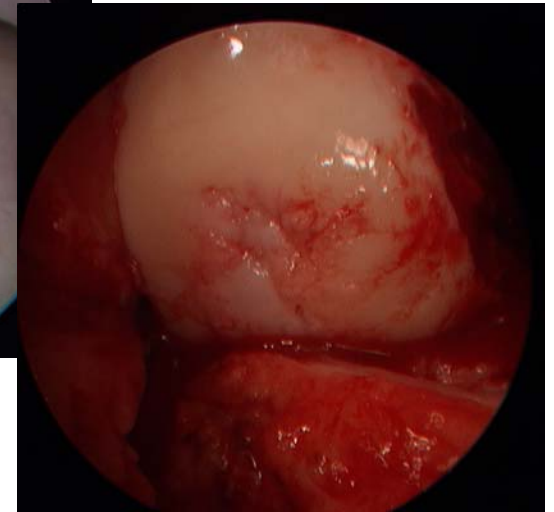
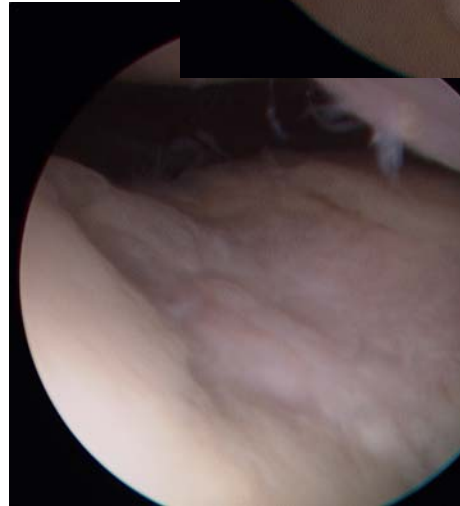
Case #1

- 21 yr old hockey player
- Traumatic patellar dislocation



Case #2

- 33 year old active male
- Anterior and Medial knee pain
- Prior ACL reconstruction (16 years ago)
- ROM 12-130 degrees



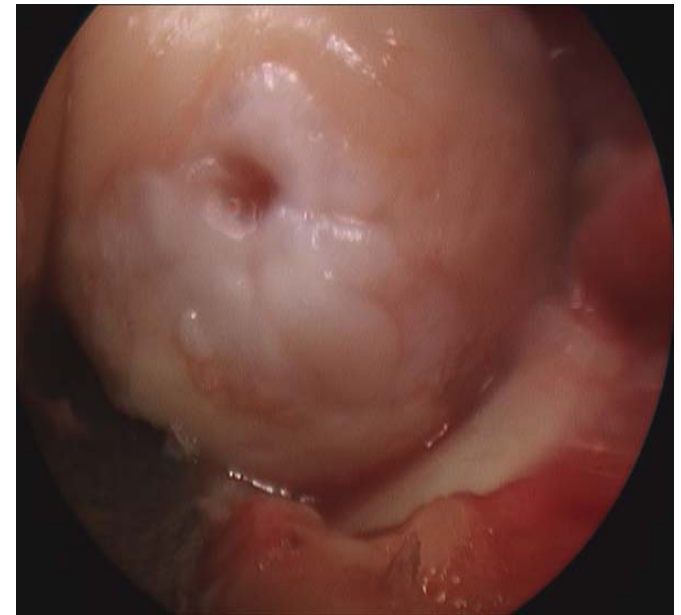
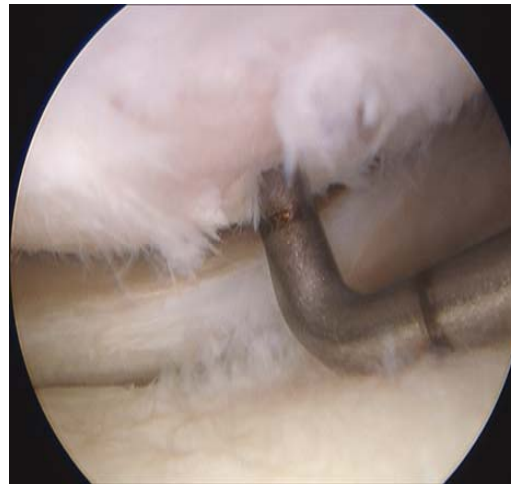
Case #2



Spectrum of Pathology

Spectrum of Treatments

- ...solution lies in understanding comprehensive pathology and full realm of treatments



Variety of Methods /Approaches to stratify and subsequently treat Cartilage Lesions

- Size
- Demand
- Age
- Comorbidities
- Relevant Pathoanatomy
 - Cartilage
 - Bone
 - Alignment
 - Stability
 - Meniscus



Lesion Size

Lesion < 2-3 cm²

Lesion > 2-3 cm²

Physical Demand

Low Demand

High Demand

Low Demand

High Demand

- Debridement
- Marrow-stimulating technique

- Debridement
- Marrow-stimulating technique
- Osteochondral autograft

- Debridement
- Marrow-stimulating technique
- Osteochondral allograft
- Autologous Chondrocyte Implantation

- Autologous Chondrocyte Implantation
- Osteochondral allograft

Outcome

Success

Failure

Success

Failure

Success

Failure

Success

Failure

Second Line Rx

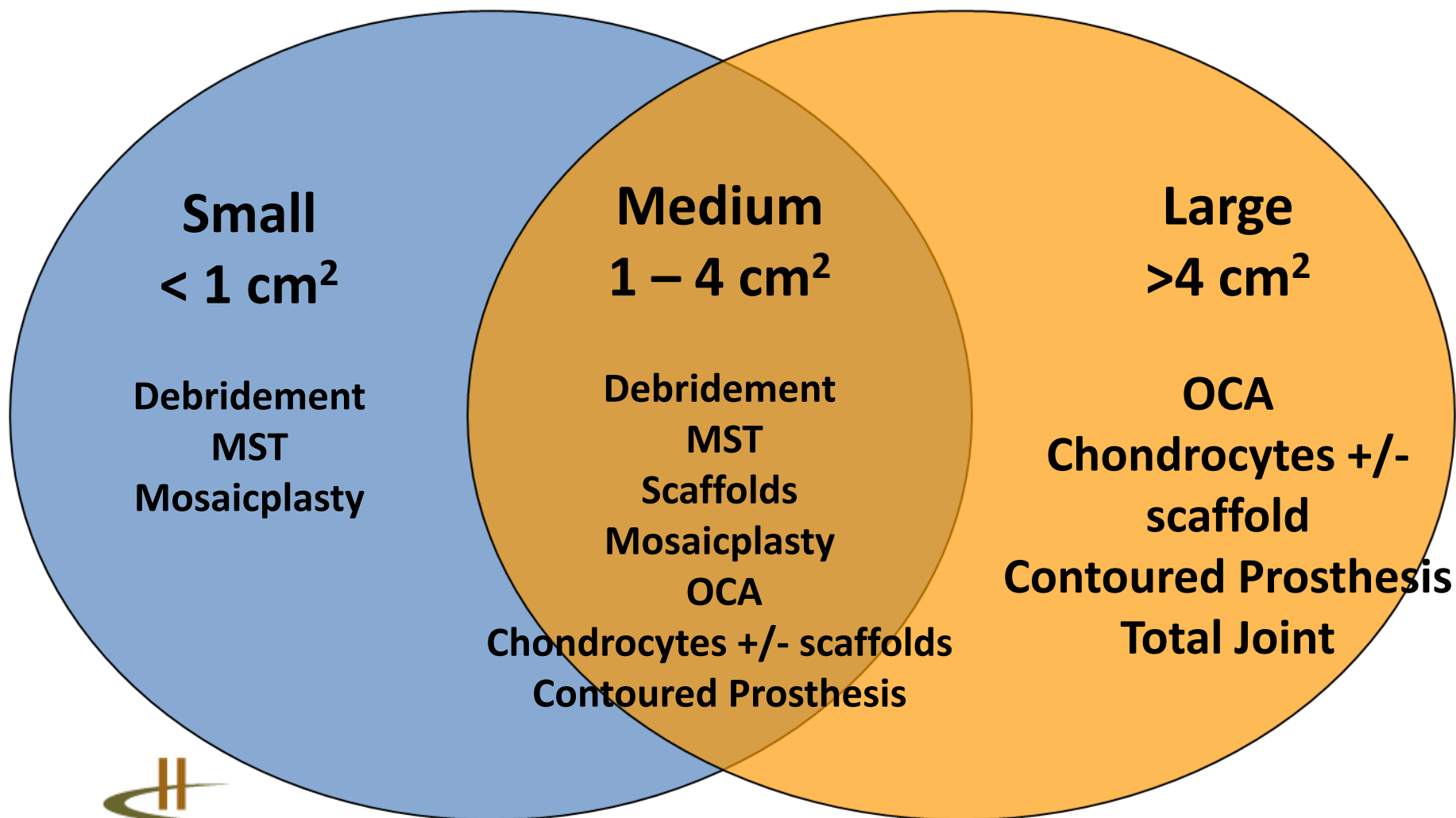
- Osteochondral autograft or allograft
- Autologous Chondrocyte Implantation

Second Line Rx

- Autologous Chondrocyte Implantation
- Osteochondral allograft



Treatment Options for Symptomatic Cartilage +/- Bone Defects Based on Size

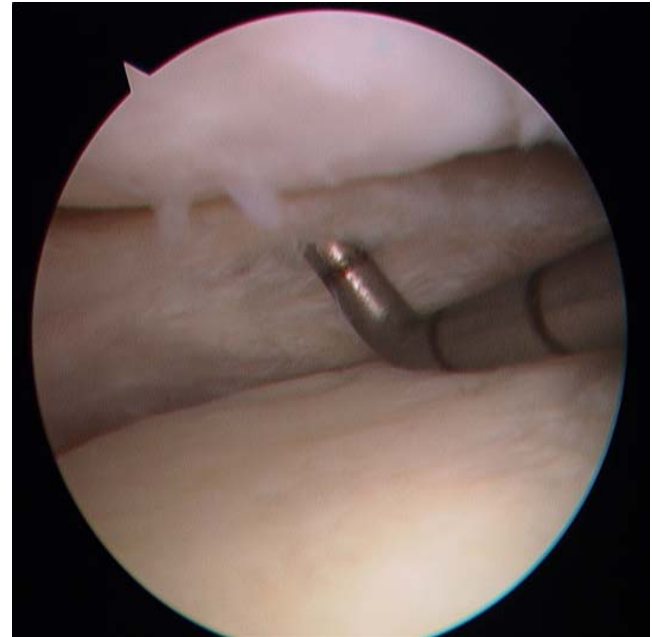


- Demand
 - Expectations
 - Activities
 - Complicity
- Age
 - Biological, not just chronological
- Comorbidities
 - BMI
 - Diabetes
 - Smoking
 - Medical Illness



Relevant Pathoanatomy

- Cartilage
 - Full depth loss??
 - Chondropenia
- Bone
 - Loss of bone
 - Osteopenia
- Meniscus
 - Consider degree of meniscal remnant



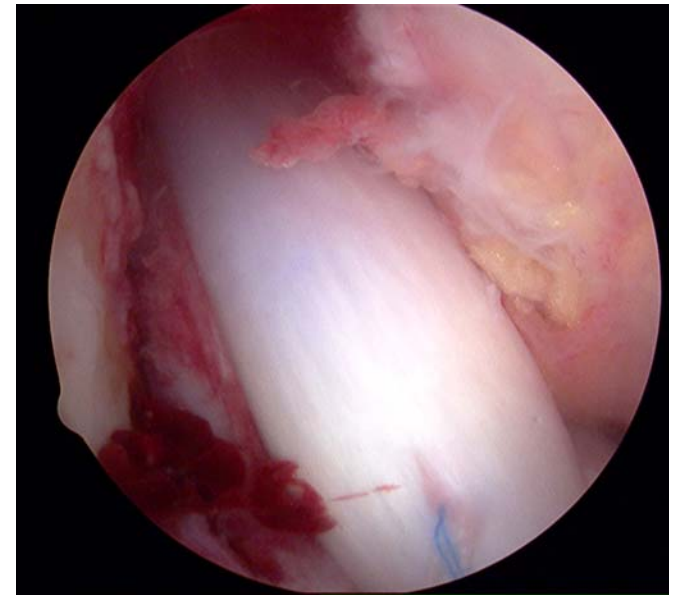
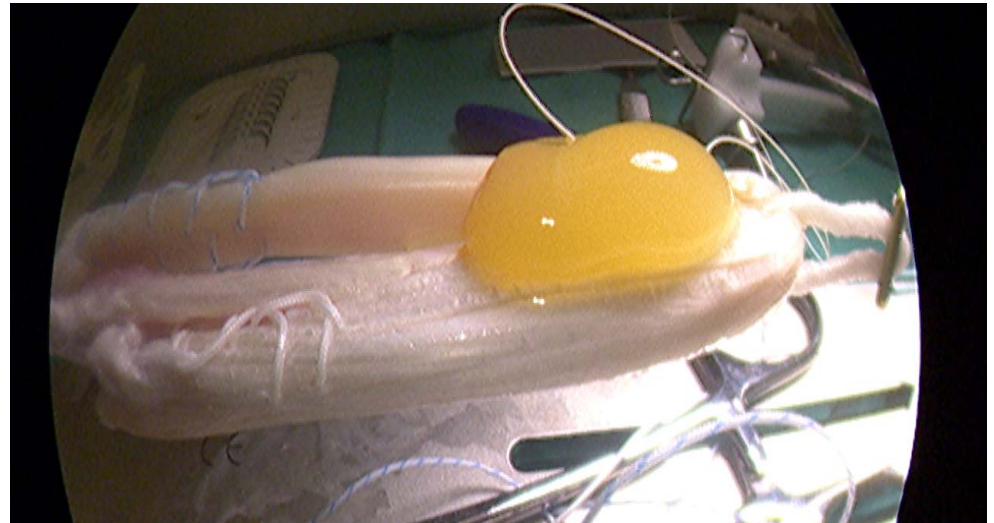
Relevant Pathoanatomy

- Alignment
 - Exact degree of alignment critical in decision making
 - Cannot expect biological solution to work in overloaded compartment



Relevant Pathoanatomy

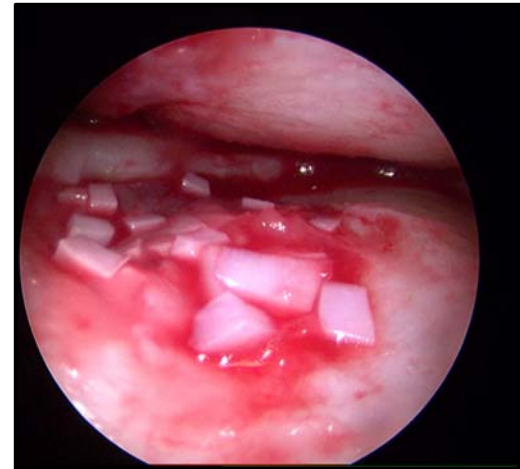
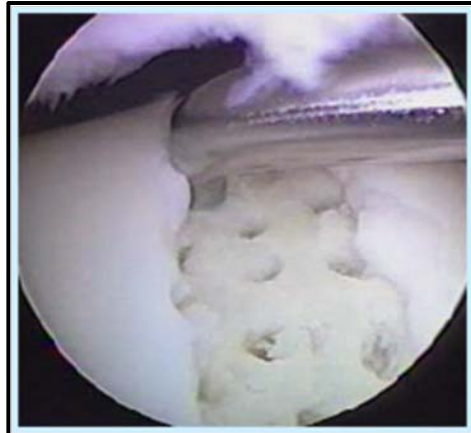
- Stability
 - Must stabilize knee to expect biological approach to heal and restore function



Cartilage Restoration/Joint Resurfacing Treatments:

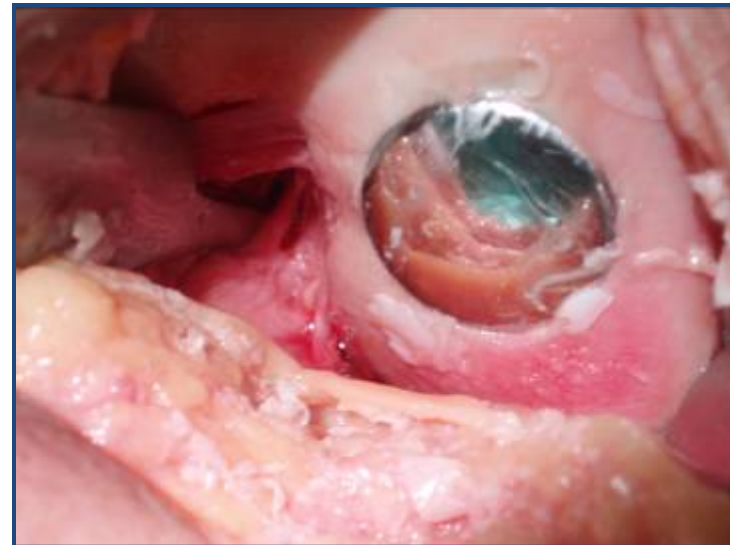
...an evolving continuum of options

- Marrow stimulation
- Biological restoration
 - Mosaicplasty / OATS
 - OCA
 - Chondral Auto and Allografts
 - Bio-synthetics/scaffolds
 - Modulated therapy
 - Cellular therapy
 - Autogenous Chondrocytes
 - Allograft Chondrocytes
 - Selected Chondrocytes
 - Stem Cells
 - Combination Products
- Joint Resurfacing
 - Polymeric/Hydrogels
 - Inlay Arthroplasty
 - Micro-invasive prostheses
 - Digitally custom onlay
 - Total Joint

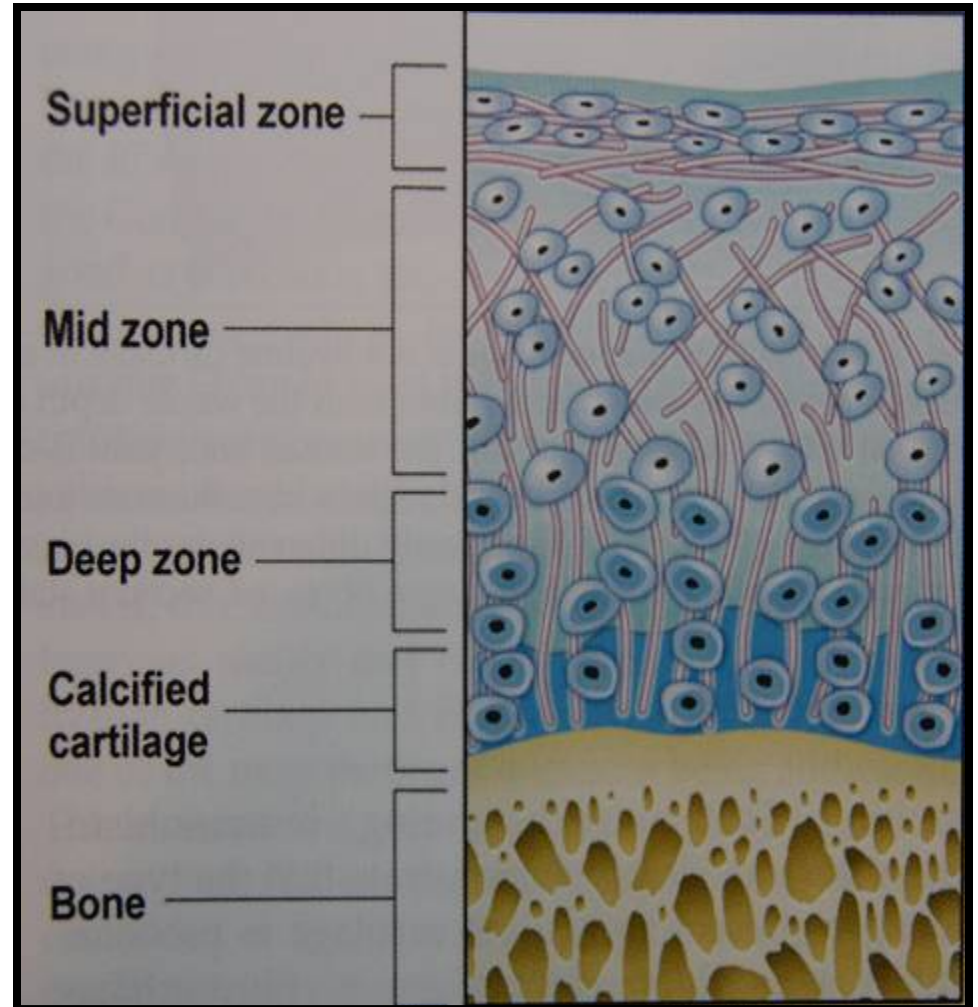
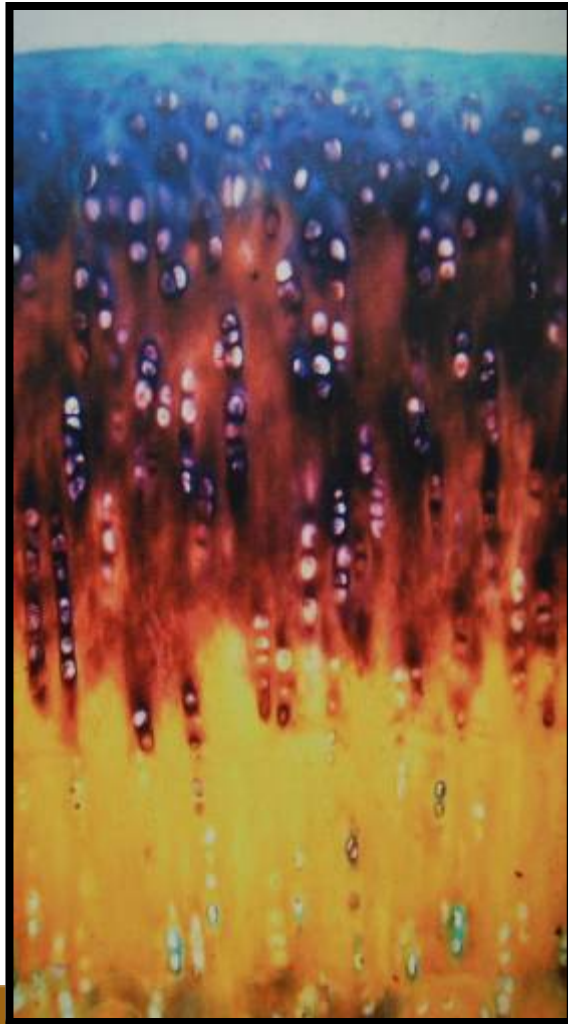


Transitional Thinking about treatments...

- As lesions get deeper....
 - Need bulk restoration
- Cartilage “only” lesions, - more superficial options
- As patients get older.....
 - Go from biologic to prosthetic solutions, with fewer autologous stem cells and less healing capacity
- Constant incorporation of new options with these principals in mind

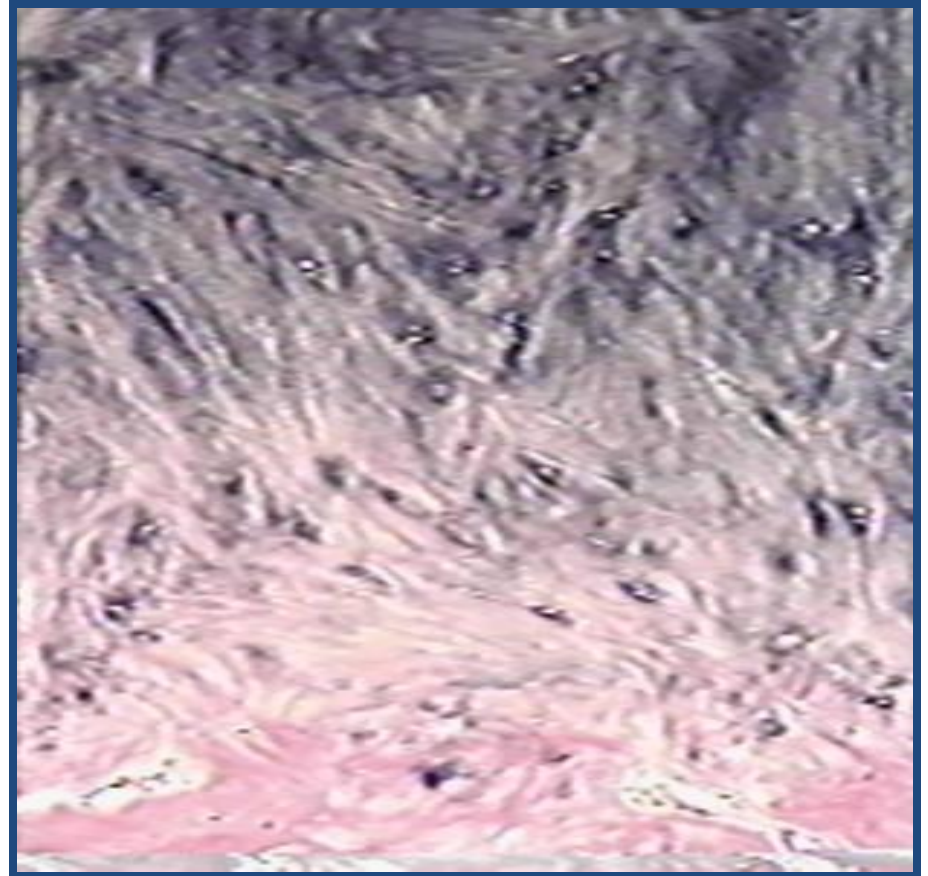


Goal of Cartilage Restoration- *Ultimately* Replicate Hyaline Articular Cartilage



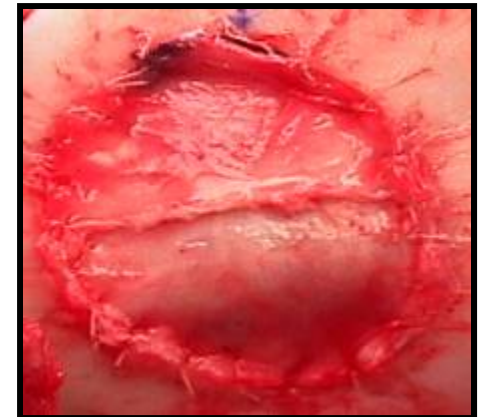
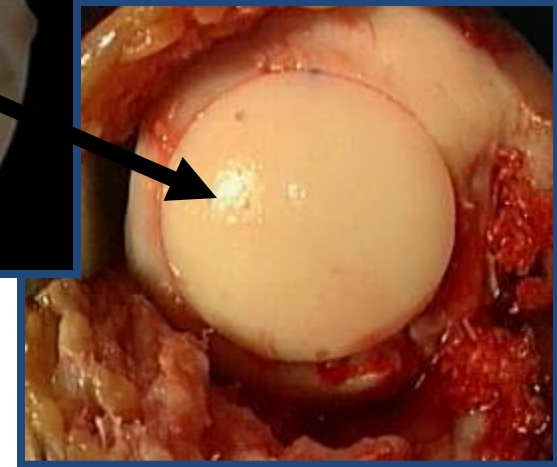
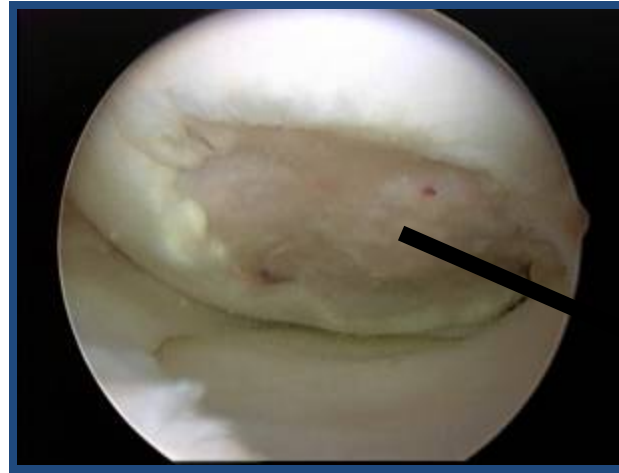
Marrow Stimulation

- Techniques
 - Drilling
 - Picking
 - Abrasion
 - Microfracture
- Marrow stimulation results:
 - Fibrocartilage
- Limited potential with increased age, injury chronicity
- Cheap, fast, easy
 - Short term efficacy seductive.

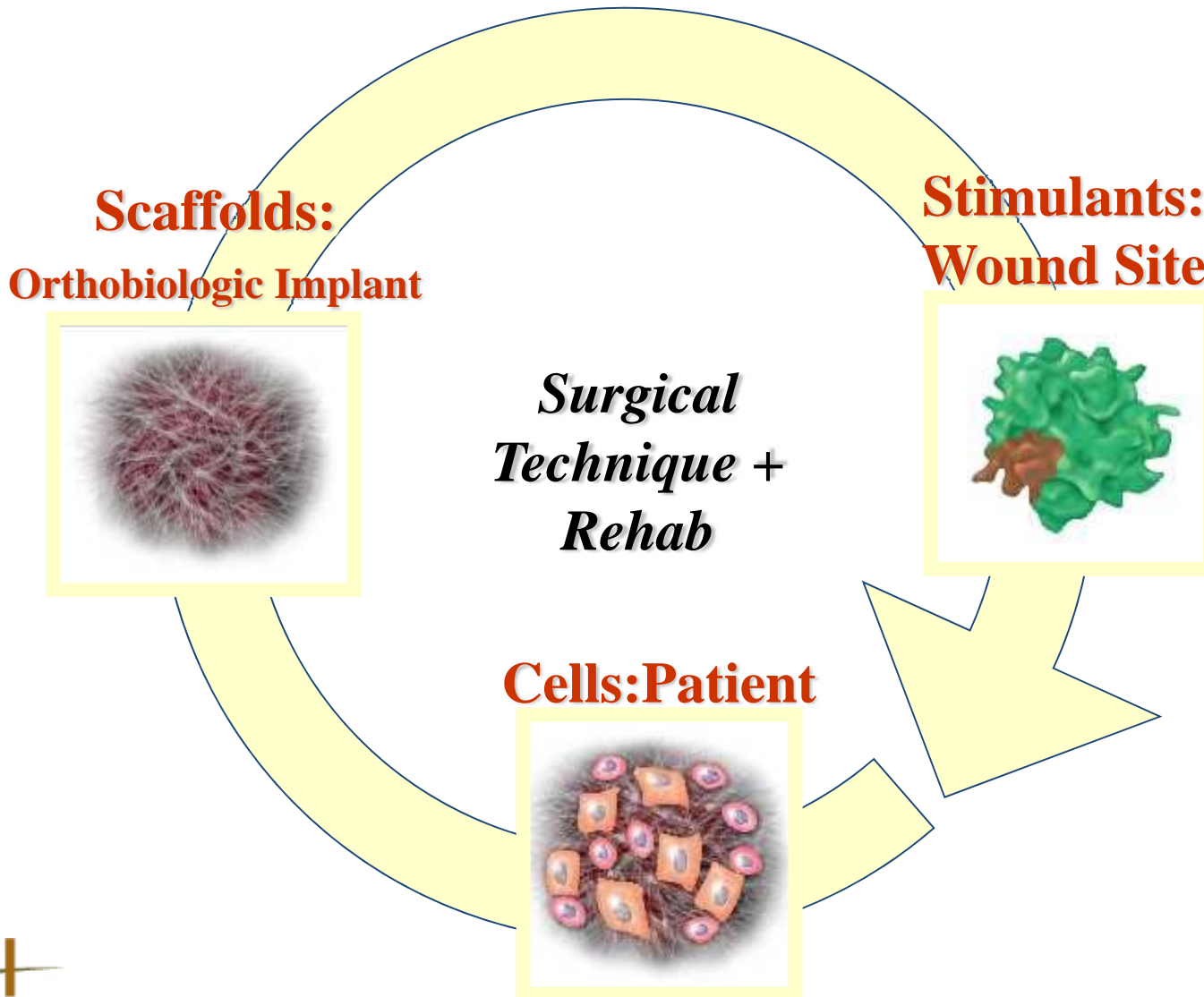


Biological Options

- Biologically Active Scaffolds
 - ACI, MACI
 - ChondroCelect
- Chondral Allografts
 - Juvenile – minced, expanded
- Osteochondral Grafts
 - Autogenous
 - Allogeneic

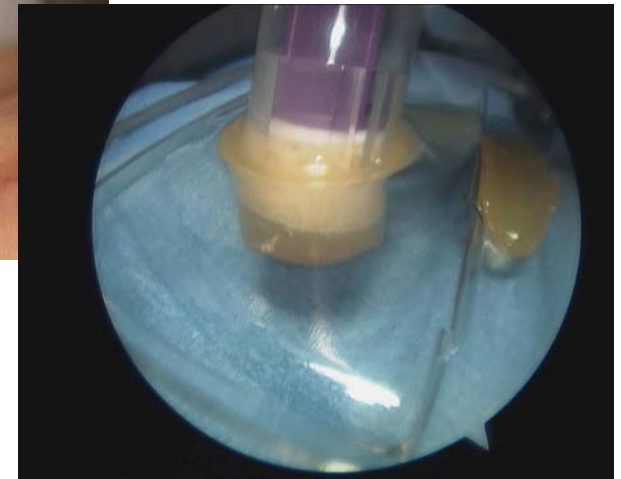
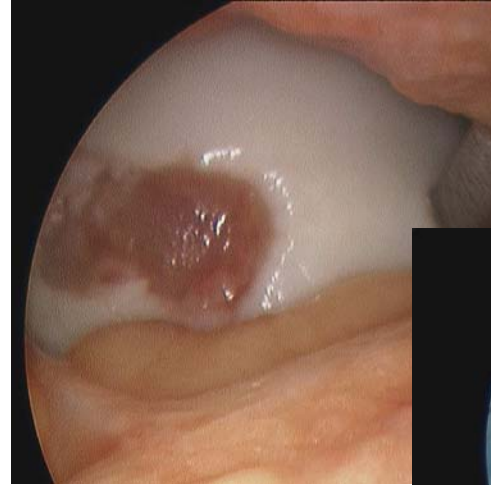


What is needed for a scaffold to be effective ?



Where does orthobiologic osteochondral scaffold fit in?

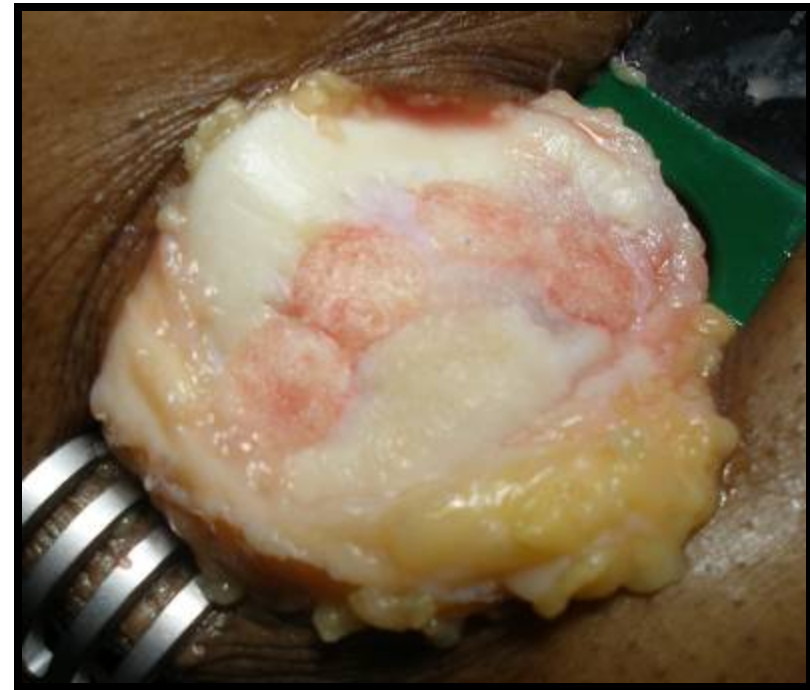
- Off the shelf alternative
- Substantially enhanced microfracture
- Less morbidity than mosaicplasty
- Fill donor sites mosaicplasty
- No allograft donor issues
- Smaller type defects
 - < appx 2cm



Orthobiologic Scaffold-

How it Works

- Keeps blood / cells where they need to be during healing
- Solid construct prevents formation of fibrous tissue
- Clean cut / press fit gives good host-implant contact
- Optimized pore size for chondrocyte and cellular migration
- Provides gradual loading as tissue matures

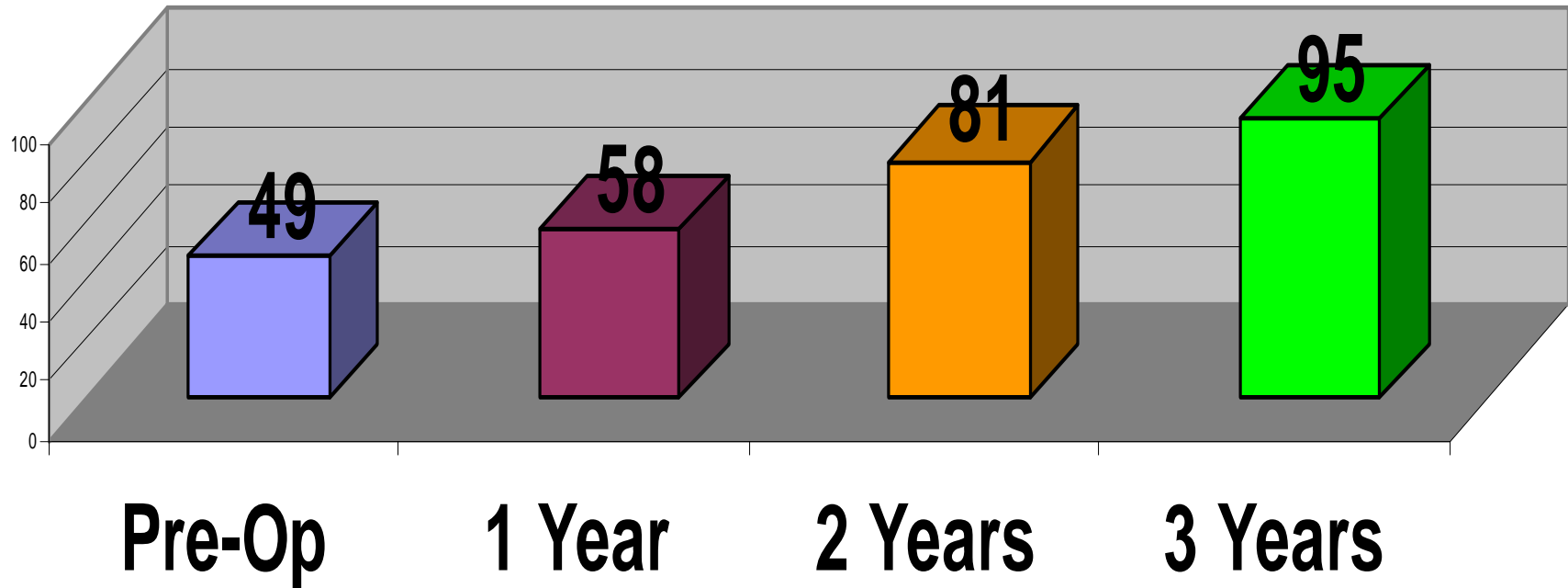


Davidson Scaffold Series

- 26 Sequential patients enrolled
- F-U > 2 years
- IRB approved
- Full thickness defects
- Lesions 7-19mm

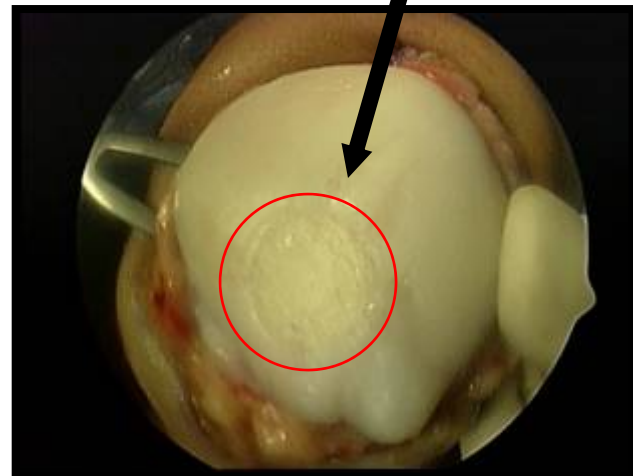


KOOS Mean Pain Score



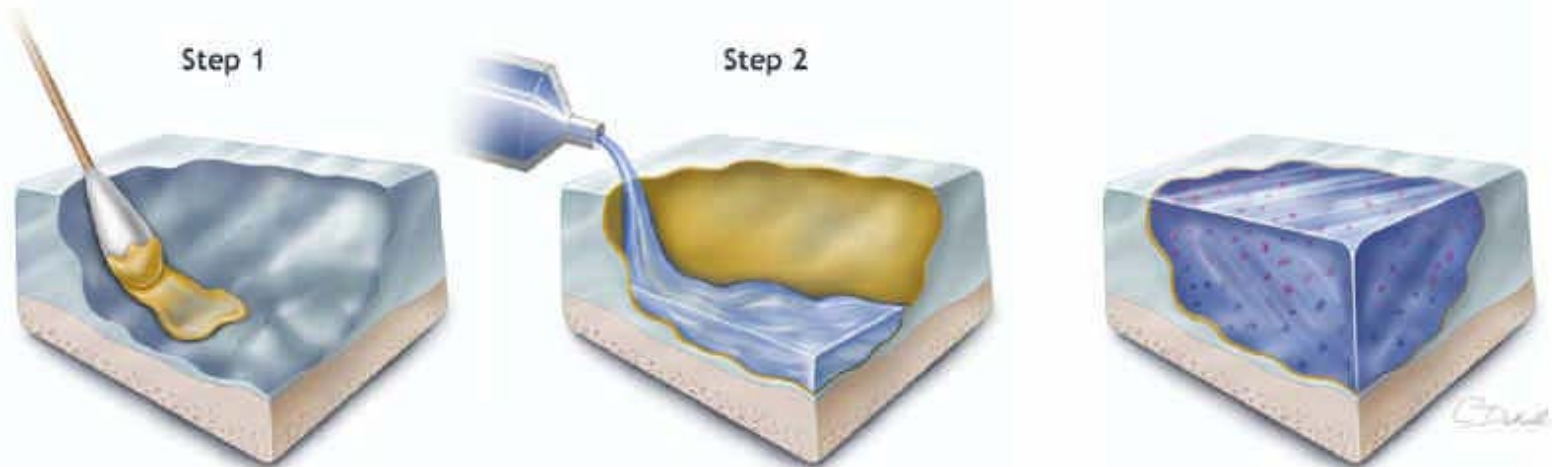
Prospective RCT Beginning, *to include NYU/HJD*

- RCT vs. Microfx
- Biphasic, Mineralized Collagen Scaffold
- FDA Phase I trial
- Appx 300 pts
- Appx 25 centers
- 3 year trial
- Clinical and Radiographic endpoints



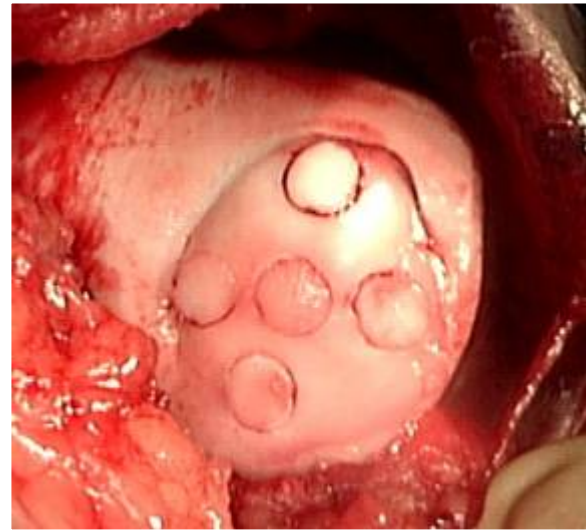
Another “Enhanced” MST

- Cartilix – Biomet
- ChonDux[®] Cartilage Repair System
- Combines a biological adhesive and photopolymerized hydrogel with microfracture



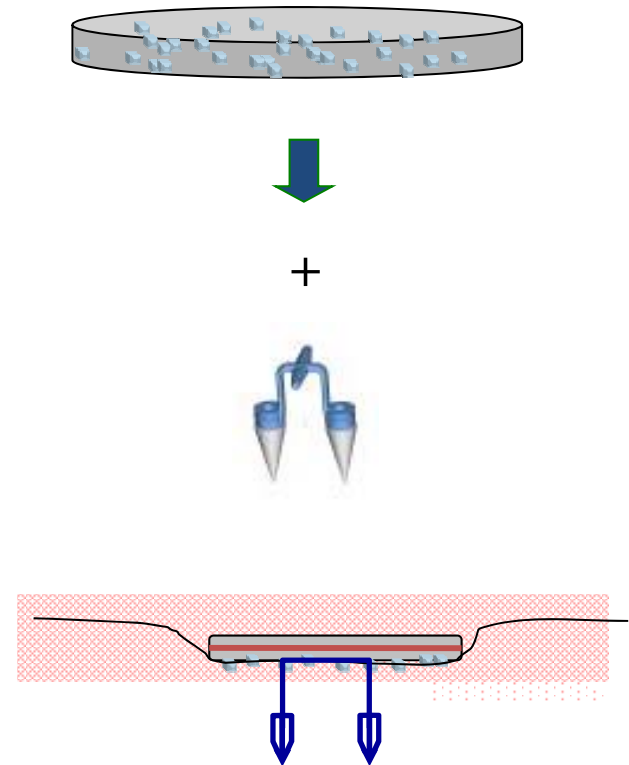
Osteochondral Grafts - Auto vs. Allo

- Autograft (OATS)
 - No donor needed
 - Limited availability
 - Small lesions only
 - Repair OCD
- Allograft (OCA)
 - Very effective
 - Young patients
 - Handle Bone loss
 - Larger lesions
 - Generally $> 2 \text{ cm}^2$
 - Limited Availability
 - Expensive



CAIS™ - Minced Cartilage Autograft (J&J)

- Minced Autologous cartilage
- Loaded onto Scaffold
- Fixated into cartilage defect
- Time 0 application
- Limited by endogenous cartilage, poor in some cases

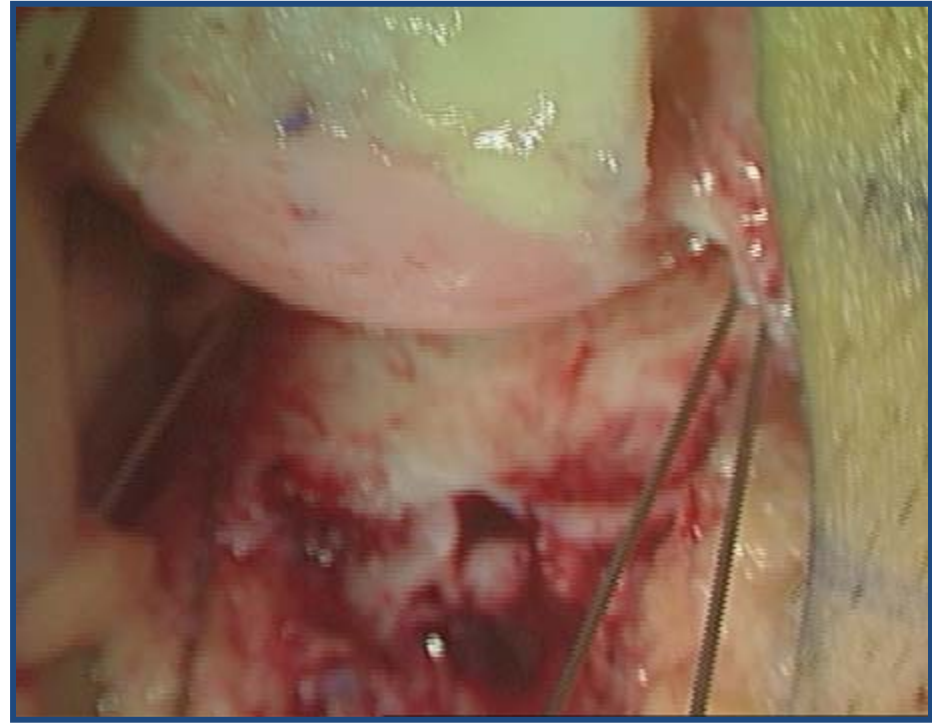
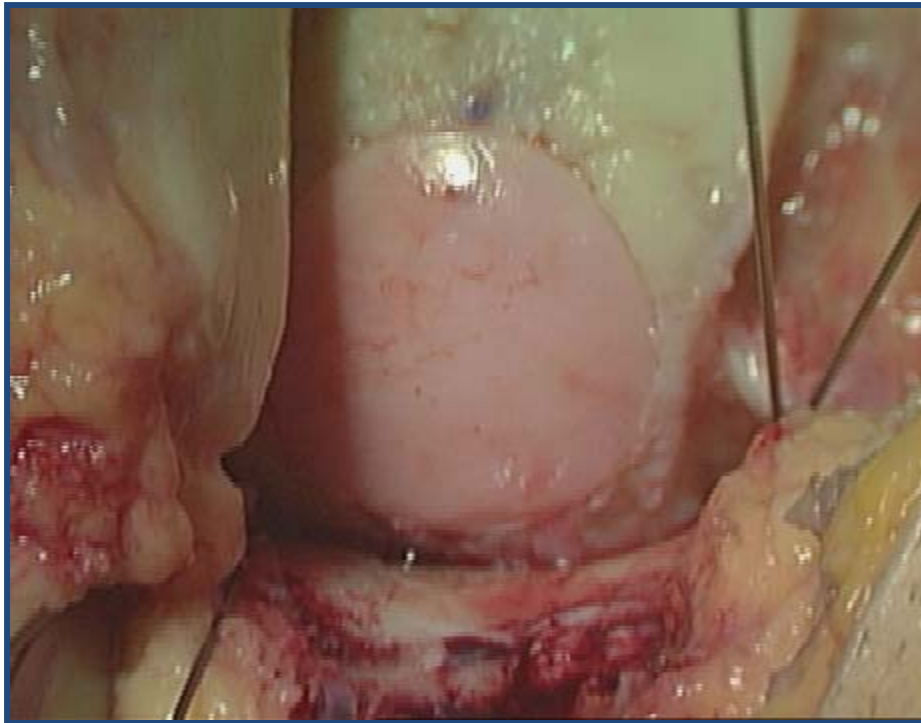


Allograft OATS – Relative Indications

- Larger Defects (>2 cm sq)
- Deeper defects
- Bone loss
- Patellofemoral
- Younger Patients
- OCD

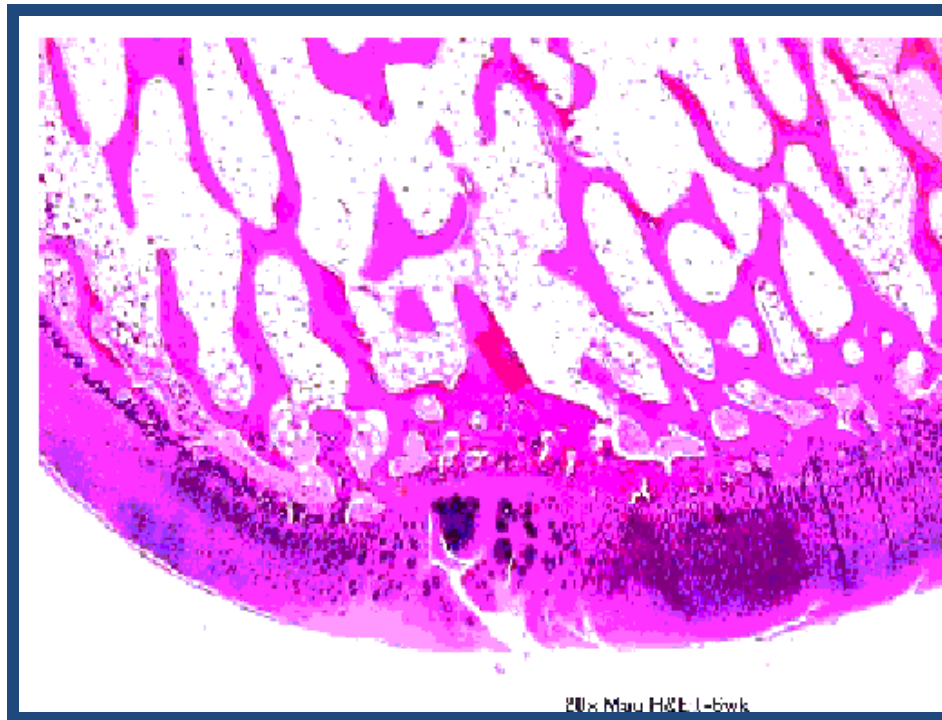


OA Graft - Procedure



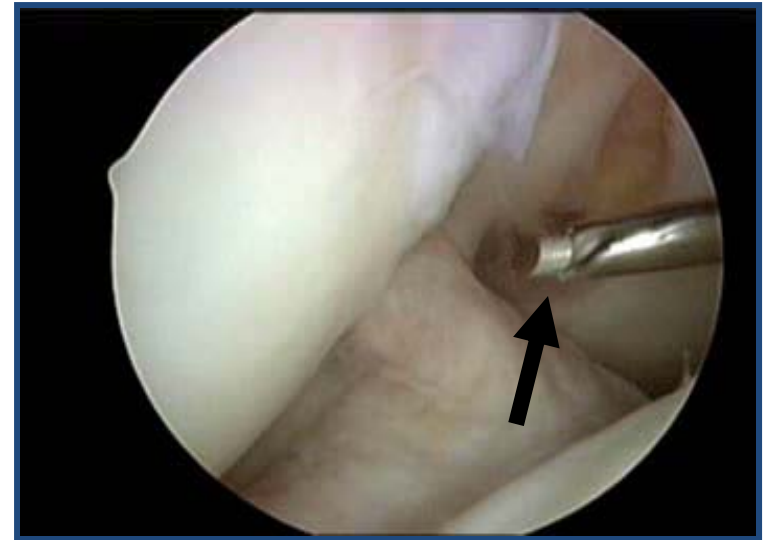
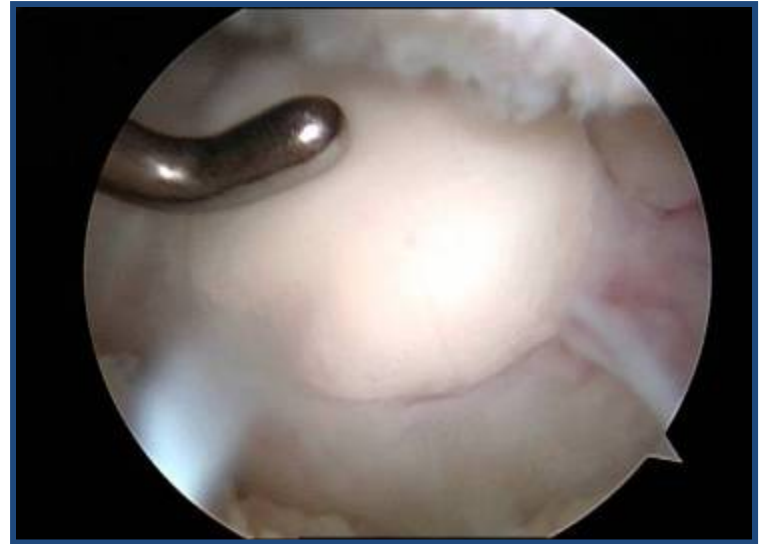
Two-Year Clinical, Histologic and Radiographic Outcomes of Distal Femoral Resurfacing with Fresh-Stored Osteoarticular Allografts

Davidson,PA; Rivenburgh, DW; Dawson,P; Rozin, R.
Am J Sports Med July 2007 Vol. 35 p. 1082-1091.



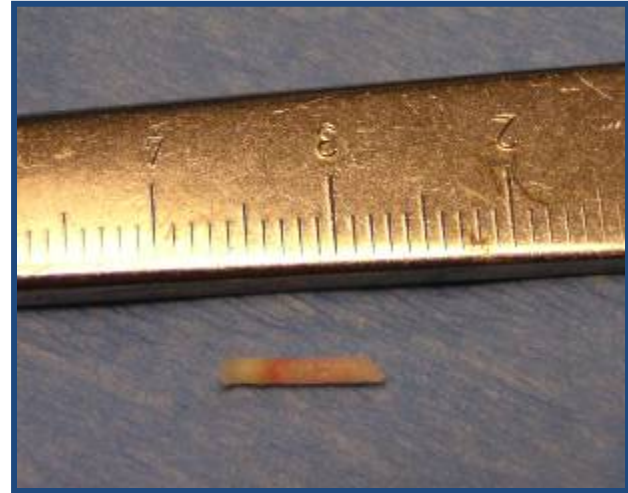
Materials and Methods

- Biopsy taken from both graft and native cartilage
- Jamshidi 1.2 mm needle used
- Biopsy included both cartilage and bone
- Patients volunteered for IRB approved study

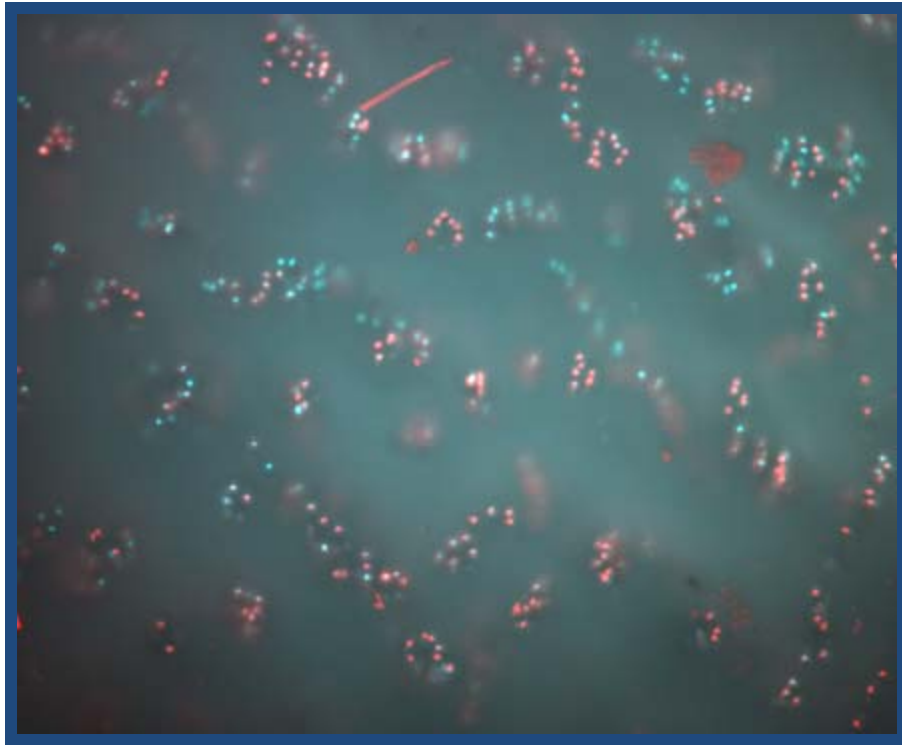


Demographics: Biopsy Study Group

- Primary diagnosis:
 - Trauma 4, Instability 2, OCD 4
- Mean recipient age at implant: 29 years
 - Range 21-50 years
- Mean donor age: 22 years
 - Range 15 - 45
- Mean days between asystole and implantation: **32** days
 - Range: 8-43 days
- Mean interval between implant and biopsy: 34 mos.
 - Range: 23-48 months
- Mean graft size: **6.15 cm²**
 - Range 2.54 - 17.2 cm²



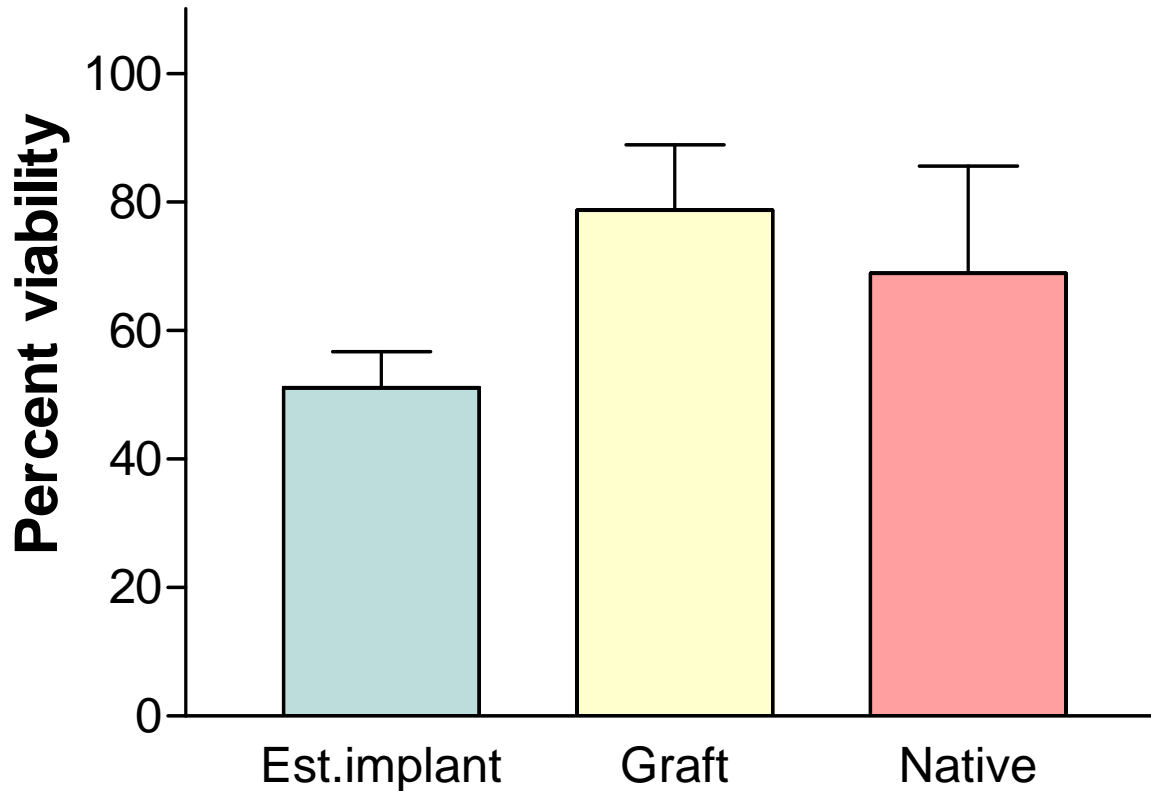
**Patient E.– Native cartilage
Approximately 67% Viable**



**Patient E. – Graft cartilage
Approximately 76% Viable**



Davidson OA Biopsy Study



Implants were performed at a mean of 32 days post-asystole

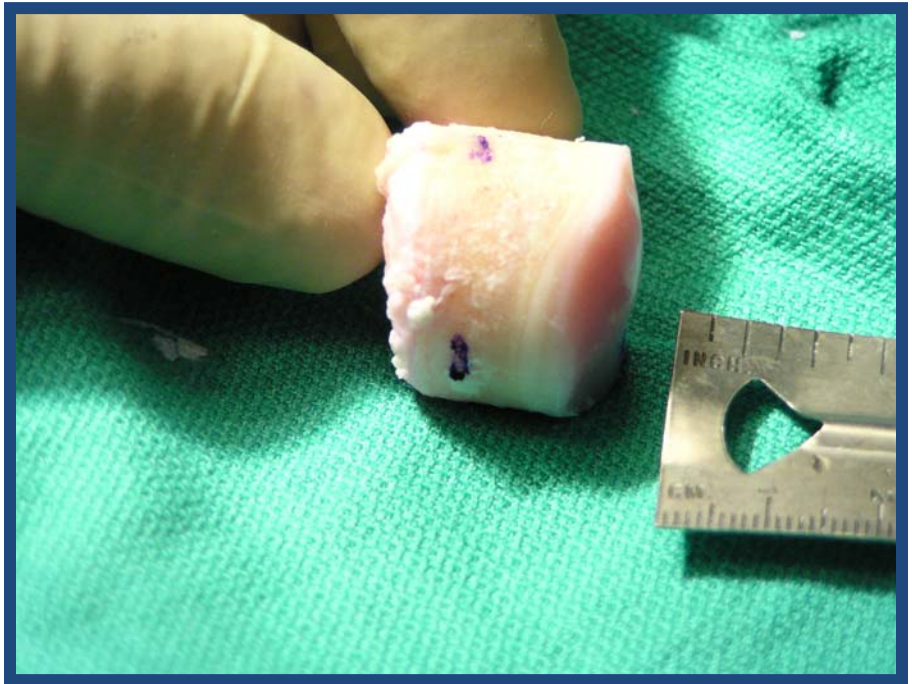
Biopsies were taken at a mean of 34 months post-implant

- Estimated original graft viability
- Graft viability at biopsy
- Native viability at biopsy



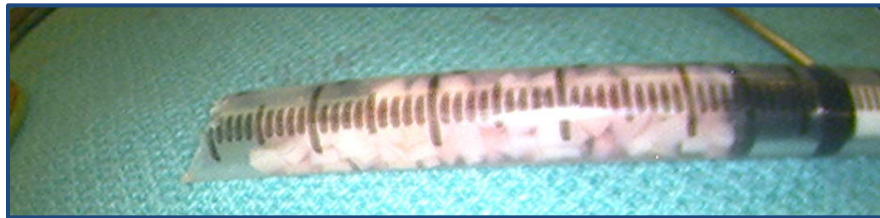
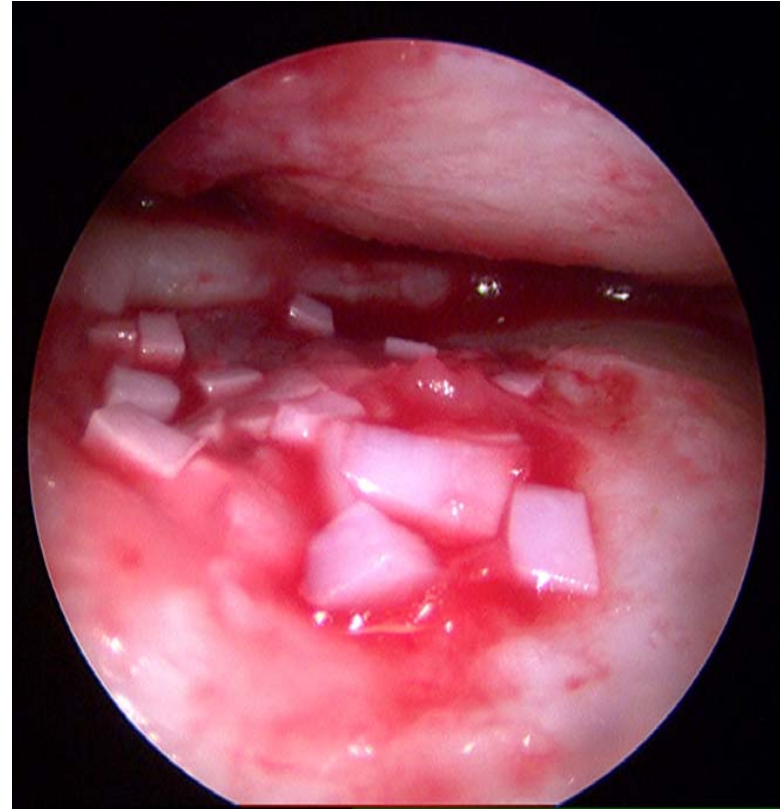
Results: IKDC Scores

- 0-100 point system
- Pre-op mean: 41 (range 27-62)
- Post-op mean: 88 (range 61-97)



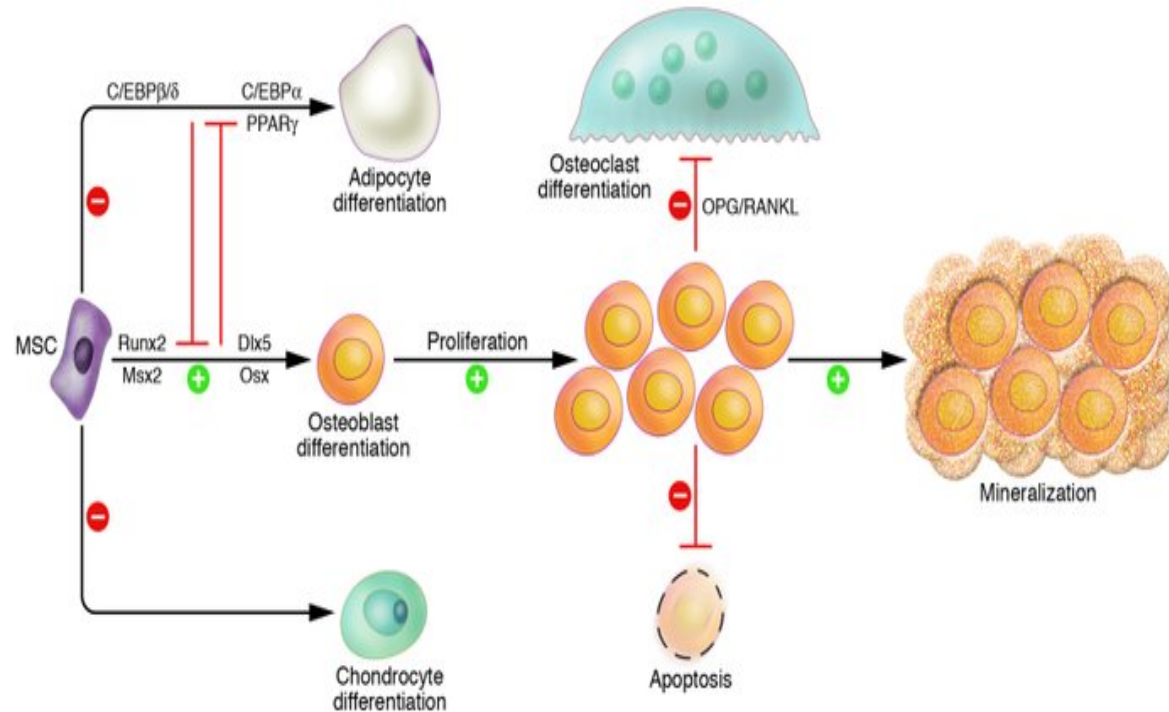
Juvenile Chondral Allograft

DeNovo NT® - Zimmer

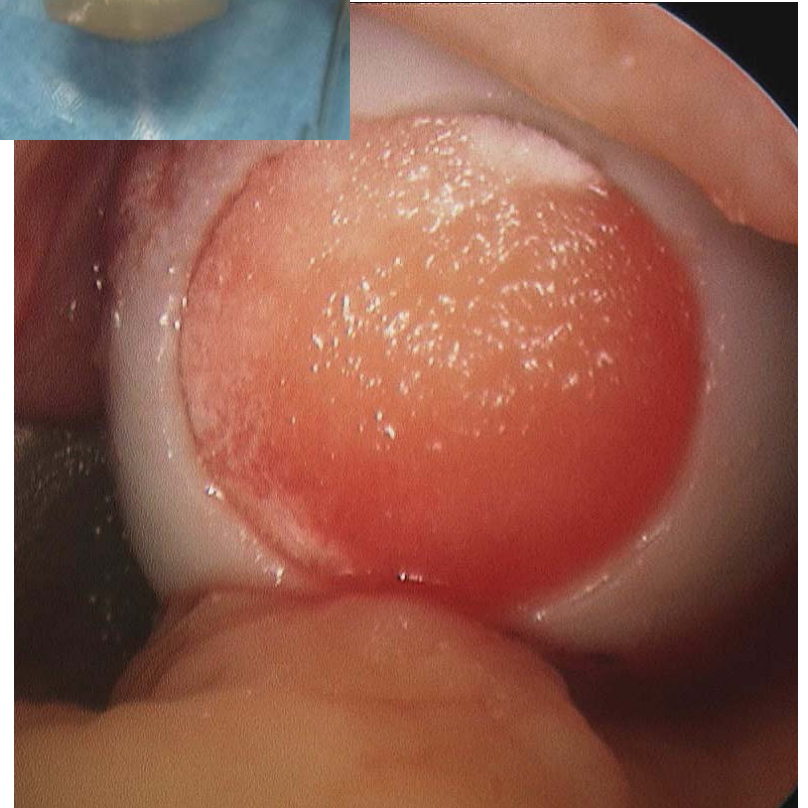


Cell Based Therapies

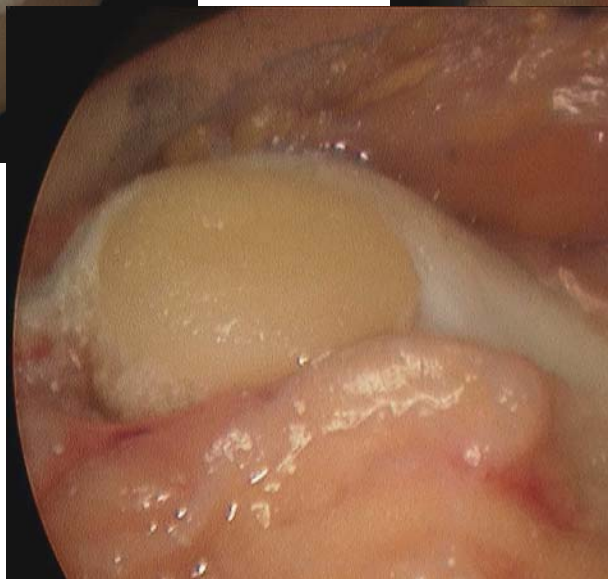
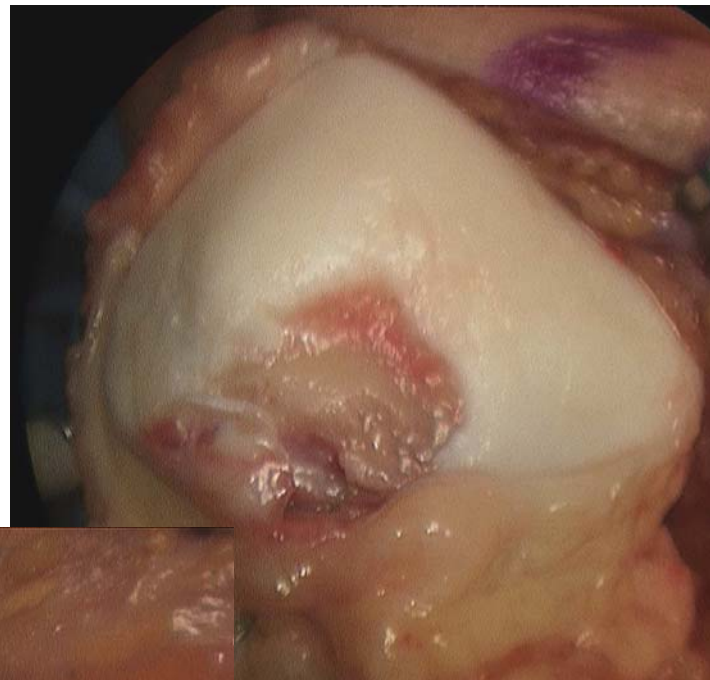
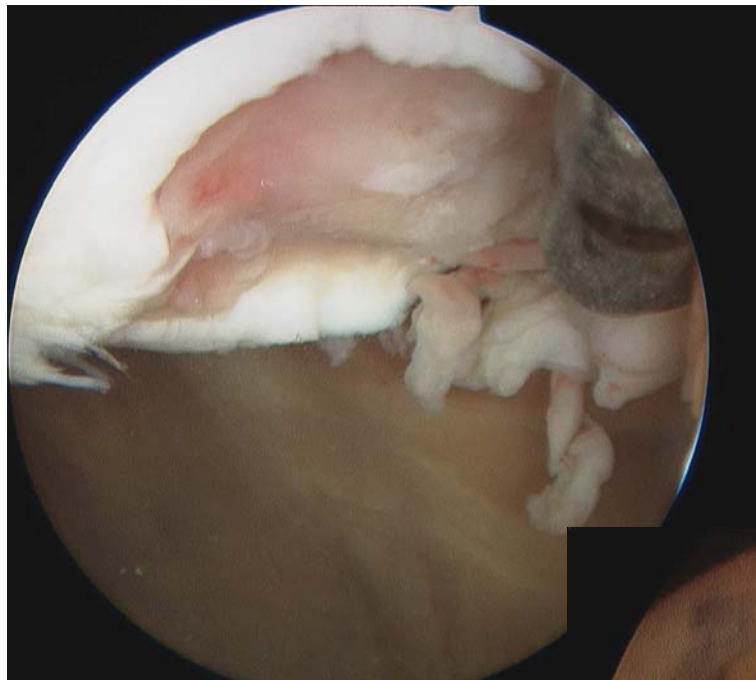
- Many still development stage
- ACI, MACI, ChondroCelect
- Combination Scaffolds with Cells
- Stem Cells
 - Auto and Allo
 - Adult and Juvenile
- Practically, introduction to US will be RCT vs. Microfracture



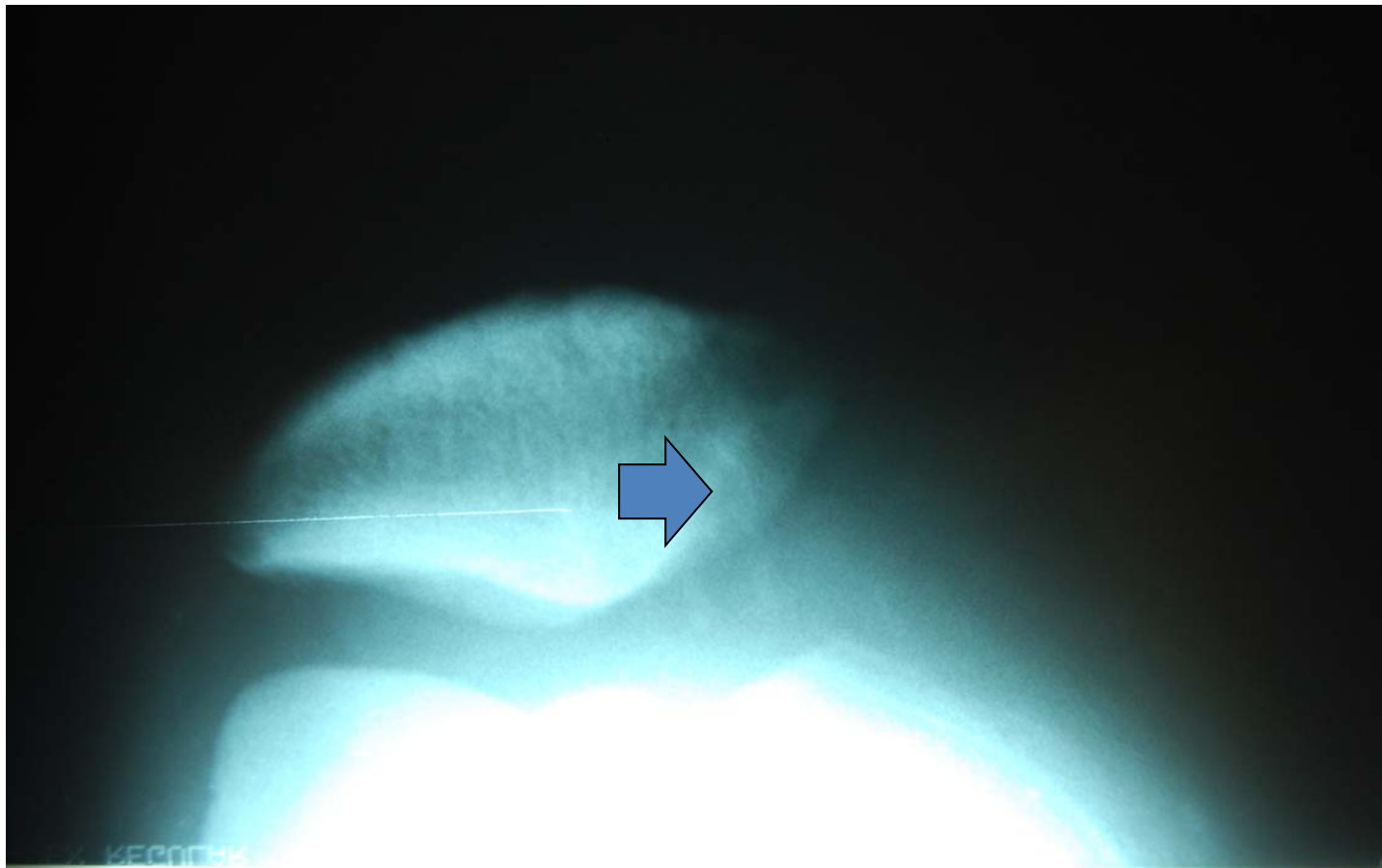
Case #1 – Hockey Player - LFC



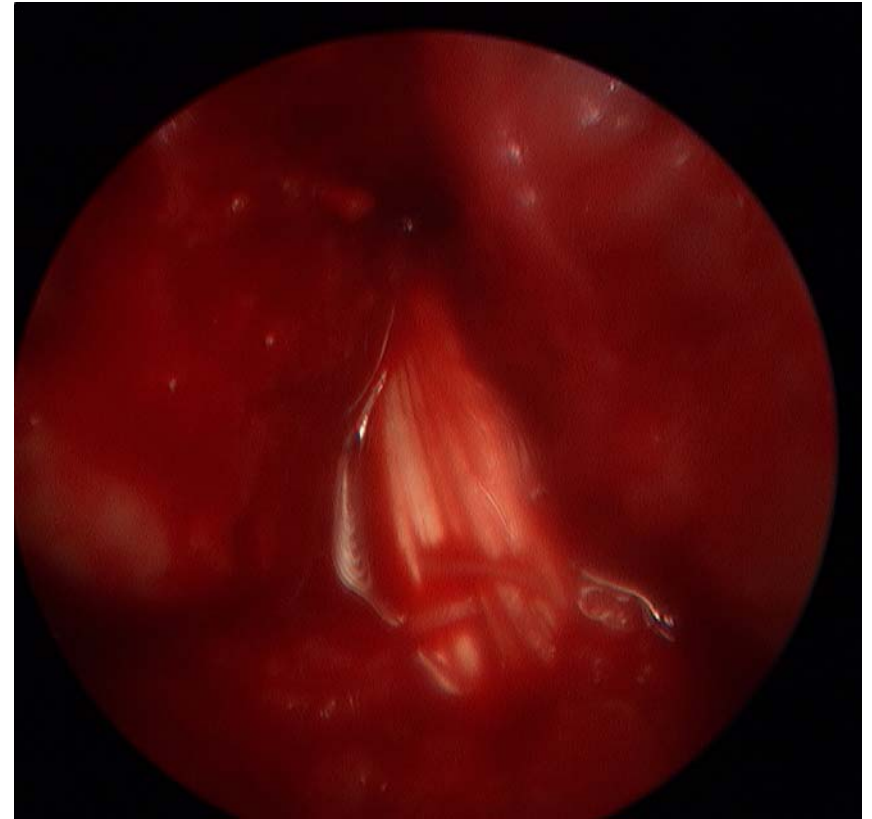
Case #1 Hockey Player - Patella



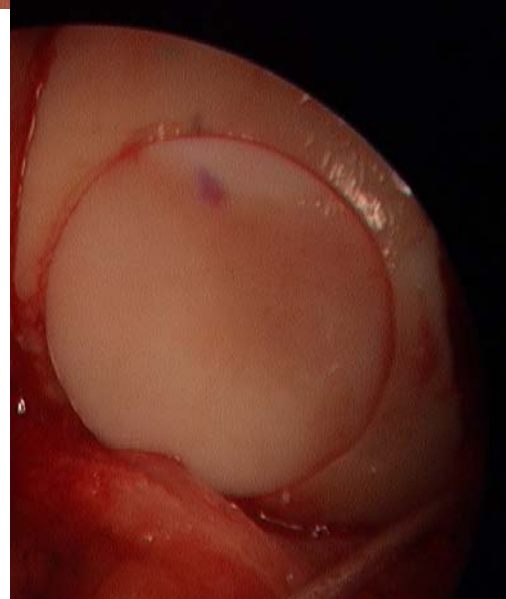
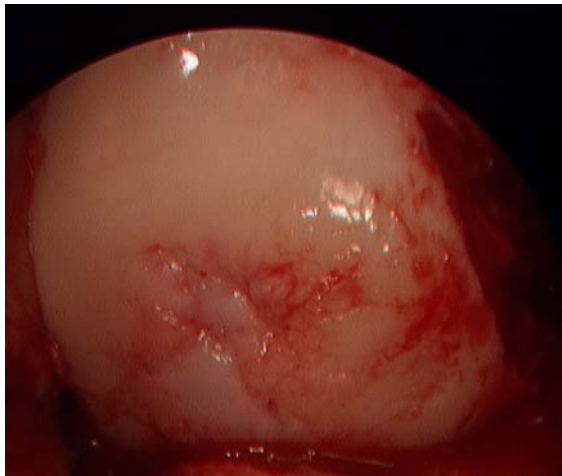
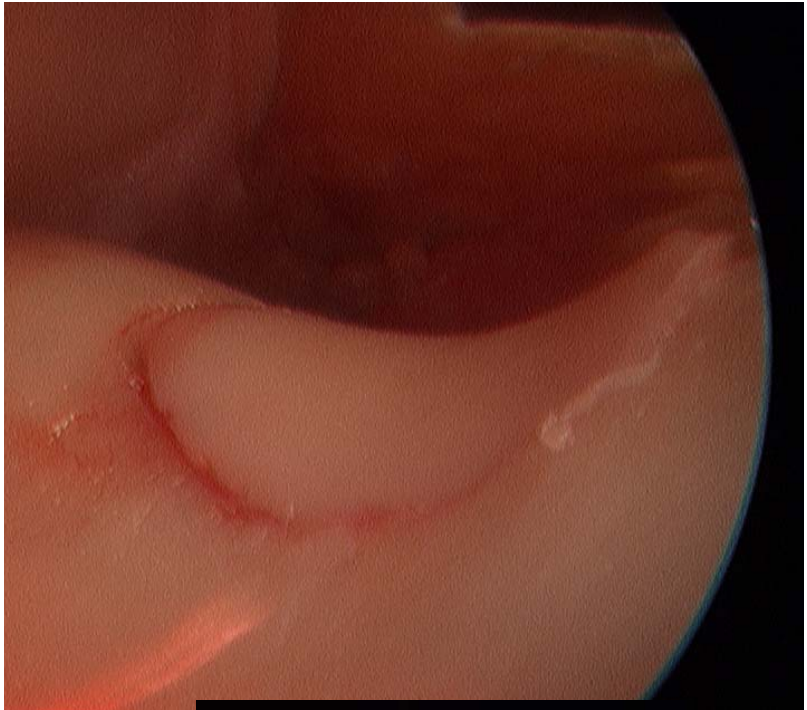
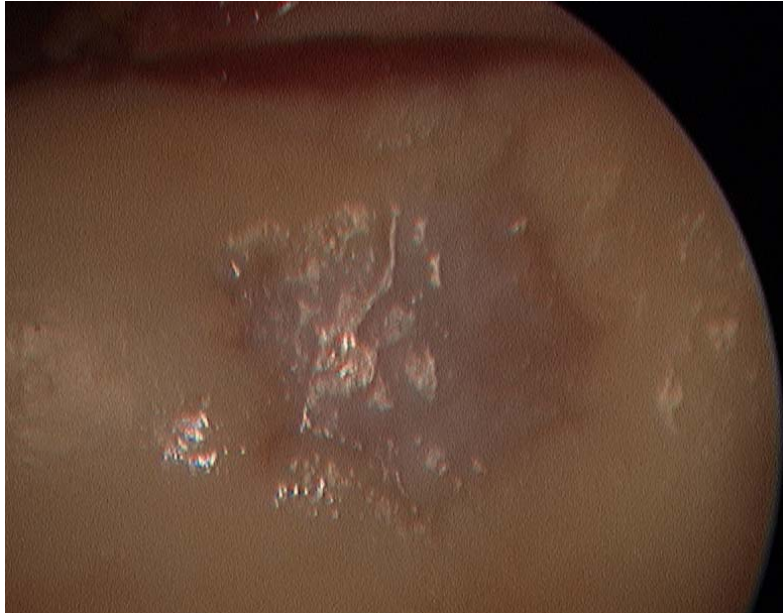
Case #1 Xrays- 6 mos post op



Case #2



Case #2



Summary

- Cartilage Restoration and Joint Resurfacing is really a continuum of options
- Must consider variable elements/parameters of each patient
- Must be familiar with ever expanding range of treatment options
- Complex decision making goes into each case, and does not necessarily follow a fixed algorithm
- Understanding spectrum of pathology and context of options will guide treatment path



Thank You

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