Cartilage Repair
Overview & Treatment Options

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SPORTS MEDICINE
Knee Anatomy

Terminology
- medial - lateral
- anterior - posterior
- proximal - distal
- varus - valgus
- acute - chronic
Knee Anatomy

- Bones
  - femur
  - tibia
  - patella
Knee Anatomy

- **Cartilage**
  - **articular**
    - type 2 collagen (hyaline)
    - patella-femoral
    - tibial-femoral
  - **meniscal**
    - type 1 collagen
    - medial
    - lateral
Knee Anatomy

- Tendons
  - quadriceps tendon
  - patellar tendon
  - popliteal tendon
  - hamstring tendons
  - ITB
Knee Anatomy

- Ligaments
  - ACL
  - PCL
  - MCL
  - LCL
  - PLC
  - MPFL
Knee Anatomy

- Lining
  - capsule
  - synovium
1st Sports Doc

- Galen 100 Ad
  - Athletes over indulge...live shorter and get arthritis
Articular Cartilage Injuries: The Problem

Cartilage is a troublesome thing and once destroyed, it is not repaired.

W. Hunter 1743
Articular Cartilage Injuries

- Impact of knee injuries
  - Adverse biochemical response within joint
  - Progressive cartilage damage (chondropenia)
  - Leads to DJD (arthritis)
Articular Cartilage Injuries: The Big Question

- Can our treatment positively affect the natural history?
Articular Cartilage Injuries: Treatment Challenges

- Active pts with high (? unreasonable) expectations
- Unique structure & function of hyaline cartilage
- Complex load bearing, fluid filled, mobile joint environment
- Variable causes
  - Trauma
  - OCD
  - Early DJD
Articular Cartilage Injuries: Treatment Challenges

- Disordered healing response within joint to disease process
- Unpredictable symptom response
- Poorly understood national history
- Lack of long term studies for different cartilage repair options
Articular Cartilage Injuries: Ideal Treatment Goals

- Feasible, practical, arthroscopic, single-stage procedure
- Anatomic restoration of hyaline cartilage
- Minimal morbidity w/o burning bridges for possible future procedures
- Cost effective & reimbursable
- Proven short & long-term success
  - Pain relief, functional recovery
  - Biological stable
  - Altered natural history (avoidance of early DJD)
Articular Cartilage Injuries: Current Treatment Considerations

- How to make precise & timely diagnosis?
- Who needs surgery & when?
- Which lesions should be treated?
- Which procedures?
- What are optimal methods for outcome analysis?
- What future treatment advances?
Outline

**Topic of discussion**
- *Full thickness* articular cartilage defects
- Treatment considerations
- Present treatment algorithm
Articular Cartilage Defects

- **Cause**
  - Trauma
  - Degenerative
  - Infectious

- **Limited healing capacity**
  - Fibrocartilage w/ marrow stimulation

- **Unfavorable natural history**
  - DJD

- **Associated symptoms**
  - Pain
  - Mechanical
Articular Cartilage Defects: Evaluation

**ARTHROSCOPIC GRADING**

- **Outerbridge classification**

  - **GRADE I**
  - **GRADE II**
  - **GRADE III**
  - **GRADE IV**

  ![Images of cartilage defects](image-url)
Articular Cartilage Defects

Treatment options:

- **Non-surgical**
  - Rx, PT, Bracing, Injections, Wt Loss, Activity modification, Nutritional supplementation

- **Surgical**
  - Arthroscopic chondroplasty/debridement, Microfracture, OATS (Auto vs Allo), ACI, Unloading osteotomy, prosthetic resurfacing, prosthetic arthroplasty, (Joint fusion)
Surgery Options

Arthroscopic Debridement (Chondroplasty)

- **Mechanism**
  - remove loose cartilage leaving stable rim
  - ↓ mechanical abrasion

- **Mechanical (shaver, biter)**
  - better than lavage *JBJS-B*, 1996
  - 52% g/e results @ 33 mo *CORR*, 1990
  - mechanical symptom relief
  - temporary OA relief ~ 60%

- **Thermal**
  - CAUTION: Chondrocyte necrosis
Surgery Options

Microfracture

- **Technique**
  - stabilize lesion rim
  - penetrate subchondral bone
  - stimulate bleeding response
  - protected WB, CPM
  - metaplastic transformation to fibrocartilage (type 1)

- **Results**
    - 200 young active patients
    - 75% sx improvement, 20% unchanged, & 5% worse @ 3-5 yrs
Osteochondral Transfer (OATS)

- **Mechanism**
  - fill defect with plugs of articular cartilage and bone from non-articular donor site
  - Autograft, allograft

- **Terminology**
  - Mosaicplasty, OATS, CORR

- **Results for Autograft**
    - 227 patients; 57 @ 3 yr f/u
    - 91% g/e results
    - 12 second-look biopsy
    - hyaline cartilage plug, fibrocartilage b/t grafts
Arthrex Autograft OATS
Surgery Options

Allograft OATS

- ↑ chondrocyte death over time
- Fresh
  - Within 7 days
  - Potential disease transmission
- Refrigerated (4°C) OA graft
  - 14-28 day “window”
  - Possible Immunogenic reaction with allograft bone
  - Prefer young donor with matched topography
Arthrex Allograft OATS
Arthrex Allograft OATS

- Results
  - Gen’l good for functional outcome scores
  - Deteriorate with time (>5 years)
  - 88% graft incorporation (McCulloch et al. AJSM, 2007)
Surgery Options

ACI

(\textit{Genzyme/Carticel})

- Goals
  - Grow articular cartilage within defect
- Technique
  - Articular cartilage biopsy
  - Chondrocyte culture/cell multiplication
  - Surgical implantation
Autologous Chondrocyte Implantation (ACI)

- Biopsy
  - intercondylar notch, proximal/superior to sulcus terminalis
  - 5x10mm, 200-300 mg
- *Genzyme* lab (Boston)
- Minimum 6 week processing
• 2-stage expansion of autologous chondrocytes in laboratory
• Re-insertion
  • Chondrocyte suspension under periosteal cover
    → Formation of hyaline-like cartilage
• Indications:
  – Size: >2-3 cm², no upper limit
  – Location: any
  – Age: < 55
  – Osteochondral lesions < 6-8 mm depth
  – Second line treatment
ACI

Defect Preparation
15 blade, ring curet
Stable shoulders, remove calcified cartilage
Defect Coverage
Periosteum or Collagen membrane (off label)
Interrupted sutures and fibrin glue
ACI

Chondrocyte Injection
3-12M cells injected
ACI

Versatility

Simple  Complex  Salvage
Efficacious treatment of full thickness chondral and osteochondral defects represents one of the most demanding challenges in the practice of orthopedics.

László Hangody
Patient Characteristics:
Candidates for Cartilage Restoration

- Full-thickness (Grade III/IV) defect or OCD
- Symptomatic patient
  - WB pain/swelling/mechanical
- Failed conservative tx
- Cooperative & educated patient
- Absence of inflammatory (RA) & infectious conditions
- Absence of (or correctable) articular co-morbidities
  - Mal-alignment, instability, meniscus deficiency
Defect Characteristics
Considerations for Cartilage Restoration

- Defect size
- Defect location
- Number of defects
- Contained versus uncontained
- Chondral versus osteochondral
Defect Characteristics

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Articular co-morbidities

- Malalignment $\rightarrow$ Osteotomy
  - HTO, DFO, TTO
- Instability $\rightarrow$ Ligament reconstruction
- Meniscal deficiency $\rightarrow$ Transplant
Cartilage Restoration
Treatment Algorithm

- Defect Size
- Defect Location
- Defect Depth
Cartilage Restoration Treatment Algorithm

**Defect Size**

Small lesion (<1 cm): single plug OATS, MicroFx

Large lesion (>2 cm): ACI, allograft OATS, MicroFx

Multiple lesions: ACI, MicroFx

In between: dealer’s choice
Cartilage Restoration
Treatment Algorithm

Defect Location

Femoral condyle: any technique
Trochlea: ACI, MicroFx
Patella: ACI (with unloading AMZ)
Cartilage Restoration Treatment Algorithm

Defect Depth

Surface lesion: any technique
< 6-8mm deep: any technique
> 6-8mm deep: osteochondral graft (OATS) or sandwich ACI
Complex/Salvage Conditions

- Articular & Meniscus Cartilage deficiency
- Bipolar lesions
- Multiple compartment lesions
- Mal-alignment
- Failed cartilage repair
- Early OA in young pt
“Biologic Arthroplasty”

- Meniscus Transplant
- Allograft OATS
- Unloading HTO
Lesion-Specific Prosthetic Transfer

- **ARTHROSURFACE**
  - Tibial-femoral
  - Patella-femoral

**UniCAP™ Femoral Component**
- Cobalt Chrome articulating surface
- Titanium plasma spray undercoating
- Bead-blasted Titanium taper post
- Morse taper interlock

**UniCAP™ Tibial Component**
- Inlay cemented UHMWPE
- Meniscus preserving
- Implantation technique similar to ACL reconstruction
Patient Specific Resurfacing Arthroplasty

- Kinamed PFA
Patient Specific Resurfacing Arthroplasty

- **CONFORMIS**
  - Uni
  - Duo
  - (Total)