The Role of Resurfacing Arthroplasty in the Knee

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Articular Cartilage: State of the Art 2009
NYU Hospital for Joint Diseases
OUTLINE

• Continuum of Options
• Introduction of Inlay Arthroplasty Concept
  – Biomechanical Basis
  – FDA Trial
• Knee CAP
  – HemiCAP, UniCAP, PF
  – Indications
  – Technique
  – Cases
Transitioning from Biological to Prosthetic Resurfacing......

**Inlay Prostheses**, then--

*Uni or Bicompartmental Traditional Prostheses, TKA*
Goals/Basis of Prosthetic Knee Resurfacing

- Provide Pain Relief
- Improve Function
- Extension of Biological Cartilage Restoration
- Maintain principles and themes of Biologic Surgery
- Long lasting
- Solution for “younger patient” told “must wait for TKA”
- Minimize perioperative morbidity
- Maximize Outcomes
  - Equal, or better than traditional treatments
ANATOMY is KEY

• Concave and convex geometric surfaces – complex curves
• Intraoperative articular mapping involves measuring/replicating complex geometric surface configurations
• Accounts for morphologic variability
• Implants are patient driven
Progression of Knee Resurfacing

• Wide spectrum of options
• Individualize according to the specific patient
• Evaluate not just affected joint, BUT
  – Whole leg
    • Hip, foot/ankle
    • Alignment
  – Whole patient
    • Demands, expectations
    • Health Status
• Inlay Device is Least Invasive Prostheses
Inlay Resurfacing Device

• Little or no edge loading
• Preservation of all ligaments
• No decreased proprioception
• Concurrent Procedures unlimited by volume
  • ACL, Osteotomy, etc…
• Outpatient procedure
• Minimal Blood Loss
• Canulated procedure,
  • Reproducible
  • Simple
Alignment

Guidelines for Inlay

- Inlay only can restore limited joint height
- Inlay appropriate if deformity is correctable
- Stiff varus/valgus deformity may require soft tissue balancing
- Medial Inlay < 5° varus
- 5-10° varus, consider more traditional Uni
- > 10°, consider osteotomy together with resurfacing
Onlay Arthroplasty
Implants generated from patient anatomy

- Implants manufactured from individual patient digital data (CT or MR)
- Less bone resection than TKA
- Can preserve ligaments
- Allows greater angular and height correction
- More invasive than inlay
- Another complimentary option
Introduction of CAP (contoured articular prosthesis)

- Geometry based on patient’s native anatomy
- Intraoperative joint mapping (topo map)
- Account for complex asymmetrical geometry
- Extension of biological resurfacing
Knee Implants

- **HemiCAP** (unipolar knee)
  - Not currently FDA approved in US
- **UniCAP**
- **PF HemiCAP**
- **PF XLT**
1st question I asked: “what about the reciprocal surfaces”
Tibiofemoral peak contact pressure in focal anatomic femoral resurfacing: A biomechanical study

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Basic Science – Contact Pressure Study of HemiCAP

- No statistically significant differences in peak contact pressure for untreated knee and flush HemiCAP® during the
  - dynamic knee bending cycle
  - during static testing
  - two times body weight at 30° static testing
- 90% to 217% increase in peak contact pressure for 1mm proud implant across all testing cycles
- Conclusion: Slightly recessed implantation!

Basic Science - reciprocal surface (tibial plateau)

Multiple frames summary Tekscan Sensor:
- Peak contact pressure with contact averaged over 10 dynamic cycles
- 1x body weight ground reaction force (70kg)
- Range of Motion: 5 to 45 degrees
Basic Science- Relative Loading

Tibiofemoral peak contact pressure with a contoured articular prosthesis and a complete resection of the meniscus (posterior horn)

- Tibiofemoral peak contact pressure:
  - Untreated and flush demonstrate matching curves.
  - Significant increase with non-functional meniscus / radial tear
2nd question, “is the construct as stable and mechanically sound as we would theorize”?

Finite Element – Analysis

v. Hasselbach, German Congress for Orthopaedics and Traumatology, Berlin 2007

- No stress shielding
- Effective load transmission into underlying bone
Finite Element - Analysis

E-Module Hemi CAP

200,000 N/mm²
90,000 N/mm²
2,000 N/mm²

Conclusion:
- No stress shielding
- only 10-14% of articular surface coverage
- Effective load transmission into underlying bone
Focal Anatomic Resurfacing of the Femoral Condyle: 1 and 2 year Multicenter Results

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Clinical Results - US FDA HemiCAP trial

US Multicenter Study: Study Population and Current Follow-up

- Consented: 50
  - HemiCAP Implantations: 40
    - Current Follow-up: 31
      - Two Years: 31
        - Final assessment completed
    - Intraoperative Exclusions: 11
      - One Year (active): 5
      - Deceased: 1
      - Lost to Follow-up: 2
      - Device Removal: 1
        - Conversion to unicompartmental knee replacement: 6 months postoperatively
Clinical Results
US Multicenter Study (N=31)
• Average WOMAC Domain Score Comparison: 24 mo to baseline

![Bar chart showing WOMAC domain scores comparison between baseline and 24 months.]

- Pain: Baseline 296, 24 months 69
- Stiffness: Baseline 126, 24 months 37
- Function: Baseline 973, 24 months 221
- Global WOMAC: Baseline 1395, 24 months 327
Clinical Results

US Multicenter Study (N=31)

- Average WOMAC Domain Score Comparison per Time Point

![Graph showing WOMAC scores over time](chart.png)
Clinical Results
2 Year Radiographic Evaluation:

- **No evidence** in any patient at **any** time point for:
  - Progression of peri-prosthetic radiolucency
  - Device migration/subsidence into the bone
  - Disassembly of the CAP and screw
  - Joint space narrowing
  - Peri-prosthetic cyst formation
Clinical Results (HemiCAP for Femoral Condyle)
C. v. Hasselbach, Essen, Presented at German Congress for Orthopaedics and Traumatology, Berlin 2007

- Patient Population: N = 121
- Follow-up: Mean 14 months (1-25)
- Patient Age: Mean 52.5 years (34-67)
- Gender: Female N = 13 (29.5%), Male N = 31 (70.5%)
- Previous Cartilage Procedures: Mean N= 2.3 (0-6)
- Procedure Duration: 24 minutes
- Postoperative Recovery until Return to Work: Mean 35.3 days (15-82)
- HSS Knee Scores improved from 85.2 preop to 95.3 postop
- 17 Re-look Arthroscopies: Contoured Implant Integration, No Deleterious Cartilage Effects
- Radiographic Examination: No peri-Prosthetic Radiolucency, or Implant Subsidence
Clinical Results - Australian National Knee Registry

- HemiCAP® Resurfacing of Femur (initial experience)
- N=90 implants in 81 patients reported over the course of 4 years up until 12/31/07
- Observed component years: 107 (~mean follow-up around 1 year)
- Male = Female
- 8 revisions
  - progression of disease (N=4) and
  - Continued pain (N=4)
  - 5/8 revised to unicondylar knee; 3/8 to TKA
Case Presentation: 41 year old male – 2 yrs post MFX for medial pain, worsening with time
Arthrosurface
P-F Inlay Prostheses
PF- PROSTHETIC RESURFACING

• Vast difference between traditional PFA and Inlay
• Traditional prostheses limited success and rarely used
• Inlay device allows for concurrent re-alignment
• Inlay device for younger patients
• Excellent new solution for vexing problem
Trochlear Implants

Variety of Geometry

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Patellar Implants
Variety of Sizes/Shapes, Cemented

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Case Report

#1

- 41 year old female
- 2 prior knee surgeries
- Anterior knee pain
- Former “hard core” athlete
- Could not even walk with kids

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Case #1
(healthy medial and lateral)
Surgical Exposure

1st - Arthroscopic Lateral Release

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Surgical Exposure
Either MIS medial incision (or midline)
Technique –

• Guidewire key to cannulated system

• Perpendicular placement
  – Careful attention to this!!
Technique- Drill for set screw (no plunge)
Insert set screw (not too deep!)
Height measuring cap
Articular Mapping

...if measured values NOT on chart, must consider WHY
Drilling for implant

- High speed drill
- Do not use reamer
- Cooling irrigation
Device Trial –
can adjust/mark rotation
Patellar Preparation
basically need patella “deep enough”
Patella in place
Patella- Trochlea alignment

Key step- want (need) Patella directly over FTG cannot have poly on cartilage/bone
Radiographs pre and post
PF Resurfacing – Before and After
UniCAP™
aka... inlay arthroplasty, scope assisted Uni, AKR , etc..
UniCAP Advantages

• UniCAP may prevent patello-femoral complications/encroachment of conventional UKA through inlay resurfacing

• Revision to standard UKA may be possible due to shallow implant bed resurfacing technique
  • UniCAP avoids L-cut
  • Ample room for ACL, osteotomy, soft tissue procedures

• UniCAP limitations are at the same time its advantages:
  • Meniscal sparing technology for patients with healthy, functional meniscus
UniCAP Advantages

• Knee biomechanics are left intact through inlay resurfacing
  • Joint height, soft tissue tension are maintained
  • Conventional UKA are at risk of “overstuffing” the joint

• Patient selection remains critical:
  • Proper joint stability, avoiding increased translational movement
  • Monocompartmental degeneration, or concurrent multi-compartmental resurfacing, avoiding continuation of “referred pain”
UniCAP case example –
medial knee resurfacing  46 year old cyclist
UniCAP – medial knee resurfacing
UniCAP – medial knee resurfacing
UniCAP – medial knee resurfacing
UniCAP – medial knee resurfacing
Case Report – 51 year old dancer

- Chronic knee pain and instability
- Prior (30 yr ago) ACL reconstr
- 5 degree varus
- No Patellar nor lateral pain
ACL graft – Medial UniCAP
“Ideal” First Patient for CAP

- 30-60 yrs (APRX)
- Nearly normal align
- Any comorbidity mitigating against Biological solution
- Unicompartmental medial disease
Resurfacing Arthroplasty Allows Expanded Indications Beyond “Focal Defects”

- Osteoarthritis
- Post traumatic arthritis
- Unicompartmental Disease
- Multicompartmental Disease
- Concurrent Procedures
- Outpatient Procedure
- Truly minimally invasive
Advantages of Inlay Resurfacing Arthroplasty

- Immediate, excellent pain relief
- Simple, canulated, reproducible, yet elegant surgery
- Very few soft tissue balancing challenges
- Minimally bone sacrificing
- Minimal EBL, can be outpatient
- Can easily convert to traditional arthroplasty

- Patient acceptance
- Allows concurrent soft tissue procedure
- Maintain cartilage restoration principles
- Based on patient, or ambient anatomy
Thank You
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