Management of Patellofemoral Cartilage Lesions

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Royalties
- Arthrex T3 AMZ guide
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- Advanced Bionautics
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- DePuy/Mitek (JNJ company)
- Eli Lilly
- MedShape
- NuTech
- Genzyme
- Dora
- RTI
- Regenerative Biologics
- SMR
- Sanofi (Prior Genzyme)
- Regeneration Technologies
- Zimmer

Pain

- Pain is the central perception of a peripheral noxious stimulation
- Being subjective, it is often difficult to assign a single cause
- Dehabilitation often is a major component: not an operative solution
Majority of PF Pain Patients Respond to Nonoperative Management

Treat with “Core to Floor” comprehensive therapy

Assigning “Pain” to Chondrosis: Diagnosis of Exclusion as Articular Cartilage is aneurl
Pain therefore originates from:

- Bone (Local or Remote, subchondral BML, referred hip)
- Soft tissue (Synovium, Capsule, Tendons and Ligaments)
- Nerves (Local or Remote, e.g., saphenous, neuroma)

PF Chondrosis is Common: Most are Asymptomatic

Table 1. Epidemiology of Patellofemoral Cartilage Lesions

- Patellofemoral chondral lesions were seen in 68% of more than 26,000 patients who underwent knee arthroscopy (Widuchowski Knee 2007)
- High grade focal chondral defects are reported to occur between 11-30% in patients undergoing routine knee arthroscopy (Hoen AAOS 2004)
- 11-23% of these lesions involved the patella and 6-15% involved the trochlea (Bajaj)
- In one series looking at professionals athletes, the prevalence of patellofemoral defects was 15%, with 64% of these lesions located in the patella (Flanagan Med Sci Sports Exer 2010)
- The rate of patellofemoral chondral or osteochondral injury following acute dislocation event ranges from 39-95% (Nomura E Arthroscopy 2003)
- Regarding traumatic dislocations events, patients with normal alignment had a 5.5 times elevated risk of articular surface damage versus patients with abnormal alignment (e.g. patella alta, trochlea dysplasia) given the energy of the index event (Stankski CL AAOS 1996). Despite this fact, patients with abnormal anatomy and chronic patella instability still have a chondral injury rate that approaches 95%.
**Why is there a chondral lesion?**

Aids assignment of Co-Morbidities

- Post patellar instability: distal medial
- Chronic patellar subluxation: lateral
- Post Direct Impact Trauma: superior pole
- Osteochondritis dissecans
- First site of genetically programmed OA

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**Chondrosis Mapping aids in Planning:**

Not all chondral lesions need Restoration

- Inferior Pole and Lateral Facet: 87% G/E
- Medial Facet: 55% G/E
- Proximal Pole and Diffuse: 20% G/E
- Concomitant Central Trochlear Involvement: All Poor

*Pitariano & Fukarson Classification 1997*

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**Preoperative Planning for Chondral Treatment:**

Assess Entire Limb

*AAOS Let's Discuss: Joint Preservation of the Knee*

Chapter 13: Issues Specific to Cartilage Restoration in the Patellofemoral Joint

_Sherman SL, Nuelle C, Farr J_
Table 2. Pre-operative Considerations for Patellofemoral Cartilage Restoration

<table>
<thead>
<tr>
<th>Consideration/Position</th>
<th>Clinical Tests/Objective Correlation</th>
</tr>
</thead>
</table>
| Dynamic stability/Strength | Physical examination, Motion Analysis, 
Quad, Hamstring, ITB, Gastroc |
| Lateral Soft Tissue Stability | MRI correlation of lesion size, 
CT Classification, Modified Outerbridge Classification |
| Femoral Rotational Osteotomy | Increased femoral antversion |
| Varus Producing Femoral Osteotomy | Genu valgum |
| MPFL repair/reconstruction | Incompetence of the MPFL |
| Lateral release/lengthening | Fixed patella tilt with lateral retinacular tightness |
| Trochleoplasty | Not currently indicated as adjunct to cartilage restoration |

Patient/Pathology Specific Treatment Plan

Treat patients with pain on the basis of:
1. Abnormal mechanical factors
2. “Treatable” chondral defects (size & grade as per standard technique recommendations)

- Exclude ill-defined pain, CRPS, debilitation and those exceeding their “Scott Dye Envelope of Function”

Table 4. Concomitant Procedures That Accompany Patellofemoral Cartilage Restoration

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Indication</th>
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<tbody>
<tr>
<td>Femoral rotational osteotomy</td>
<td>Increased femoral antversion</td>
</tr>
<tr>
<td>Rotational Tibial Osteotomy</td>
<td>Increased external tibial torsion</td>
</tr>
<tr>
<td>Varus Producing Femoral Osteotomy</td>
<td>Genu valgum</td>
</tr>
<tr>
<td>TTO</td>
<td>Abnormal TT-TG, Abnormal Caton-Deschamps Ratio</td>
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<td>MPFL repair/reconstruction</td>
<td>Incompetence of the MPFL</td>
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<td>Lateral release/lengthening</td>
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<td>Trochleoplasty</td>
<td>Not currently indicated as adjunct to cartilage restoration</td>
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3 most common concomitant PF Procedures when treating Cartilage Lesions

- Lateral Lengthening
- Tibial Tuberosity Osteotomy
- MPFL Reconstruction—only if RPI; not for pain or alignment

Marrow Stimulation: Optimal use may be Contained Smaller/ Irregular lesions

Drilling may be better than Microfracture
- Characterization of Subchondral Bone Repair for Marrow-Stimulated Chondral Defects and its Relationship to Articular Cartilage Resurfacing
  Hongmei (Buschmann and Hoemann Lab) AJSM 2011
- Science and Animal Models of Marrow Stimulation for Cartilage Repair.

Patellar Microfracture Poor Result per Kreuz
**PF Microfracture Literature**

<table>
<thead>
<tr>
<th>Procedure</th>
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<tr>
<td>Kreuz, Arthroscopy 2006</td>
<td>Case series, 70 patients, Patella 3.6 cm³</td>
<td>12 to 36 months</td>
<td>Results in the Patella deteriorated starting at 12 to 15 months in the patella.</td>
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<td>Microfracture, Negri et al, Arthroscopy 2012</td>
<td>Meta-analysis, 9 studies, N = 307, Age 17-90y</td>
<td>Range 9-13 cm²</td>
<td>2 to 5 yrs</td>
<td>Decreased outcomes after 18-20 months for treatment of chondral lesions with autologous chondrocyte implantation.</td>
<td>More standardized treatment increase (≤2 cm) around 80% at 2 yrs compared to the patella.</td>
</tr>
<tr>
<td>Microfracture, Kavalaran et al, Arthroscopy 2006</td>
<td>Meta-analysis, 61 patients, Patella 1.8 cm²</td>
<td>Range 1-10 cm²</td>
<td>11.3 months (age 16-57 y)</td>
<td>No statistical difference in results based on site.</td>
<td>No statistical difference in results based on site 80% improved KOOS.</td>
</tr>
<tr>
<td>Microfracture, Mithoefer et al, JBJS 2005</td>
<td>Propective cohort, 48 patients, 4.8 cm²</td>
<td>Range 0.2-20 cm²</td>
<td>41 months</td>
<td>67% G/E results.</td>
<td>Best results with good KOOS, low BMI, and preoperatively less than 12 months.</td>
</tr>
</tbody>
</table>

**PF Microfracture: Pearls and Pitfalls**

- Easy to perform/ consider drilling options
- Inexpensive
- May be arthroscopic (Mini-arthrotomy option for patellar lesions)
- "Easy to just Microfx" and ignore the need to optimization of force/contact area, stability and tracking
- Variable clinical results
- Patella is a sesamoid bone: the bone is harder & thicker
- Blood supply different -- possibly fewer stem-cells
- Fibrocartilage in high shear force environment
Osteochondral Autograft: One Plug

Osteochondral Autograft: Multiple Plugs

Nho et al AJSM 2008

PF OC Autograft Plug Literature

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<tr>
<td>Hangody and Fules</td>
<td>Case series</td>
<td>831 patients</td>
<td></td>
<td>10 yrs</td>
<td>92% G/E for femoral condyles</td>
<td></td>
</tr>
<tr>
<td>Gawa et al.</td>
<td>Prospective</td>
<td>19 pts</td>
<td>25.5 yrs</td>
<td>24 months</td>
<td>Marshall scores improved from 40.7 to 47.1</td>
<td>Similar outcomes at 2 yrs</td>
</tr>
<tr>
<td>Bentley et al.</td>
<td>RCT vs. ACI</td>
<td>42 patients</td>
<td>31.3 yrs</td>
<td>19 months</td>
<td>69% G/E results Only 5 had PF, these 5 failed</td>
<td></td>
</tr>
<tr>
<td>Nho et al.</td>
<td>Case series</td>
<td>22 patients</td>
<td>30.4 yrs</td>
<td>28.7 months</td>
<td>Preop IKDC improved from 47 to 70% satisfactory clinical and MRI results</td>
<td></td>
</tr>
<tr>
<td>Astur et al.</td>
<td>Prospective</td>
<td>33 patients</td>
<td>37.6 yrs</td>
<td>30.2 months</td>
<td>Lysholm improved from 57.27 to 80.76 Kujala improved from 54.76 to 75.18</td>
<td>All G/E &gt; 2yrs</td>
</tr>
</tbody>
</table>
• Consider drill techniques for dense subchondral plate of patella
• Recognize the difference in donor/recipient cartilage thickness
• Implications that harvest sites are often in/near the site of pathology

Patellar OCA Plug

Trochlear OCA

Courtesy Tony Schepsis
### Custom OCA Shells

![Custom OCA Shells](image1)

### PF + LFC OCA Shells

![PF + LFC OCA Shells](image2)

### PF OC Allograft Literature

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<tr>
<td>Fresh osteochondral allograft</td>
<td>prospective, nonrandomized study of clinical outcomes</td>
<td>femoral condyle and tibial plateau</td>
<td>5 years, 10 years, 15 years</td>
<td>Kaplan-Meier survivorship showed 95% graft survival at 5 years, 85% at 10 years, and 74% survival at 15 years.</td>
<td>Long term outcomes confirm the value of fresh osteochondral allografts to reconstruct articular defects of the knee in the young active patient.</td>
</tr>
<tr>
<td>Osteochondral allograft transplantation</td>
<td>Retrospective study, N = 20 (18 patients)</td>
<td>patellar and trochlea/patella</td>
<td>Mean patella 7.1 cm² (range, 1.8–17.8 cm²); Mean trochlea 13.2 cm² (range, 2.5–22.5 cm²); Mean 94 mo (range 24–214 mo)</td>
<td>60% good/excellent, 25% failure: revision allograft (2), total knee arthroplasty (2), arthrodesis (1). Radiographs (12 knees): no PF arthrosis (4), mild arthrosis (6).</td>
<td>Osteochondral allografts can yield promising results when successful; however, this study reported poor long-term survival in these large defects.</td>
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<tr>
<td>Osteochondral allograft transplantation</td>
<td>Retrospective cohort study, N = 14 knees (11 patients)</td>
<td>patellar and trochlea/patella</td>
<td>Mean previous operations, 4.4; 2 patellar and 12 patellofemoral</td>
<td>Fresh Shell PF grafts Mean, 10 y (range, 2.5–17.5 y); 6/14 revised to arthroplasty; 10 of 11 successes would have procedure again. Knee Society Scores 46/82, Functional Scores 70/75, Lysholm 47/80, Mean extension lag 12°/3°.</td>
<td>Fresh osteochondral allografts for diffuse PF osteoarthritis can provide limited results, with a 42% failure rate. Patients may benefit because of delay of arthroplasty.</td>
</tr>
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<td>Osteochondral allograft transplantation</td>
<td>Systematic review of 9 studies; N = 644 knees</td>
<td>patellar and trochlear lesions</td>
<td>Mean 6.3 cm²; 58 mo (range, 19–120 mo)</td>
<td>Overall OCA 86% in the FC, less in the Patella; 18% failure rate overall. Patients have inferior results in the patellofemoral joint compared with tibiofemoral lesions.</td>
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### Additional Bugbee OCA Studies

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<tr>
<td>Fresh osteochondral allograft transplantation for isolated patellar cartilage injury. Gracitelli, AJSM 2015 (San Diego)</td>
<td>Twelve patients (12 knees) who underwent isolated OCA transplantation of the patella between 1983 and 2010. The mean allograft area was 10.1 cm² (range, 4.0–18.0 cm²).</td>
<td>Seventeen of the 28 knees (60.7%) had further surgery after the OCA transplantation; 8 of the 28 knees (28.6%) were considered OCA failures. Patellar allograft survivorship was 78.1% at 5 and 10 years and 55.8% at 15 years.</td>
<td>Pain and function improved from the preoperative visit to latest follow-up, and 89% of patients were extremely satisfied or satisfied with the results of the OCA transplantation.</td>
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<td>Bipolar osteochondral lesions of the knee. Mericet al., AJSM 2015 (San Diego)</td>
<td>Bipolar chondral lesions in 46 patients (48 knees) who underwent isolated OCA transplantation of the patella between 1983 and 2010. The mean allograft area was 19.2 cm². For OCAs still in situ, 7 years (range, 2.0–19.7 years) survivorship of the bipolar OCA was 64.1% at 5 years. Thirty knees underwent further surgery (52 knees, 63%) were considered failures.</td>
<td>Osteochondral allograft transplantation is a useful salvage treatment option for bipolar cartilage lesions of the knee. High reoperation and failure rates were observed, but patients with surviving allografts showed significant clinical improvement.</td>
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<tr>
<td>Osteochondral allograft transplantation in the femoral trochlea. Cameron et al., AJSM 2016 (San Diego)</td>
<td>Graft survivorship and clinical outcomes in 28 patients (29 knees) who had an OCA limited to the femoral trochlea. The mean allograft area was 6.1 cm² (range, 2.3–20.0).</td>
<td>Graft survivorship was 100% at 5 years and 91.7% at 10 years. One patient was converted to a total knee arthroplasty 7.6 years after OCA surgery. 89% of patients were extremely satisfied (63%) or very satisfied (26%) with their outcome at latest follow-up.</td>
<td>Fresh OCA transplantation resulted in excellent clinical outcomes in this patient cohort with articular cartilage damage to the femoral trochlea. The procedure resulted in improved pain and function and high patient satisfaction.</td>
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### PF Osteochondral Allograft: Pearls and Pitfalls

- Availability
- Normalize environment
- Bipolar limitations
- Current stored tissue is NOT the same as historical fresh transplants
- Minimize bone thickness to shorten time for creeping substitution

### Patellofemoral Specific ACI Considerations

- Patella and Bipolar are “off label” in US—see package insert
- Match facet curvature
- Depth of cartilage walls
PF Bipolar ACI

Match Facet Curvature

PF Bipolar ACI
Review of the ACI Literature for the Patella

Key Findings:
- Number of ACI Patella Publications: 15
- Majority of Lesions were central, Panpatella
- Average size lesion treated with ACI 4.4cm²
- Clinical Outcomes: 40-84% Good to Excellent
  (TTO with ACI produced better outcomes 80 to 85%)
  (No TTO 40 to 55%)
  IKDC scores +29 or greater
  Modified Cincinnati Score +3.5 or greater
- Range: 24 mths to 20 years
- Patient Satisfaction: >90%
- Failure Rate: 16 to 28%
- Re-operation rate: 10 to 30% (Periosteum)
- Well designed Rehab Protocol
### Autologous Chondrocyte Implantation for Patellar Chondral Defects: Results

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<td>Patellar ACI, central, medial, lateral</td>
<td>8 cases, 2011</td>
<td>Patellar, central, medial, lateral</td>
<td>2 years</td>
<td>Mean IKDC 4.5</td>
<td>Good outcomes, no failures.</td>
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<td>Patellar ACI, central, medial, lateral</td>
<td>40 cases, 2014</td>
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### AcI Annotated References

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PF ACI: Pearls and Pitfalls

- Technically difficult
- Rehabilitation pre and post op extremely important
- Normalize environment

- 2nd and 3rd Generation ACI also report good results with patella (Steinwachs CACI, Gobi Hyalgraft-C)
Particulated Juvenile Articular Cartilage

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<tr>
<td>Particulated juvenile cartilage (Biologic 2007)</td>
<td>Case report, 2 patients</td>
<td>1.68 cm²</td>
<td>2 yrs</td>
<td>IKDC improved from 32 to 85</td>
<td>All KOOS subdomains improved by at least 21 and as much as 70</td>
<td></td>
</tr>
<tr>
<td>Particulated juvenile cartilage (Bonner et al, JKS 2010)</td>
<td>Case series of pediatric with chondral lesions on the femoral condyle or trochlea</td>
<td>2.75 cm² (range 1.62-4.62)</td>
<td>2 yrs</td>
<td>Improvements in all scores across 24 month follow-up period</td>
<td></td>
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<td>Particulated juvenile cartilage (Farr et al, Cartilage 2011)</td>
<td>Case series of pediatric with chondral lesions on the patella</td>
<td>2.7 cm²</td>
<td>28.8 months</td>
<td>73% normal or nearly normal ICRS MRI</td>
<td>80% showed at least 90% defect coverage</td>
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<td>Particulated juvenile cartilage (Tompkins et al, Arthroscopy 2013)</td>
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<td>Case series of pediatric with chondral lesions on the patella</td>
<td>2.7 cm²</td>
<td>2 yrs</td>
<td>IKDC improved from 45.7 to 73.6</td>
<td>All KOOS subdomains improved by at least 16.8 and as much as 28.1</td>
<td>MRI suggests return to level approximating normal cartilage by 2 yrs</td>
</tr>
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PF PJAC:
Pearls and Pitfalls

- Technically straightforward
- Rehabilitation pre and post op extremely important
- Normalize environment as for ACI
- Less expensive than ACI or OCA
- Limited Clinical Reported Outcomes

PF CPAC

- 27 YO M who enjoys running, cycling, basketball and weight training
- Onset of pain Jan 2012, progressively increased and stopped cycling and running due to pain by June 2012
- 3/2013: DA, Subchondroplasty Patella
- Retropatellar R knee pain; intermittent, sharp when loaded; crepitus; no instability
- ROM: 0/0/130; swelling and effusion proportional to activity

Initial Imaging: 2/2013

- Caton-Deschamps:
- TT-TG: 9mm
- TT-PCL: 24mm
Initial Imaging: 4/2013
Post Patellar Chondroplasty and CaPhos to Patella

Minimal Pain Improvement; therefore
cartilage restoration 5/14;
Standard “Cell Therapy” Lesion Prep

Use of Cryopreserved Perforated Allograft Cartilage
6 Month Follow-Up: 11/14

- PreOp Pain Resolved; Mild soft tissue aching proportional to activity
- ROM: 0/0/135, symmetrical
- MRI: Implant expansion of thickness with good basilar integration, incomplete marginal integration; small joint effusion

6 month Follow-Up Imaging

Thank You

Knee Videos at YouTube JackFarrMD Channel: www.youtube.com/user/JackFarrMD