The Role of Partial Knee Arthroplasty for Medial OA of the Knee: It’s Time has come, Again
34th Annual Verne T. Inman Lecture

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Carolinas Medical Center
Charlotte, NC

Disclosures

- Biomet: Consultant, royalty recipient
- Chairman, Quality Committee, American Association of Hip and Knee Surgeons
- Reviewer, Journal of Arthroplasty

Partial Knee Arthroplasty (PKA) Overview

- Define anteromedial OA of the knee
- Discuss the current indications for PKA for medial OA as now understood
- Basic science of PKA: kinematics, polyethylene wear, tibial stress
- PKA clinical results: single surgeon/unit, morbidity and mortality, and national joint registry data

Partial Knee Arthroplasty (PKA) Overview

- Early reported series------variable results
- Appropriate indications and patient selection
- Prosthetic design
- Polyethylene quality and thickness
- Technical aspects: component to component mal-position, impingement, overcorrection
Partial Knee Arthroplasty (PKA) Overview: Advantages

- MIS approach
- Less morbidity/mortality
- Faster, easier rehabilitation
- Improved function: knee “feels” more normal
- Easier revision to TKA
- Higher patient satisfaction

For the Skeptics in the Crowd

- Entered practice in 1983.
- Had done a few PKA (Marmor) as a resident.
- 1983-2002, did not do PKA. Not sure I believed in the concept. After all, TKA’s do so well.
- How to handle the patient with a painful PKA
- 2000-2001, experience in UAE prompted thought change

Partial Knee Arthroplasty (PKA) Overview: Disadvantages

- Higher early failure rate
- What to do with patient who has continued pain
- Long term survivorship thought to be less than TKA
- Overcoming surgeon bias against PKA

A PKA Skeptics View
**Why the Change of Practice?**

We’ve all seen isolated medial compartment disease when performing a TKA.

- Intact Lateral Compartment
- Intact ACL
- Medial disease

**Define what we mean by Anteromedial OA of the knee**

- It is a distinct subset of patients with OA of the knee
- The term “Anteromedial OA” was coined by John Goodfellow
- May represent 25-35% of patients with OA of the knee

**Anteromedial OA:**

- The indication for medial PKA
  - Full thickness medial cartilage loss
  - Intact ACL/PCL
  - Intact MCL/LCL
  - Full thickness, functional lateral compartment
  - Correctable varus as demonstrated on stress X-ray

White, Ludowski, Goodfellow, JBJS Br, 1991
Anteromedial OA of the Knee

Medial tibial defect: eburnated bone

Intact posterior cartilage

Indications for PKA in Medial OA of the Knee

Published Unicompartmental Arthroplasty Results

<table>
<thead>
<tr>
<th>Year</th>
<th>Authors</th>
<th>Compartment</th>
<th>Prosthesis</th>
<th>Number</th>
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What were the indications used in these series?

PKA Indications: Medial Kozinn and Scott

- Age > 60; low demand
- Weight bearing pain; none at rest
- Weight < 82 kg
- F/C <15°, flexion >90°
- Varus < 10°
- No chondrocalcinosis (relative)
- Operative findings
  - Intact ACL
  - Intact PF joint (confusion)
  - Intact lateral compartment

Kozinn & Scott, JBJS 1989
Traditional Indications ~ Kozinn & Scott

Varus OA, Prospective Data, n = 4,021 knees

- Anatomic criteria
  - Normal ACL, normal LM, mild lateral and PF changes
  - 6.1% “qualify”

- Clinical criteria
  - More than 60 yo, less than 82 kg, FC < 5°, < 10° varus
  - 2.2% “qualify”

Traditional Indications ~ Kozinn & Scott

PFJ damage and anterior pain
- Obesity
- Age: Young < 60 and Older > 75
- Chondrocalcinosis
- Knee motion: <10 f/c and >90-95 flexion

Pandit, JBJS 2011

Site of Pre-op Pain

<table>
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<tr>
<th>Location</th>
<th>Count</th>
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<td>Medial</td>
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<td>Anterior</td>
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<td>Lateral</td>
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<td>General</td>
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Beard, et al. JBJS 89(12):1602-7 2007

Relation Between AKP and PFOA

- Distribution of PFOA on skyline
- No relationship between AKP and degeneration

Beard, et al. JBJS 89(12):1602-7 2007
Influence of AKP on Outcome

- No relationship between AKP and 2yr outcome
  - OKS p=0.5, Q12 p=0.6
  - KSSO p=0.9, KSSF p=0.2
- Pre-op AKP does not compromise outcome

Skyline View - Medial

- Bone on bone 6%
  - No relationship between grade of damage and outcome

Skyline View - Lateral

- Bone on bone 4%
  - Change OKS worse (p=0.03)
  - Other measures NSD
  - Scores similar to TKR
  - Relative contraindication
- Trend to worse outcome with worse damage
- Bone loss, grooving & subluxation
  - TKR
- Less damage - UKR

Survivorship vs PFJ

- 17 Revisions at 6 years (97.3%)
- 384 Normal PFJ (61.3%)
  - Predicted survival: 93.8%
- 242 Abnormal PFJ (38.7%)
  - Predicted survival: 97.9%
- 92 Significant disease (14.7%)
  - Predicted Survival: 97.0%
2000 Consecutive UKA Anteromedial OA
- Avg. time to revision: 17 Months
- 10 Persistent pain
- 14 Tibial loosening
- 5 Tibial collapse
- 1 Tibial fracture
- 1 Femoral loosening
- 1 Deep infection
- 4 Dislocation
- 1 Progression of Lateral OA
- 1 Doing well, “looked wrong”

Preoperative lateral subluxation of the patella is a predictor of poor early outcome of Oxford phase-III medial unicompartmental knee arthroplasty
- 260 consecutive patients. 1 year outcome
- Subluxation of the patella (7 pts) was found to be the only predictor of poor outcome at follow-up
- Site of pain not predictive of outcome


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Obesity

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- 260 consecutive patients. 1 year outcome
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Fixed Bearing UKA in Obese Patients

Berend, KR et al CORR 2005
Influence of Obesity on Outcome of PKA

2586 MB-UKA (up to 12 years)
Two Centers: JIS/Oxford UK

- BMI 30-35: 764 UKA
  - Survivorship: 94%  
- BMI 35-40: 310 UKA
  - Survivorship: 94%  
- BMI >40: 209 UKA
  - Survivorship: 98%  
  - \( P = 0.51 \)

BMI 30-35: 764 UKA
Survivorship: 94%
BMI 35-40: 310 UKA
Survivorship: 94%
BMI >40: 209 UKA
Survivorship: 98%

\( P = 0.51 \)

Chondrocalcinosis

- 206 pts with 234 UKA between 1990-2000
- 85 patients with CC at surgery
- 63 patients developed later
- Survivorship at 15 years
  - 90% with CC
  - 87% without CC

Revision to TKA as endpoint


Age

- Old/unfit
  - minimal invasive
  - low morbidity
- Young (50s or less)
  - <60 & >60 NSD
  - Mean 55, n=52
  - 92% 10-yr survival

Age and gender should not be considered contraindications for performing Oxford PKA.


AGE

- 459 Oxford PKA in 392 patients
- Mean age 63 (34-87)
- Survivorship: 94% at 5 yrs
  - 93% at 8 yrs
- 4.4% revision to TKA (50% aseptic loosening)
No difference in knee scores
No difference in survivorship
No difference in revision rate.

Older age should not be considered contraindications for performing PKA.

Joint Registries have consistently reported significantly higher revision rates with PKA in young patients
Don’t always know implants: metal backed vs all-poly tibia
Don’t always know indications and technique

Partial Thickness Cartilage Loss
A cautionary note

- Partial loss
  - Avoid UKR as it probably does not explain pain
  - 6 times higher re-op rate if > 2mm of joint space
  - 8 times higher re-op rate if medial thickness >40% of lateral space

Preoperative ROM

- In true anteromedial OA, this is not a problem.
- The ACL is normal, the deformity is correctable
- Knee kinematics are preserved
- Typical ROM: 5-10 to 120-135
Summary of Indications

- For Anteromedial OA of the knee, there are no distinct contraindications
- Anteromedial OA as defined is the clear indication for PKA
- Older, “accepted” indications and contraindications have been refuted by published data

Basic Science of PKA

- Kinematics
- Polyethylene Wear
- Tibial Stress

Kinematics of PKA

- PKA can restore or preserve near normal kinematics when compared to TKA.
- Cadaver model

Knee Kinematics in Unicompartmental Arthroplasty

Price et al JBJS 88B 2006

Patil et al, JBJS 87A, 2005
These studies suggest that femoral-tibial kinematics of UKA’s mimic the normal knee, in contra-distinction to TKA.

These studies also suggest that patello-femoral function in UKA is linked to the status of the ACL.

Could series that report patello-femoral pain following UKA include patients with absent or non-functional ACL?

- Total particulate load.
  - quality of poly.
  - conformity of components.

- Osteolysis and loosening.
  - Inflammatory mediated @ bone-cement and non-replaced compartments.

- Uninvolved compartment degeneration.
  - Result of long term low grade reaction to above.
Wear in Fixed vs MB PKA

Wear in fixed vs MB Uni

Wear in Fixed vs MB Uni

Wear in Fixed vs MB Uni

Area of Wear

Repecci 5 yrs PO
Oxford MB Wear

- 16 bearings—0.8 to 12.8 yrs after implantation.
- Compared to 14 unused bearings.
- Measured effect of wear on both upper and lower surfaces.

Mean wear of 0.036 mm/yr

Psychoyios et al, JBJS Br 80B, 1998

Oxford MB Wear

- Bearings with impingement on bone or cement, 10 bearings.
- Mean wear 0.054 mm/yr.
- Maximum 0.083 mm/yr.
- Mean volumetric wear. 31mm³/yr

20-year Wear *In Vivo*

- 7 knees, Phase 2
- Follow-up mean 20-yr
- RSA measured wear
  - Fit CAD models
- At 20 years
  - Mean wear 0.4mm, max 0.6mm
  - Mean wear rate 0.02mm/yr, max 0.03mm/yr

Kendrick, et al. JBJS 2010

Oxford MB Wear

- Bearings without impingement, 6 bearings.
- Mean wear 0.010 mm/yr.
- Mean volumetric wear. 6mm³/yr
St Georg Sled
Fixed Bearing

- 19 tibial components
- 0.89mm~5.6 yrs
- Mean wear 0.15 mm/yr.
- Mean volumetric wear 17.3 mm³/yr

St Georg sled 20 yr Survivorship 85.9%

PKA Wear

- Surgical Technique may be prime culprit.
  + soft tissue balance.
  + accurate component to component position.
  + avoiding impingement- cement/bone.
  + correct to the pre-disease alignment.

- Implant Design and Instrumentation.
  + reproducible implantation.
  + improved poly, sterilization, packaging.
  + improvements in articular geometry.
  + MB vs Fixed bearing. Still an ongoing debate.

Tibial Stress after PKA:
Is this potential cause of persistent pain?

- Proximal medial metapyhseal tibia
- Worse with activity
- Relieved with rest

Quantify Tibial Strains

- Metal backed vs. all poly components
- Bearing mobility
- Tibial slope
- Vertical cut orientation or rotation

Small, Berend, et al. JOA 2010
Metal Backing – Effect on PKA bone strain

All-poly:
High focal strains, hotspot under contact point

Metal backed:
Lower overall strains, improved distribution

Results: Anterior Position (Extension)

Results: Posterior Position (Flexion)

Tibial Component Slope
Aramis Image Capture
Lab Study Conclusions

- All-poly >> metal backed in all regions
- Kinematics (Bearing movement, contact position, M/L) significantly affect tibial loading in vitro
- Slope appears to be a combined variable with loading position
- Explain early medial pain, remodeling, and aseptic loosening after UKA

PKA Clinical Results

- Single surgeon/single unit results
- Morbidity and Mortality of PKA
- What do national registries tell us
Single Surgeon/Single Unit Results of PKA

- Typically high percentage of good and excellent results
- Designing surgeon series have best results
- Failure rates 50% less than registry results
- Does volume and experience play a role?

Anteromedial Arthritis of the Knee

O’Rourke, Johnston et al, CORR 2005
- 136 Marmor fixed bearing Uni
- 20 yr survival-----------82%

Naudie et al, JBJS Am 2004
- 113 MG fixed bearing Uni
- 10 yr survival----------90%

Anteromedial Arthritis of the Knee

Berger et al, CORR Oct. 99
- 62 MG fixed bearing Uni
- 10 yr survival----------98%

Svard and Price AAOS 2007
- 683 Oxford MB
- 20 yr survival--------92%

Oxford Phase 1 Study

- 1983 to 1988
- 23 to 28 year follow-up
- 125 implants (104 patients)

- 90% definitive knee replacement with
  - No revision
  - Good clinical score
**Fixed vs Mobile Bearing**  
**France**

- 75 pts (79) M-G fixed bearing  
- 72 pts (77) Oxford MB  
  
  **Min 15 yr f/u**  

**Survivorship @ 20 yrs:**  
- M-G 83%  
- Oxford 80%  

**No difference in KSS or radiographic results**  

**Implant specific modes of failure:**  
- M-G wear  
- MB dislocation  


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**Unicompartmental Knee Replacement Did Not Differ from Total Knee Replacement with Regard to Clinical Outcomes at 15 Years**  
Newman J, Pydisetty RV, Ackroyd C.  


- **52 PKA**  
- **50 TKA**

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<tr>
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<th>UKR</th>
<th>TKR</th>
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<td>Bristol knee score</td>
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<tr>
<td>Excellent (91 to 100)</td>
<td>71%</td>
<td>53%</td>
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<td>Good (81 to 90)</td>
<td>4.8%</td>
<td>16%</td>
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<td>Poor (61 to 70)</td>
<td>19%</td>
<td>26%</td>
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**Survivorship 15 yrs**  
- 3 of 4 revised  
- 4 of 6 revised

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**Morbidity and Mortality of PKA vs TKA**  
**1000 Consecutive UKA: 2004-2008**

- **90-day Perioperative Morbidity and Mortality**  
  - Hospital length of stay: 1.4 days (0-9 days)  
  - Deaths: 0 (0.0%)  
  - MI, CHF, Arrhythmia: 7 (0.7%)  
  - Transfusions: 5 (0.5%)  
  - VTE: 1 symptomatic DVT (0.1%)  
  - Deep infection: 1 (0.1%)  
  - Manipulation: 7 (0.7%)  
  - Return to OR Any Reason  

Berend KR et al. Orthopedics 2010

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**Post-Operative Morbidity Associated with TKA and UKA:**  
**A Multicenter Analysis**

- Nick Brown, BS  
- Neil Sheth, MD  
- Keith Berend, MD  
- Adolph Lombardi, MD  
- Mike Berend, MD  
- Craig J. Della Valle, MD  
- Philip M. Faris, MD  
- Robert A. Malinzak, MD

Courtesy of Rush University, Joint Implant Surgeons, and The Center for Hip and Knee Surgery
Methods

- Retrospective review, n = 2,919 knees
- (5 yr period)
- Consecutive series of 2,290 TKA’s and 629 UKA’s
- Three institutions:
  - Rush University Medical Center, Chicago, IL
  - Joint Implant Surgeons, Columbus, OH
  - CHKS, Mooresville, IN
- Excluded bilateral procedures, dx other than OA
- Standard Demographic data
- Charlson Comorbidity Index

Complications

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<th>TKA</th>
<th>UKA</th>
<th>P-Value</th>
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<td>MUA</td>
<td>124 (5.0%)</td>
<td>3 (0.4%)</td>
<td>&lt;0.0001</td>
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<td>Re-admission</td>
<td>82 (6.1%)</td>
<td>8 (2.1%)</td>
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<td>ICU admission</td>
<td>32 (1.4%)</td>
<td>1 (0.2%)</td>
<td>0.019</td>
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<tr>
<td>Transfusion</td>
<td>37 (1.6%)</td>
<td>1 (0.2%)</td>
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TKA trend toward increased VTED, PJI, Re-operation

Complications

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<td>DVT</td>
<td>11 (0.5%)</td>
<td>2 (0.3%)</td>
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<td>PE</td>
<td>13 (0.6%)</td>
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<td>0.747</td>
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<td>Deep infection</td>
<td>18 (0.8%)</td>
<td>1 (0.2%)</td>
<td>0.130</td>
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<tr>
<td>Re-op (90 d)</td>
<td>31 (1.4%)</td>
<td>4 (0.6%)</td>
<td>0.064</td>
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<tr>
<td>Death</td>
<td>6 (0.3%)</td>
<td>1 (0.2%)</td>
<td>1.00</td>
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<tr>
<td>Re-op (Any)</td>
<td>96 (4.2%)</td>
<td>17 (2.7%)</td>
<td>0.07</td>
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Total Complications

- TKA 11.0%
- 252 of 2290
- VS
- UKA 4.3%
- 27 of 629
- P < 0.001, Odds 2.8
Results: Stratified by Charlson Index

- If only Charlson Index “0” patients
  - TKA: 110 of 799 (13.3%)
  - UKA: 9 of 260 (3.3%)

- If Charlson 1 or >
  - TKA: 75 of 543 (13.8%)
  - UKA: 5 of 119 (4.2%)

TKA vs UKA: A Medicare Data Analysis

Mike Bolognesi, MD
Keith Berend, MD

Demographics

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<td>Mean age</td>
<td>74.6</td>
<td>74.2</td>
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<td>% Male gender</td>
<td>34%</td>
<td>45%</td>
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<td>Surgeon yrs. from graduation</td>
<td>23</td>
<td>24</td>
<td>&lt;0.001</td>
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<td>Inpatient</td>
<td>99%</td>
<td>92%</td>
<td>&lt;0.001</td>
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TKA more commonly:
- Older
- Female
- Surgeon practice longer
- Done as inpatient

Methods

- 5% National sample of Medicare sample of unilateral TKA and UKA
- 1999-2009
- Cox proportional hazard models (p<0.05)
- TKA: 65,685 (1,313,700)
- UKA: 3,105 (62,100)
  - 4.7% UKA utilization
### Results: Discharge

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<td>Discharge to extended care facility</td>
<td>20.0%</td>
<td>3.1%</td>
<td>&lt;0.001</td>
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<tr>
<td>Length of stay (days)</td>
<td>3.9</td>
<td>2.4</td>
<td>&lt;0.001</td>
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UKA = LOS and more commonly discharged home
$$ savings to the entire system

### Results: Complications

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<th>UKA</th>
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<tr>
<td>DVT/PE</td>
<td>0.7%</td>
<td>0.3%</td>
<td>0.028</td>
</tr>
<tr>
<td>Myocardial</td>
<td>0.4%</td>
<td>0.3%</td>
<td>0.275</td>
</tr>
<tr>
<td>Deep infection</td>
<td>2.1%</td>
<td>1.4</td>
<td>0.009</td>
</tr>
<tr>
<td>Revision (1yr)</td>
<td>1.2%</td>
<td>2.3%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Revision (5 yr)</td>
<td>3.7</td>
<td>8.0%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Death (90 days)</td>
<td>0.7%</td>
<td>0.3%</td>
<td>0.014</td>
</tr>
</tbody>
</table>

TKA inc. VTE, PJI, Death at 90-days
UKA inc. revision at 1 yr and 5 yr
Does not include MUA, wash-out, I&D procedures

### Mortality After UKR vs TKR (NJR)

- **Death rate - hazard ratio (adjusted)**
  - 90 day: 2.8 (95% CI 1.7-4.5)
  - 5 year: 1.6 (95% CI 1.4-1.7)

### Registry results

- Can remove surgeon bias
- Allow us to look at both high and low volume surgeons
- High and low volume centers
- Do not give any information regarding indications and technique
- Can tease out cause for revision in some
Swedish Arthroplasty Register

TKA failure at 10 yrs

<65 5%
>65 2.5%

PKA failure at 10 yrs

<65 10%
>65 5%

As experience and technique improve, so do results

Swedish Arthroplasty Register

Infection

Australian Arthroplasty Registry

90% at 10 yrs
Australian Arthroplasty Registry

New Zealand Arthroplasty Registry

PKA vs TKA

Revision of PKA 3X higher than TKA
Same in all registries
Some will use this data to discourage use of PKA

PKA vs TKA

OKS at 6 months
Predictive of long term result
PKA OKS 39
TKA OKS 37
Statistics favor PKA
Clinical PKA = TKA

So how do you explain the increased revision rate in PKA?

Worse 6m OKS score associated with higher 2 year revision rate
OKS <20 similar to worse than pre-op, Revision rate 30x higher than >40
Revision Rate vs Clinical Outcome NZJR

- Whatever the OKS revision rate of UKR is 5X that of TKR
- Some factor or factors independent of clinical outcome increases revision rate by 5 times

Surgeon Experience/Volume

- NZJR data (2005)
- Experience has greater effect on outcome than type of implant

Center and Surgeon Volume Influence the Revision Rate Following Unicondylar Knee Replacement
An Analysis of 23,400 Medial Cemented Unicondylar Knee Replacements

- Funnel plot of revisions per 100 component years versus center volume during the study period

Conclusions

- PKA for anteromedial OA of the knee is a viable, safe, minimally invasive option to TKA
- Short term failure rates are 2X TKA, but level off with time.
- Most failures occur in first 2 years
- Increased education, skills courses, and increased surgeon volume lead to results comparable to TKA in long term
Thank-you