

# ARTICULAR CARTILAGE REPAIR

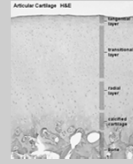
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## ARTICULAR CARTILAGE

### FUNCTIONS

- Both a cushion and slick surface for movement
- Allows bones to slide against each other in a joint
- Allows load bearing without permanent distortion
- Shock/Impact Absorbing



- Nourishment provided by synovial fluid, NOT underlying bone
  - Withdrawal of synovial fluid can lead to rapid cartilage deterioration



## OUTLINE

- Articular Cartilage Properties
- Injuries to Articular Cartilage
- Treatment of Articular Cartilage Lesions
  - Traditional Techniques
    - Marrow Stimulation
    - Cell-Based Techniques
    - Whole-Tissue Transplantation
  - Emerging Technologies
    - DeNovo
    - Biocartilage
    - CartiForm
  - PRP and Stem Cells



## ARTICULAR CARTILAGE LESIONS

- Limited intrinsic capacity for spontaneous healing
  - Avascular
  - Hypocellular
- Potential for considerable pain and disability if untreated
- Subsequent development of osteoarthritis



## ARTICULAR CARTILAGE

- Hyaline Cartilage
  - Caps the ends of bones that form synovial joints
  - Contains predominantly Type II Collagen
  - Thickness Varies in Different Joints
    - Up to 2-4mm in the knee joint



## ARTICULAR CARTILAGE LESIONS

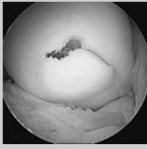

Must differentiate osteoarthritis versus focal articular cartilage lesion



## ARTICULAR CARTILAGE LESIONS


300,000 knee cartilage procedures in the US annually

- Insidious Onset
  - Osteochondritis Dissecans (OCD)
    - Dissection of the articular cartilage from underlying subchondral bone
    - No clear cause
    - Typically affects adolescents
    - Worse prognosis in adults
- Traumatic Onset (athletic activities)
  - ACL injuries
  - Patella dislocations
  - But, many are incidental and asymptomatic

## OPERATIVE TREATMENT



- Repair
  - OCD Lesions
    - bioabsorbable pins/screws

## ARTICULAR CARTILAGE LESIONS

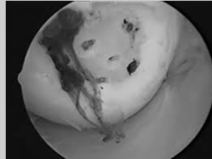

- Common association with structural abnormalities
  - Limb Malalignment
    - Excessive varus/valgus overloads compartment
    - Osteotomy
  - Ligamentous Instability
    - ACL
    - Patellar Instability
  - Meniscal Deficiency
    - Subtotal meniscectomy increases stresses 300%
    - Meniscal allograft transplantation

\*neglecting these abnormalities will lead to failure of any chondral repair procedure\*

## OPERATIVE TREATMENT

- Marrow Stimulation Techniques (MSTs)
  - Drilling
  - Abrasion Arthroplasty
- MICROFRACTURE
  - Relatively easy procedure
  - Single operation
  - Useful for smaller lesions (<2cm<sup>2</sup>)
  - Adjunct to ACL or MPFL surgery
  - 70-80% satisfaction and RTP
- BUT -
  - Type I Collagen (Fibrocartilage)
  - Results deteriorate over time





## NONOPERATIVE TREATMENT

- Physical
  - Weight Loss
  - Activity Modification
  - Therapy
  - Bracing
- Pharmacologic
  - NSAIDS
  - Glucosamine/Chondroitin
- Injections
  - Steroids
  - Viscosupplementation
- OCD - stable, juvenile lesions
  - Protected weight-bearing, immobilization



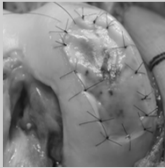

## MICROFRACTURE



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## OPERATIVE TREATMENT

- **Cartilage Restoration (Cell-Based Technology)**
  - **Autologous Chondrocyte Implantation (ACI)**
    - Articular cartilage harvest and re-implantation
    - Type II collagen
    - Useful for large lesions
    - Good long-term clinical results
    - BUT -
      - 2 stage operation
      - Very expensive \$\$\$\$\$\$\$
      - Technically demanding, time consuming
  - **MACI (Matrix-Assisted ACI)**
    - Cultured chondrocytes implanted onto a scaffold
    - Still two-stage operation
    - Not approved by FDA for use in United States





## OPERATIVE TREATMENT

Lesion location	Assessment	Lesion size	High demand	Low demand
Femoral condyle	1 Malalignment 2 Meniscal deficiency 3 Ligament insufficiency	≤2-3 cm	1 Microfracture* 2 Osteochondral autograft transplantation*	1 Microfracture* 2 Osteochondral autograft transplantation*
		>2-3 cm	1 Osteochondral allograft* 2 Autologous chondrocyte implantation* 3 Microfracture 4 Osteochondral autograft transplantation	1 Osteochondral allograft* 2 Autologous chondrocyte implantation*
Patello-femoral joint	1 Rehabilitation 2 Patellofemoral alignment	≤2-3 cm	1 Microfracture* 2 Autologous chondrocyte implantation	1 Autologous chondrocyte implantation* 2 Osteochondral autograft transplantation
		>2-3 cm	1 Microfracture* 2 Autologous chondrocyte implantation	1 Osteochondral allograft* 2 Autologous chondrocyte implantation*

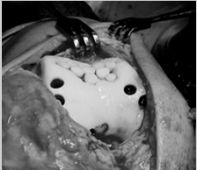

**Secondary treatment options**

1 Autologous chondrocyte implantation\*  
2 Osteochondral allograft\*  
3 Osteochondral autograft




## OPERATIVE TREATMENT

- **Cartilage Replacement (Whole-Tissue Transplantation)**
  - **Osteochondral Autograft Transplantation (OATS, Mosaicplasty)**
    - Tissue readily available
    - Inexpensive
    - BUT
      - Limited amount of available donor tissue
      - Donor site morbidity
      - Technically demanding procedure



## EMERGING TECHNOLOGIES

- **Why do we need new techniques??**
  - **Microfracture**
    - Type I collagen
    - Not useful for larger lesions
    - Limited long-term results
  - **OATS**
    - Donor site morbidity
    - Not useful for larger lesions
    - Technically demanding
  - **Osteochondral Allograft**
    - Limited tissue available
    - Even more technically demanding
    - Potential for allogenic disease transmission/rejection





## OPERATIVE TREATMENT

- **Cartilage Replacement (Whole-Tissue Transplantation)**
  - **Osteochondral Allograft Transplantation**
    - No Donor site morbidity
    - Useful for larger defects/even hemicondyle
    - Ability to precisely match contour of condyle
    - Eliminates "dead space" of mosaicplasty
    - Useful when bone loss is present
  - BUT
    - Expensive
    - Limited graft availability
    - Even more technically demanding
    - Risk of disease transmission
    - Risk of incomplete graft incorporation/rejection

## EMERGING TECHNOLOGIES



- **With all these emerging techniques**
  - Limited clinical data
  - Long-term effects unknown

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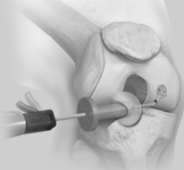

### EMERGING TECHNOLOGIES

- DeNovo (Zimmer)
  - Particulated Juvenile Cartilage
  - Higher density of chondrocytes
  - Type II Hyaline Cartilage
- BUT-
  - Expensive
  - Limited availability
  - Difficult to obtain insurance approval
  - Limited shelf-life (60 days)

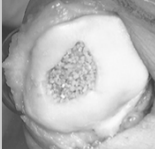

### EMERGING TECHNOLOGIES

- Biocartilage
  - Cheap
  - Readily available
  - Extended shelf life – 5 years
  - Can be performed arthroscopically
- BUT
  - **It's Cheap and Easy**
    - May not always be the right treatment
      - Bone loss
      - Uncontained lesion
      - Larger lesion

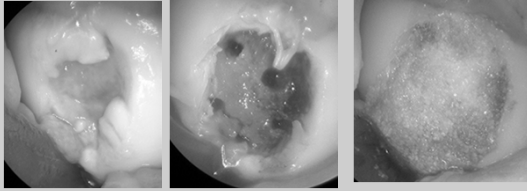




### EMERGING TECHNOLOGIES

- DeNovo
- Largest Study to date – 25 pts with 2 year f/u
  - Farr et al AJSM 2014
- Improved function
- MRI shows normal cartilage by 2 years
- BUT
  - Mixture of Type II > Type I collagen

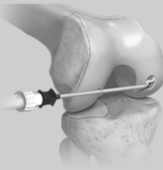





### CASE





### EMERGING TECHNOLOGIES

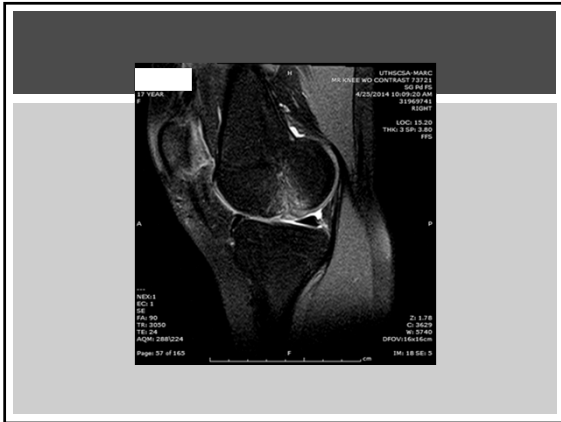
- BioCartilage (Arthrex)
  - Micronized articular cartilage allograft
    - Mixed with PRP or Stem Cells
  - Cartilage extracellular matrix (type II collagen, proteoglycans, growth factors)
    - No chondrocytes
  - Microfracture Augmentation

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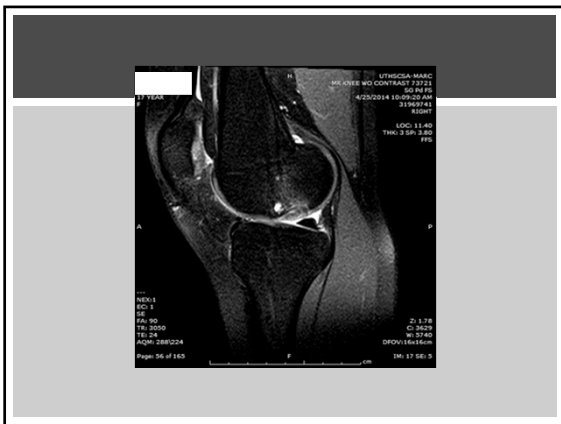


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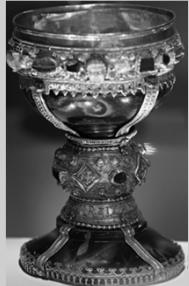



### PRP VS. STEM CELLS

- PRP - Platelet Rich Plasma**
  - Platelets - release growth factors
  - Ability to attract MSCs, Macrophages, Fibroblasts
  - Stimulate Cell Proliferation
- Stem Cells**
  - Proliferative Potential
  - Multipotentiality
    - Ability to differentiate and mature into a different cell lines
      - Osteocyte
      - Chondrocyte
      - Adipocyte
  - Peripheral Blood Stem Cells
  - Mesenchymal Stem Cells
    - Bone marrow
    - Synovial tissue
    - Periosteum
    - Fat

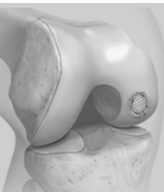






### PRP & STEM CELLS


### EMERGING TECHNOLOGIES

- Cartiform (Arthrex)**
  - Porous osteochondral allograft
    - AKA skin graft, MACI
  - Viable chondrocytes, growth factors
  - Preserves layers or normal articular cartilage
  - Easy to cut, contour
  - 2 year shelf-life
    - Can be frozen with 70% chondrocyte viability
  - BUT -
    - Expensive
    - Limited clinical data
    - Open procedure

### PRP & STEM CELLS

- No evidence that PRP or Stem Cells injections alone are useful for focal articular cartilage lesions
- Can be useful as an adjunct to cartilage restoration
  - Study shows Stem cells as effective as ACI (Saw et al 2012)
  - Study shows Stem Cells added to microfracture outperform microfracture alone (Nejadnik et al 2010)
- Neither proven to reverse or slow degenerative joint disease
- Public perception versus Evidence-based Reality
  - Expensive burden to patient
  - Not covered by insurance companies
  - Legal aspects/FDA approval



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## CONCLUSIONS

1. Articular cartilage lesions can lead to disability and osteoarthritis if untreated
2. Traditional repair/regenerative techniques are performed based on size of the lesion and activity level of the patient
3. When used appropriately, traditional techniques have yielded good results
4. Emerging Techniques for cartilage restoration have shown early encouraging results, but no long-term data
5. PRP and Stem Cells can be useful adjuncts to cartilage restoration, but are not indicated for isolated use



## THANK YOU



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