Case: LZ

- 33 yo female
  - ICU Nurse
  - Left medial knee pain with ADLs
  - Recurrent Effusions
**Definition**

What is “biologic joint reconstruction”?

- Correction of all co-existing articular abnormalities:
  - Cartilage defects
  - Malalignment
  - Ligamentous instability
  - Meniscal deficiency

- Cartilage Repair

- Concurrent Procedures

**Indications**

- Full-thickness chondral defect (Grade III/IV)
- Symptomatic patient (wt.bearing pain/swelling)
- Matching symptoms (med. defect – med. pain)
- Failed conservative management (PT, Inj., wt.)
- Failed or lack of surgical alternatives (i.e. TTO, TKR)

**Contra-indications**

- OA
- Inflammatory conditions
- Smoker
- BMI >30 (>35)
- Unreasonable expectations
**Treatment Algorithm**

**Cartilage Repair Options**

**Surgical Options**
- Debridement
- Microfracture
- Osteochondral Autograft
- Osteochondral Allograft
- Preserved Osteochondral Allograft
- Morcellized Cartilage Allograft
- ACI

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**2011 Estimated Number of Cartilage Related Procedures**

- Debridement and microfracture, 521,000
- Osteochondral Autograft, 9,060
- ACI, 1,200
- Osteochondral Allograft, 1,980
- Other, 12,240
Treatment algorithm

- Defect Location (Tibiofemoral vs Patellofemoral)
- Defect Size (Small vs Large)
- Subchondral Bone (Intact vs abnormal)

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

László Hangody
Biologic Joint Restoration Center @ ALLEGHENY HEALTH NETWORK

Size matters!

Defect size influences outcomes!

- Small defects (<2-4cm²)
  - Anything works, so why do big bad things?
    - Debridement
    - OAT
    - Microfracture
    - Microfracture Plus
    - Particulated cartilage allograft

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Size matters!

Defect size influences outcomes!

- Small and large defects different animals
- Apparent cut-off between 2 and 4 cm²
  - Knutsen: MFx outcomes worse >4 cm²
  - Asik, Gudas, Mithoefer: MFx worse >2 cm²
  - Reasonable to group small (<2-4 cm²) and large (>2-4 cm²) defects

Size matters!

Defect size influences outcomes!

- Large defects (>2-4 cm²)
  - Small things don’t work well
  - Important to normalize environment!
    - ACI
    - Osteochondral allograft
Bone affects cartilage repair

Consider the following when choosing technique:

- **Bone loss** (OCD, OC fracture)
  
  For ACI: Bone grafting for >8-10mm

- **Marrow edema**
  
  Decreased outcomes with severe edema for ACI

- **Subchondral cysts**
  
  Graft large cysts with autograft bone

- **Intralesional osteophyte**
  
  Remove with high speed bur

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**Treatment Algorithm**

<table>
<thead>
<tr>
<th>Small defects (&lt;2-4cm²)</th>
<th>Large defects (&gt;2-4cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MFX</td>
<td>ACI</td>
</tr>
<tr>
<td>+ no donor site morbidity</td>
<td>+ no size limitation</td>
</tr>
<tr>
<td>+ arthroscopic procedure</td>
<td>+ hyaline cartilage</td>
</tr>
<tr>
<td>+ complex rehab (CPM)</td>
<td>+ primary bone healing</td>
</tr>
<tr>
<td>+ and TDWB 6-8w</td>
<td>+ quicker recovery</td>
</tr>
<tr>
<td>+ prolonged RTP 6-9</td>
<td>+ return-to-play</td>
</tr>
<tr>
<td>+ months</td>
<td>+ than microfracture</td>
</tr>
<tr>
<td>+ technically difficult</td>
<td>+ (mini-open)</td>
</tr>
<tr>
<td>+ donor site morbidity</td>
<td>+ quicker recovery</td>
</tr>
<tr>
<td>+ with multiple plugs</td>
<td>+ return-to-play</td>
</tr>
<tr>
<td></td>
<td>+ than microfracture</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>OAT</th>
<th>OA graft</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ no size limitation</td>
<td>+ no size limitation</td>
</tr>
<tr>
<td>+ hyaline cartilage</td>
<td>+ hyaline cartilage</td>
</tr>
<tr>
<td>+ arthroscopy</td>
<td>+ arthroscopy</td>
</tr>
<tr>
<td>+ high re-op rate</td>
<td>+ very complex rehab (CPM)</td>
</tr>
<tr>
<td>+ TDWB 6-8w</td>
<td>+ (mini-open)</td>
</tr>
<tr>
<td>+ prolonged RTP 12-18</td>
<td>+ bone healing</td>
</tr>
<tr>
<td>+ months</td>
<td>+ cost</td>
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<tr>
<td>+ cost</td>
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</tbody>
</table>

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**Articular Co-Morbidities**

- Correction of all co-existing articular abnormalities:
  - Cartilage defects
  - Malalignment
  - Ligamentous instability
  - Meniscal deficiency
Articular Co-Morbidities

Malalignment is independent risk factor for the development (RR 2x) and progression (RR 4x) of knee OA

When do I correct?
WB line outside the tibial spines (approx. 3 degrees)

Bode et al. 2013. 1.5deg varus
ACI (58%) vs ACI + HTO (89%)

Articular Co-Morbidities

Meniscal deficiency increases contact stresses 4x

When do I transplant?
Always laterally!
Medially if young or not valgus

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Treatment Options
Treatment Options

Surgical Management
- Debridement
- Microfracture
- Osteochondral Autograft
- Osteochondral Allograft
- Particulated Cartilage Allograft
- ACI

Osteochondral Allograft

Indications:
• Large lesions (>3-4cm²)
• Good for deeper osteochondral defects
• Can use for AVN

Mechanism:
• Transfer of mature hyaline cartilage
• Replaces entire osteochondral unit
• Primary bone-to-bone healing

Technique:
• Size-matched fresh allograft hemi-condyle
• Limited arthrotomy
• Over-ream to 6-8mm depth (bleeding bone)
Osteochondral Allograft

Technique:
- Take graft from corresponding area on donor condyle
- Measure depth and cut graft accordingly
- Press-fit graft; supplemental fixation as needed

Complications:
- Subchondral collapse
- Makes a surface defect into an osteochondral lesion
# Results

<table>
<thead>
<tr>
<th>Study</th>
<th>Study Design</th>
<th>Follow-up interval</th>
<th>Patient population</th>
<th>Treatment groups</th>
<th>Outcomes</th>
<th>References</th>
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</thead>
<tbody>
<tr>
<td>Gortz</td>
<td>Case series</td>
<td>4.5 years</td>
<td>43 patients</td>
<td>N/A</td>
<td>88% good and excellent results</td>
<td>[1]</td>
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<tr>
<td>Gross</td>
<td>Case series</td>
<td>10 years</td>
<td>127 patients</td>
<td>N/A</td>
<td>Survivorship of 95% at 5 years, 80-85% at 10 years, and 65-74% at 15 years</td>
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<tr>
<td>Levy</td>
<td>Case series</td>
<td>2.4 to 10 yrs (ave. 13.5)</td>
<td>122 patients</td>
<td>N/A</td>
<td>Survivorship of 82% at 10 years, 74% at 15 years, and 66% at 20 years</td>
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<tr>
<td>Krych</td>
<td>Case series</td>
<td>2.5 years</td>
<td>43 patients</td>
<td>N/A</td>
<td>79% full return to pre-injury level of activity, 88% limited return to sport possible</td>
<td>[4]</td>
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<tr>
<td>Gortz</td>
<td>Case series</td>
<td>5.58 years</td>
<td>22 patients</td>
<td>N/A</td>
<td>89% graft survival rate</td>
<td>[5]</td>
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<tr>
<td>Murphy</td>
<td>Case series</td>
<td>8.4 years</td>
<td>39 patients</td>
<td>N/A</td>
<td>90% survivorship at 10 years</td>
<td>[6]</td>
</tr>
</tbody>
</table>

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## ACI

**Indications:**
- Large lesions (>3-4 cm²)
- No correlation of outcome with size
- Any location (patella and tibia off-label)

**Mechanism:**
- 2-stage ex vivo expansion of autologous chondrocytes
- Chondrocyte suspension under (membrane) cover
- Formation of hyaline-like cartilage
ACI

Technique (Biopsy):
• Biopsy
• Intercondylar notch, prox./sup. to sulcus terminalis
• 5x10mm, 200-300 mg

ACI

• Approach by defect location and other procedures
• Outline defect; include all soft/fissured cartilage
• Create stable vertical shoulders
• Template defect with glove paper or aluminum foil

ACI

• Place sized membrane on defect, trim
• Secure with multiple interrupted 6-0 sutures
• Waterproof suture-line with fibrin glue
• Inject cells and close injection site
ACI

Complications:
- Delamination
- Periosteal hypertrophy (20-50%)

Results against MFx
- Van Assche (RCT)
  - No difference at 2 years (2.4cm²)
- Kon (Cohort)
  - Similar at 2y, MACI better at 5y (2.4cm²)
- Saris (RCT)
  - Histology, outcomes at 3y, at 5y only for more acute defects (<3y) (2.7cm²)
- Basad (RCT)
  - MACI better at 2y (>4cm²)
- Kon (RCT)
  - MACI better at 2y (4.8cm²)

Case: LZ
- 33 yo female
  - ICU Nurse
  - Left medial knee pain with ADLs
  - Recurrent Effusions
Where’s the development?

Dead people parts....
- Particulated cartilage allograft
- Preserved osteochondral allograft
- Micronized cartilage ECM (MFX plus)
- Perforated cartilage allograft
- Allogeneic stem cells

Allograft tissue not FDA regulated
Gets us new products, but be careful...

Questions?