Disclosures

• Consultant for Stryker
Osteoarthritis

Most Common Joint Disorder in US
- 15,000,000 have OA of the Knee

Lifetime risk of Symptomatic OA
- 40% for men
- 47% for women

Etiology

Interplay between Intrinsic and Extrinsic factors

Intrinsic
- Age
- Gender
- Genetics

Extrinsic
- Obesity
- Injury/Occupation
- Alignment
Intrinsic Factors

**Age**
Cumulative exposure to environmental stresses

**Gender**
Female gender is associated with increased risk for development of OA
Possible hormonal relationship
Other factors such as alignment

**Genetics**
Heritable component estimated to be 50 – 65%
Predisposition to extrinsic factors
Extrinsic Factors

Obesity
Increased lifetime risk for development of OA to 60%
Increases risk of development of OA due to injury or occupation

Occupation/Injury
Occupations requiring carrying, repetitive kneeling or squatting
Athletes

Alignment
Alignment

OA Development

• Varus alignment increases risk by 2X
• Valgus alignment increases risk by 54%

OA Progression

• Varus alignment has a 4X increased risk
• Valgus alignment has a 5X increased risk
75% of compressive loads born in medial compartment of a neutrally aligned knee

Increase of 4-6% in Varus alignment can increase loading of the medial compartment by 20%

Participation in weight bearing sports predisposes development of Varus alignment in adolescent athletes

Proportion of athletes with Varus alignment of the knees is higher
Athletes are predisposed to the development of Osteoarthritis

- Repetitive High Impact Activity
- Endure excessive loads
- Varus Alignment
- Long-distance running, soccer, weightlifting, and wrestling had a prevalence of OA 3 to 7 times that of controls*
- American football was also associated with a 9 times higher prevalence of knee OA*
- Injuries are common

Injury in Athletes and prevalence of OA

Arthroscopy

Meniscectomy

Reported rates of TKA at 1, 2, and 3 years after arthroscopy were 10.1%, 13.7%, and 15.6%, respectively.

Orthopedics. 2016 Nov 1;39(6):e1041-e1044

132 fold increase in rate of TKA compared to age-matched pairs

J Bone Joint Surg Br. 2012 Dec;94(12):1649-54
ACL Reconstruction

• Yields a lower cumulative incidence of OA development and TKR
• 7 times greater risk of Knee Arthroplasty compared to matched controls

• J Bone Joint Surg Am. 2014 Jan 1;96(1):2-10
Knee Arthroplasty

- INDICATIONS: OA with Pain and/or functional impairment which fails to respond to conservative treatment
- In up to 19% of patients who were candidates for Joint Arthroplasty, return to sports was the primary indication

- Meneghini RM, Russo GS, Lieberman JR. Modern perceptions and expectations regarding total knee arthroplasty [published online June 17, 2013]. J Knee Surg
KNEE ARTHROPLASTY OPTIONS

MEDIAL  PATELLOFEMORAL  LATERAL  TOTAL KNEE
Arthroplasty in the Athlete

• 61.4% of 726 patients returned to their previous sport in some capacity*

• 27% of patients decreased their activity secondary to pain, which led to the conclusion that patients should be cautioned against expecting to return to high-impact sports*

• UKA had higher return to athletic participation than those with TKA**


How Long Does it Last?

• Pooled Registry data indicates that for:
  • TKA, survival at 25 yrs is 82%
  • UKA 25 year survival is 69%

• SURVIVAL is dependent upon:
  • Age at time of procedure
  • Activity level
  • Other extrinsic factors such as BMI
  • *Surgical Technique—Alignment and Balance*
WHY ARE WE CONCERNED ABOUT BALANCE AND ALIGNMENT?
<table>
<thead>
<tr>
<th>Primary TKR</th>
<th>Number of Cases</th>
<th>Percent EARLY REVISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varus &gt; 3°</td>
<td>35</td>
<td>14%</td>
</tr>
<tr>
<td>Neutral</td>
<td>244</td>
<td>1%</td>
</tr>
<tr>
<td>Valgus &gt; 3°</td>
<td>82</td>
<td>0%</td>
</tr>
</tbody>
</table>

NOTE: 32% MALIGNED
VARUS MALALIGNMENT

- **FINITE ELEMENT ANALYSIS**
  - 145.9% INCREASE IN POLYETHYLENE CONTACT STRESSES
    - Liau et al, Clinical Biomechanics 2002

- **IN VITRO LOADING OF TKR IN CADAVER TIBIA**
  - 86.6% INCREASE IN POLYETHYLENE STRAIN
    - Green et al, J Arthroplasty 2002
FINITE ELEMENT ANALYSIS
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WHY SHOULD WE BE CONCERNED ABOUT BALANCE AND ALIGNMENT?
The Dirty Truth

Only 81% of patients are SATISFIED with their Total Knee Replacement in terms of pain relief and function.

Patient Satisfaction after Total Knee Arthroplasty: Who is Satisfied and Who is Not?
Reasons for TKA Revision

50% were performed <2 yrs After Index Surgery

33% Of Early Revisions Performed Due to:

• Component Malposition & Malalignment
• Instability/Poor Balance

Conventional Instrumentation for Knees

Intramedullary and Extramedullary Alignment
Conventional Instrumentation

META-ANALYSIS

- 13 Studies
- “Safe Zone” +/- 3° from Neutral Mechanical Axis
- Only 75.6% of Knees met Criteria
Instrumentation for Unicompartmental Arthroplasty

- Less Accurate than TKA
- Poor Reproducibility
Notoriously Inconsistent Results
Take Advantage of Available Technologies
MAKO ROBOTIC ARM ASSISTED ARTHROPLASTY

- 3-Dimensional Pre-operative Planning
- Accurate Intra-operative Adjustments
- Haptic Guidance
- Consistent and Reproducible Results
CT scan obtained to produce a Patient-specific 3D Model
ENHANCED PREOPERATIVE PLANNING

Varus
0.0°

External
2.6°
PCA

External
0.0°
TEA

Flexion
2.0°

Bone Resection

7.0
8.0
L
M

8.5
11.0
L
M

7.0
3.5

7.0
3.5

0.0°

0.0°

0.0°
P. Slope

Triathlon® CR Cruciform
Femur
Post
Tibia
Poly

Capture points
Femur

Femur checkpoint too close to cut

Implant Planning
HAPTIC GUIDANCE: CONTROL OF BONE RESECTION

Distal

Flexion 89.0°
Robotic Arm Assisted TKA: Greater Accuracy

RESULTS: Early Functional Recovery

- Less Postoperative PAIN
- Decreased Blood Loss
- Less Time to Straight Leg Raise
- Fewer In-patient PT sessions
- Increased Maximum Knee Flexion at Discharge
- 26% Reduction in length of Stay

Results: Improved Early Outcomes

100 Robotic TKA VS 100 Conventional TKA @ 6 weeks

Malkani, A, et al 2018
Unicompartmental Arthroplasty
ENHANCED PREOPERATIVE PLANNING
INTRAOPERATIVE ASSESSMENT AND DYNAMIC BALANCING
BONE PREPARATION
RADIOGRAPHIC RESULT:
Unicompartmental Arthroplasty (UKA)
A Randomized Controlled Trial Comparing Accuracy and Outcomes of Robotically Assisted PKA to Manual PKA
Principal Investigators: Drs. Blyth, Jones, Maclean, Anthony, Rowe
IMPROVED RADIOGRAPHIC CONSISTENCY
MAKOplasty® Demonstrates Early Less Post-Operative Pain Versus Manual UKA (Oxford® )

Conclusion: MAKOplasty Patients Had Significantly Less Pain than Oxford Patients Day 1 To Week 8


Oxford® is a registered trademark of Biomet, Inc.
IMPROVED PATIENT SATISFACTION LONG-TERM

Mako Partial Knee patient satisfaction

- **Very satisfied**
- **Satisfied**
- **Neutral**
- **Dissatisfied**
- **Very dissatisfied**

- **Percentage**
  - Black: minimum 2-year follow-up
  - Yellow: minimum 5-year follow-up
IMPROVED SURVIVORSHIP

Partial knee survivorship

- Cohort studies
- Annual registries
- Mako Partial Knee

Percentage

2-3 year follow-up
5-6 year follow-up
What Activities Are Permitted After Arthroplasty?
A Survey of Experienced Joint Replacement Surgeons

**Recommended**
- Walking, Swimming, Biking, Hiking, Tennis (Doubles)

**“Allowed with experience” or “No Consensus”**
- Skiing, Weight Lifting, Hockey, Gymnastics, Tennis (Singles)

**Not Recommended**
- soccer, jogging, basketball and football

SUMMARY

- OA is Prevalent in Athletes
  - Injuries
  - Repetitive Use
  - Varus Alignment common
- Robotic Assistance Allows for More Consistently Superior Results than Conventionally Performed Arthroplasty
- Return to many Sports is POSSIBLE