MAKOplasty
Unicondylar Knee Replacement

Andrew D. Pearle, MD
Assistant Attending Orthopedic Surgeon
Hospital for Special Surgery
Director, HSS CAS Center
Computer Assisted Surgery
The Big Picture

- Patient-Specific
- MIS
- Quantitative

Patient
Diagnosis
Intraoperative
Postoperative
Preoperative
Execution
Evaluation
Where are we going?
Age of Quantitative Surgery

• Technical Specifications for Surgical Procedures
  – What are the target specs
  – What are the tolerances of the specs
  – Are specs clinically relevant
  – Are CAOS tools reliable (accurate and precise)

– Pitfalls
  • Price, increased surgical time, faulty data, etc
Rationale

• Definite learning curve associated with performing UKR
  – “Although TKA systems with good instrumentation maybe implanted based on written instructions, UKA technique is best taught in the operating room”
    » Christensen CORR 1991

• Implant positioning has effect on outcome in UKR
  – Coronal plane long leg alignment (avoid over and undercorrection)
    » Hernigou CORR 2004
  – Posterior slope of implant (avoid slope >7 deg)
    » Hernigou JBJS 2004
  – Varus angulation of tibial slope (attempt to reduce)
    » Engh J Arthroplasty 2006
Rationale

• CAS techniques can improve positioning reliability in UKR and TKR
  • Ilsar, Joskowicz et al CAOS-International 2006
    – 139 clinical papers
    – Endpoint - 3 degrees from neutral alignment
      » Navigated TKR - 2130/2401 (89%)
      » Conventional TKR - 1325/1880 (71%)
  • Keene JBJS Br 2006
    – 20 navigated vs 20 conventional UKR; endpoint ± 2° of the pre-operative plan
      » Navigated UKR – 17/20 (87%)
      » Conventional UKR – 12/20 (60%)
Robotic Positioning: Principle

- Patient
- Surgeon
- Guide
- Robot
- Drill
- Images
- Start
- Goal
- Plan
Robotics: Execution Systems

- Robotic arm actually performs a surgical act (or constrains the surgeon to move in a region)
- Surgeon-driven: MAKO bone surface cutting in UKR
MAKO Tactile Guidance System
MAKOplasty®

- Inlay medial compartment unicompartmental knee resurfacing
  - “Serial prosthetic replacement”
  - Bone sparing
    - 3 mm tibial bone resected with preservation of sclerotic bed (medial tibial buttress) and cortical rim
    - Technically challenging, jigless
  - Repicci Am J Knee Surg 2002
    - 96% success rate at 8 years
CT Based Planning

Segmentation
3D model creation
CT Based Planning

• Implant positioning
  – Alignment metrics
  – Visualization on 3D reconstruction of CT scan
    • Edge loading, congruence, preservation of subchondral sclerosis
    – Predicted (and intraoperative) gap kinematics

• Targets, tolerances??
MAKOplasty® Procedure

- Register Robotic arm
- 4.0 steiman pins for tibia and femoral arrays
- Medial parapatellar incision (2-4 inches)
- Contact registration of tibia and femur
- Jigless, robotic arm assisted surgical execution
Pre-Op Planning
Gap Kinematics
Intra-Op Execution
Intra-Op Execution
MAKOplasty®

- n=140 procedures
- 6 centers
- No revisions

![WOMAC Scores by Elapsed Time (MAKO Study)](chart.png)
Quantitative Surgery

A *fool with a tool is still a fool*
- Clinical judgment
- Surgical indications
- Soft tissue handling

*Challenging to integrate quantitative feedback with the art of surgery*
Thank You