Articular Cartilage Injuries

"Preserving the lawn"

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What is Arthritis?

Loss of Cartilage
Diffuse Arthritis

Localized Arthritis
Localized Arthritis

THE PROBLEM

- Articular cartilage does NOT heal
- Avascular
- Absence of undifferentiated cells
- Low metabolic activity

Partial Thickness

Full Thickness
FUNCTION

- Distribute Load
- Minimize Peak Stress
- Provide a Low Friction Surface

NOT THE SAME

- To date, normal articular cartilage is impossible to duplicate
  - Thin, but stiff to compression
  - Exceptional ability to distribute load
  - Normal synovial joint function for 80 years or more
  - Lowest coefficient of friction (very smooth)
INCIDENCE

• 5-10%
  – Grade IV (full or near full thickness defect)

• Most are asymptomatic

• Natural history is largely unknown

“AVOID LINEAR REASONING”

“The Incidental Defect”
OPERATIVE INDICATIONS

DEFORMITY

INSTABILITY

ARTICULAR/MENISCAL DEFICIENCY

SYMPTOMS OF CHONDRAL INJURY

• Pain

• Mechanical Symptoms

• Effusion
**DIAGNOSIS**

**LISTEN**

**GOALS**

- Improve symptoms and function
- Prevent or slow progression of focal chondral injury to end stage arthritis
- Restore articular cartilage surface
  - Match biochemical and biomechanical properties of normal hyaline cartilage
REALISM

- Bad prognostic features
  - Age > 50
  - Degenerative process
    - Symptoms > 12 months
  - Bipolar lesions
  - Other pathology not addressed

- These are not solutions to arthritis

CURRENT OPTIONS

<table>
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<th>ACI</th>
<th>ALLO</th>
<th>OCG</th>
<th>MST</th>
<th>D&amp;L</th>
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<tbody>
<tr>
<td>1%</td>
<td>1%</td>
<td>8%</td>
<td>20%</td>
<td>70%</td>
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- Cost
- Technique
- Ad. Events

- Temporizing
- Smaller Defects Rev 2-3 yrs
- Small defects Persistent pain
- Availability Disease Cost
- Disease Cost
PATIENT VARIABLES

– Age
– Demand level
– Response to prior tx
– Presence of cofactors
  • Malalignment
  • Ligament insufficiency
  • Meniscal deficiency
– Patient preference

DEFECT VARIABLES

– Size
– Depth
– Location
– Number
– Geometry
– Containment
...THERE IS OFTEN OVERLAP...

DEBRIDEMENT AND LAVAGE
DEBRIDEMENT

• TECHNIQUE
  – Shaver
    • Create well-shouldered margins
  – Radiofrequency (heat probe)

• RESULTS
  – Hubbard 1996: reduced mechanical symptoms at 5 yrs
  – Voloshin 2007: good clinical results without progression at 2 yrs
  – Uribe 2002: less effusions and recurrences RF compared to shaver

DEBRIDEMENT

• WHY DOES IT WORK?
  – ARCHITECTURE

• “POT HOLE AND TIRE”
  – IMPORTANCE OF SHOULDERS
DEBRIDEMENT

• PROS
  – Single-stage / arthroscopic
  – Cost-effective
  – Walk out of the hospital
  – Simple rehab

• CONS
  – No resurfacing of the lesion (no cartilage re-growth)
  – Longer F/U shows results are usually short-lived
    • ~30-50% improvement in symptoms for only 1-2 yrs (Hangody 2003)
    • Inadequate for athletic / active patients (Levy 1996)

DEBRIDEMENT

• SUMMARY:
  – Small (<2cm) lesions with primarily mechanical symptoms
  – Older, low demand patients
MICROFRACTURE

• Penetrate subchondral bone plate
  – Mesenchymal Stem Cells (MSC) within blood grow into fibrocartilage (not hyaline cartilage!)
  – Use for low demand larger lesions
  – High demand smaller lesions

• Rehab is critical
  – Protected WB 6-8 weeks
  – CPM 6-8 weeks
MARROW STIMULATION

- 80% moderate demand patients = significant improvement up to 7 yrs out

  • Steadman et al Arthroscopy 2003:
    - Greater improvement in pts <35 yrs old
    - Max benefit seen in first 2-3 yrs post-op

- High impact athletes don’t do as well

  • Mithoefer et al AJSM 2006:
    - Only 44% of 32 high impact athletes returned to sport at same or equal level as prior to injury
    - Predictors of return to sport:
      » age < 40
      » lesion size <2 cm²
      » preop symptoms < 12 months

30% failure rate at 2 years

OSTEOCHONDRAL AUTOGRRAFT
OSTEOCHONDRAL AUTOGRAFT

- Many names for the same thing:
  - “OATS”
  - mosaicplasty

- Osteochondral plugs taken from “non-essential” areas and implanted into defect
  - Major limitation is donor site
  - All-in-one surgery
  - Cannot reconstruct lesions > 4cm²

OSTEOCHONDRAL AUTOGRAFT

WHEN TO USE:
- SIZE: 2-4cm²
- TECHNIQUE: small # of larger plugs > Mosaic
- AGE: Younger, Active, Femoral Condyle Lesion
- Avoid impaction damage, don’t leave proud
AUTOLOGOUS CHONDROCYTE IMPLANTATION (ACI)

ACI

• 2 Surgery Procedure:
  – Arthroscopic biopsy from nonessential region (cells grown in lab)
  – Cultured cells injected into prepared lesion
ACI

STAGE I: BIOPSY
Assess Lesion
Take Biopsy
Cells for Transport

ACI

STAGE II: PREPARATION OF THE LESION
ACI

STAGE II: INJECTION OF CELLS

- Indications
  - 2 - 10 cm²
  - < 6-8 mm bone loss
  - Trochlea and patella
    - Often combined with lateral release/ligament repair
    - Osteotomy
  - “Failed primary” treatment
    - Debridement
    - Microfracture
ACI

• REHAB IS CRITICAL

• Three Main Components (progress over 1 year period)
  1. Protected/Progressive Weightbearing
  2. Restoration of Range of Motion
  3. Enhancement of Muscle Control and Strengthening

ACI: Results

– G/E results in 80-90% of patient

– Most patients able to go back to all activities
OSTEOCHONDRAL ALLOGRAFT

• LIVE cadaver graft
  – A true cartilage transplant
  – Larger, deeper lesions possible

• Minimum size > 2cm²
• No real max size since no donor site morbidity
OSTEOCHONDRAL ALLOGRAFT

• Indications
  – Medium to large defects
  – Bone loss (i.e. OCD, post-traumatic, non-contained)
  – Low or high demand patients
  – First or second line treatment based on size
  – Salvage procedure (can be done for failures of any of the previously discussed procedures)

• Contraindications
  – OA
  – Deformity

OSTEOCHONDRAL ALLOGRAFT

• Disadvantages
  – Two surgery procedure
  – Procurement / availability
  – Sizing issues / technically demanding
  – Open procedure
  – Cartilage viability declines with time
OSTEOCHONDRAL ALLOGRAFT

• Disadvantages:
  – Removes bone (burns bridges)
  – Expensive
  – Disease transmission
    • Can’t sterilize like other allografts
    • Risk of viral transmission low (1 in 2 million)
  – Immune response / Delayed healing

OSTEOCHONDRAL ALLOGRAFT

• TECHNIQUE:
  • Arthroscopy, assess the lesion
  • Size the lesion
  • Prepare recipient site
  • Measure the defect
  • Fashion graft
  • Press-fit (flush or slightly recessed)
OSTEOCHONDRAL ALLOGRAFT

Results

\(>75\%\) good to excellent results for up to 10 yrs

- Toronto Group & 84% at 7.5 yrs
- Garrett & 84% at 4.5 yrs
- UCSD group & 91% at 1-18 yrs
- Emmerson & 70% at 7.7 yrs
OSTEOCHONDRAL ALLOGRAFT

When to Use:
- Size: Larger, Deeper, Uncontained
- Technique: <28 days...ideally within 14 days, minimal SC bone
- Who: OCD, post-traumatic, failed prior tx
- Technically challenging proper surgical technique is critical

LESION
- Femoral Condyle
  - Malalignment
  - Meniscal Deficiency
  - Ligament Insufficiency
- Patellofemoral
  - Staged (1st) Combined
  - Patellofemoral Alignment

SIZE
- <2-3cm²
- >2-3cm²

Low Demand
- MFX ++
- OATS ++
- ACI ++
- OC ALLO +

High Demand
- MFX ++
- OATS ++
- ACI ++
- OC ALLO +

1st
- MFX ++
- OATS ++
- ACI ++
- OC ALLO +

2nd
- MFX ++
- OATS ++
- ACI ++
- OC ALLO +
FUTURE DIRECTIONS

• Single stage ACI
  – CAIS system (Mitek): minced autogenous cartilage placed on scaffold
  – DeNovo® NT (Zimmer): minced allogeneic juvenile cartilage placed with fibrin glue
• Gene therapy
  – Chondrocytes modified to overexpress growth factors
• Synthetics
  – Articular Cartilage Repair (Depuy): vicryl non-woven mesh
  – Salucartilage (Solumedica): Polyvinyl hydrogel
• Scaffolds

Thank You!
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