TKA Preference

- Reliable
- Results: predictably “good”
- Indications clear
- Techniques well established
- Implants uniformly well designed
- Nearly all Orthopedists well trained
Potential Reasons for Declining Surgery

- Concern: pain or worsened mobility
- Duration of recovery
- Financial
- Lost work
- “Friends of friends” with poor outcomes
- Poorly informed re benefits/alternatives
Dissatisfaction After Total Knee Replacement

- 20% of patients not satisfied with the outcome following TKA*

- Only 82% to 89% of primary TKA patients are satisfied**

- Post TKA: sports activities decreased from 42% to 34%***
  - Post THA: sports activities increased from 36% to 52%***

* J Bone Joint Surg Br. 2010 Sep;92(9): Scott CE, Howie CR, MacDonald D, Biant LC
** Clin Orthop Relat Res. 2010 Jan;468(1):57-63: Bourne RB, Chesworth BM, Davis AM, Mahomed NN, Charron KD
*** The Ulm Osteoarthritis Study- K Huch
The Changing Face of Knee Arthroplasty

- The average age of TKA patients is changing
  - Highest percentage increase 45-64 years old
- Patients under 65 in age with UKR vs. TKR demonstrated significantly higher satisfaction scores
  - 2.9 times more likely to have their expectations met**

UKA in contrast to TKA

- Results highly variable, implant dependent
- Indications confusing and controversial
- Implant designs variable
- Techniques not uniform
- Many Orthopedists lack training
History of UKA

• History of UKA has been controversial

• Led to confusion concerning the value of the procedure
The Rise of UKA (1970’s)

• Introduced in the US in the 1970’s (Marmor)
  – Same incision and “similar” recovery time as TKA
  – Considered short-term repair/alternative to HTO

• Gained popularity quickly

• Initial enthusiasm brought new designs
The Fall of UKA-1980’s

• Initial enthusiasm brought new designs
• Poor results and high failure rates (loosening & progressive arthritis)
• UKA fell out of favor
• Small US Knee market share
1. Full Life Cycle: Lap Chole

- First performed in 1985
- Replaced the open cholecystectomy approach
  Minimally invasive
  - clinical and economic advantages
  - Short stays
  - Initial adoption driven by patient demand followed by clinical evidence

2. Mid to Late Stage: Robotics-assisted Prostatectomy

- 2000, robotic assistance provided a minimally invasive solution to prostatectomy that delivered successful results 2004

- 10% of prostatectomies performed robotically in U.S.**

- 2014: 85% of prostatectomies performed robotically in U.S.**


3. Beginning Stage: Robotics-assisted Partial Knee Replacement

- Introduced in 2006, robotics-assisted partial knee replacement provides a minimally invasive and highly accurate approach to a technically demanding procedure

- 2012: Estimated 14% of all partial knee replacements performed using robotics**


Robotic Adoption Predictions

Global: Medical Technology: Orthopaedic Devices

Exhibit 6: We expect >125k ortho procedures will be done robotically by 2020, with >50% of growth driven by total knee replacements

WW orthopaedic robotic procedures, by type

Goldman Sachs, Orthopaedic Robotics Opportunity Underappreciated; Buy SYK, SN, April 11, 2016.
Exhibit 21: We expect c.1,600 ortho robotics systems WW by 2020, generating over US$900 mn in cumulative new sales (2016-2020E)
Installed robotic systems, US vs. OUS; new system revenues in $ mn (RHS)
Robotic UKA

- Current FDA cleared applications
  - Medial unicompoundar knee replacement
  - Lateral unicompoundar knee replacement
  - Patellofemoral knee replacement

These cases may not represent typical surgical outcomes. Every surgery and each patient undergoing knee replacement represents unique sets of circumstances and, therefore, results may vary.
The Progression of Osteoarthritis

Early stage

Mid stage

Late stage
Evolution of Indications for UKA

- **Kozin-Scott UKA Criteria**
  1. Non-inflammatory arthritis
  2. Age greater than 60
  3. Weight less than 180 pounds
  4. Low activity level
  5. No lateral compartment disease
  6. No patello-femoral disease
  7. Greater than 90 degrees flexion contracture
  8. Less than 5 degrees flexion contracture
  9. Less than 10 degrees varus deformity correctable to neutral or 5 degrees of valgus

- **Current Evidence Based Criteria**
  1. Non-inflammatory arthritis
  2. Intact ACL
  3. No lateral compartment disease
  4. Grade I-III patello-femoral disease
  5. Correctable varus/valgus deformity of less than 15 degrees
  6. Less than 10 degrees of flexion contracture

6-8% → >35%

## TKA vs. UKA Comparison

*Brown et al, J Arthroplasty 2012*

<table>
<thead>
<tr>
<th>Measure</th>
<th>TKA</th>
<th>UKA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Age</td>
<td>65.5</td>
<td>64.3</td>
</tr>
<tr>
<td>% Female</td>
<td>67%</td>
<td>55%</td>
</tr>
<tr>
<td>Co-morbidity</td>
<td>0.58</td>
<td>0.43</td>
</tr>
<tr>
<td>BMI</td>
<td>34.5</td>
<td>31.1</td>
</tr>
<tr>
<td>MUA</td>
<td>124 (5%)</td>
<td>3 (0.4%)</td>
</tr>
<tr>
<td>Re-admission</td>
<td>82 (61%)</td>
<td>8 (2.1%)</td>
</tr>
<tr>
<td>ICU admission</td>
<td>32 (1.4%)</td>
<td>1 (0.2%)</td>
</tr>
<tr>
<td>Transfusion</td>
<td>37 (1.6%)</td>
<td>1 (0.2%)</td>
</tr>
<tr>
<td>Disch to ext care</td>
<td>411 (18%)</td>
<td>19 (3.1%)</td>
</tr>
<tr>
<td>LOS (days)</td>
<td>3.3</td>
<td>2.0</td>
</tr>
<tr>
<td>DVT</td>
<td>11 (0.5%)</td>
<td>2 (0.3%)</td>
</tr>
<tr>
<td>PE</td>
<td>13 (0.6%)</td>
<td>2 (0.3%)</td>
</tr>
<tr>
<td>Deep infection</td>
<td>18 (0.8%)</td>
<td>1 (0.2%)</td>
</tr>
<tr>
<td>90 day re-op</td>
<td>31 (1.4%)</td>
<td>4 (0.6%)</td>
</tr>
<tr>
<td>Death</td>
<td>6 (0.3%)</td>
<td>1 (0.2%)</td>
</tr>
</tbody>
</table>

- Retrospective, multicenter review of 2,919 knees
- 5 years
- 2290 TKA, 629 UKS

= Statistically significant
UKR is an excellent procedure that can be hard to get right

- When things go wrong it can be easy to spot
Alignment is Important to the Success of Partials

- Poor alignment is one of the main reasons for revision
UKA with Robotic Assistance

• Recent studies - superior short-term survivorship for robotic-assisted partial knee replacement
  - 1% revision rate at 2 years after operation
  - 4x’s lower than that of conventional technique
  - Less pain in the first 60 days after the procedure (compared to conventional technique)

NAVIO Robotics

- Navigation principles utilizing optical navigation technology
- image-free
- Intra-operative planning allows for optimal implant positioning
- Execution of the plan is performed via handheld robotics-assisted cutting tool
NAVIO Robotics

- Procedure workflow

- Registration
- Planning
- Execution/bone removal
CT-free Registration

- Mechanical and rotational axis
- Soft tissue kinematics
- Anatomic landmarks
- Ct-free collection/mapping
Advanced Planning

- Size the implant
- Balance the joint
- Confirm implant placement
Robotics-assisted Bone Removal
Why Embrace Partials?

- Kinematics, ROM, Proprioception/ACL allow patients to feel more ‘normal’

- Less pain, less blood loss, function/mental scores, and higher satisfaction

- Benefits to the old and young


- Economic Benefits
  - 30% savings from implant costs, procedure costs, recovery times
- Decreased length of stay and rehabilitation
- Less adverse events
- More cost effective solution compared to TKA
Compared to TKA, UKA has shown:

- Less blood loss
- Less rehab/recovery
- Easier ambulation, better ROM
- Less instruments/inventory
- Lower procedure costs
- More cost effectiveness

Gondusky, J Artholplasty, 2014
NAVIO Radiographic Outcomes
Thank you