THE KNEE SOCIETY

The 2014 Specialty Day Meeting of
The Knee Society

In association with the
American Association of Hip and Knee Surgeons
(AAHKS)

Final Scientific Program

Saturday, March 15, 2014
Ernest N. Morial Convention Center, Theater B
New Orleans, Louisiana
ANOUNCEMENTS

FUTURE MEETINGS AND CALLS FOR ABSTRACTS

AAOS Annual Meetings

March 24-28, 2015  Las Vegas, Nevada
March 1-5, 2016   Orlando, Florida
March 14-18, 2017 San Diego, California

The Knee Society Awards

Abstracts for the 2015 Knee Society Scientific Awards may be submitted on
The Knee Society website (www.kneesociety.org)

Abstracts are due by June 2, 2014

AAHKS 24th Annual Meeting

November 7-9, 2014
Sheraton Dallas Hotel, Dallas, TX

Call for Symposia Proposals Covering All Aspects of
Arthroplasty and Health Policy
Symposia submissions are due by May 1, 2014

Abstracts for the 2014 AAHKS Annual Meeting may be submitted on the AAHKS website (www.aahks.org)
Abstracts are due by June 2, 2014
WELCOME TO THE 2014 SPECIALTY DAY SCIENTIFIC MEETING OF THE KNEE SOCIETY AND AAHKS

GENERAL INFORMATION

The Mission of The Knee Society:

The mission of The Knee Society is to promote outstanding care to patients with knee disorders through innovative research and education.

Meeting Objectives:

The Knee Society/AAHKS Specialty Day Meeting is designed to update clinical skills and basic knowledge through research findings and biomechanical studies; to discuss the various surgical and non-surgical treatments and management of conditions related to the knee joint; to determine indications and complications in total knee arthroplasty; to critique presentations of surgical techniques and demonstrations of treatment options; and to evaluate the efficacy of new treatment options through evidence-based data.

CME Accreditation:

This activity has been planned and implemented in accordance with the Essential Areas and Policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint sponsorship of the American Academy of Orthopaedic Surgeons (AAOS) and The Knee Society. The AAOS is accredited by the ACCME to sponsor continuing medical education for physicians.

The American Academy of Orthopaedic Surgeons designates this live activity for a maximum of 7.75 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

IMPORTANT

- Please participate when audience response system (ARS) is used.
- Please do not remove ARS keypads from the session room.
- Please complete evaluation online at: https://www.surveymonkey.com/s/2014SD_KNEE
- Please silence all electronic devices while inside the session room.
- Please refrain from unauthorized photography and video recording of presentations.
- Your registration for, and attendance of, this session gives The Knee Society permission to capture images of session attendees and to use these images for internal and marketing purposes.
## ACKNOWLEDGMENTS

<table>
<thead>
<tr>
<th>Past Presidents of the Knee Society</th>
<th>Past Presidents of AAHKS</th>
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<tr>
<td>1983 Chitranjan S. Ranawat, MD</td>
<td>1991 J. Phillip Nelson, MD</td>
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<tr>
<td>1985 Richard S. Bryan, MD (Deceased)</td>
<td>1994 Richard C. Johnston, MD, MS</td>
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<td>1986 John N. Insall, MD (Deceased)</td>
<td>1995 Lawrence D. Dorr, MD</td>
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<td>1987 Charles O. Townley, MD (Deceased)</td>
<td>1996 Hugh S. Tullos, MD (Deceased)</td>
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<td>1988 David G. Murray, MD</td>
<td>1997 Merrill A. Ritter, MD</td>
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<td>1989 Frederick C. Ewald, MD</td>
<td>1998 Richard H. Rothman, MD, PhD</td>
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<td>1990 Lawrence D. Dorr, MD</td>
<td>1999 James A. Rand, MD</td>
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<td>1991 Herbert Kaufer, MD</td>
<td>2000 Richard B. Welch, MD</td>
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<td>1992 Paul A. Lotke, MD</td>
<td>2001 John J. Callaghan, MD</td>
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<td>1993 Leonard Marmor, MD</td>
<td>2002 Douglas A. Dennis, MD</td>
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<td>1994 David S. Hungerford, MD</td>
<td>2003 Clifford W. Colwell, Jr., MD</td>
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<td>1995 Richard D. Scott, MD</td>
<td>2004 Richard F. Santore, MD</td>
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<td>1996 Victor M. Goldberg, MD</td>
<td>2005 Joseph C. McCarthy, MD</td>
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<td>1997 W. Norman Scott, MD</td>
<td>2006 William J. Hozack, MD</td>
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<td>1998 James A. Rand, MD</td>
<td>2007 Daniel J. Berry, MD</td>
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<td>1999 Kenneth A. Krackow, MD</td>
<td>2008 David G. Lewallen, MD</td>
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<td>2000 Thomas S. Thornhill, MD</td>
<td>2009 William J. Robb, III, MD</td>
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<td>2001 Clifford W. Colwell, Jr., MD</td>
<td>2010 Mary I. O’Connor, MD</td>
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<td>2002 Robert E. Booth, Jr., MD</td>
<td>2011 Carlos J. Lavernia, MD</td>
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<td>2003 Cecil H. Rorabeck, MD</td>
<td>2012 Thomas P. Vail, MD</td>
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<td>2005 Russell E. Windsor, MD</td>
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<td>2006 Gerard A. Engh, MD</td>
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<td>2007 Michael A. Kelly, MD</td>
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<td>2011 Robert B. Bourne, MD, FRCSC</td>
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<td>2012 Giles R. Scuderi, MD</td>
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THE KNEE SOCIETY EXECUTIVE BOARD 2013-2014
Steven J. MacDonald, MD, FRCSC – President
Thomas K. Fehring, MD – 1st Vice President
Thomas P. Vail, MD – 2nd Vice President
Thomas P. Sculco, MD – 3rd Vice President
Robert L. Barrack, MD – Treasurer
Robert T. Trousdale, MD – Secretary
Giles R. Scuderi, MD – Immediate Past President
Robert B. Bourne, MD, FRCSC – Past President
Richard Iorio, MD – Membership Committee Chair
Keith R. Berend, MD – Membership Committee Chair-Elect
William J. Maloney, III, MD - Education Committee Chair
William L. Griffin, MD – Education Committee Chair-Elect
Kevin L. Garvin, MD – Research Committee Chair
John J. Callaghan, MD – Member-At-Large
Steven B. Haas, MD – Member-At-Large
Henry D. Clarke, MD – Ex-Officio

THE KNEE SOCIETY EDUCATION COMMITTEE 2013-2014
William J. Maloney, III, MD – Chair
William L. Griffin, MD – Chair-Elect
Kevin J. Bozic, MD, MBA
Stephen J. Incavo, MD
Timothy M. Wright, PhD – Ex-Officio
Adolph V. Lombardi, Jr, MD, FACS – Past Chair

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William J. Maloney, III, MD – Secretary
Robert T. Trousdale, MD – Treasurer
Thomas P. Vail, MD – Immediate Past President
Carlos J. Lavernia, MD – Past President

Members-At-Large:
Michael E. Berend, MD
Christopher L. Peters, MD
Stefano A. Bini, MD
Rafael J. Sierra, MD

THE 2014 PROGRAM CO-CHAIRS
The Knee Society:
William J. Maloney, III, MD

AAHKS:
Bryan D. Springer, MD

© 2014 The Knee Society
7:55 am – 8:00 am  
**WELCOME**  
Steven J. MacDonald, MD, FRCSC (London, ON Canada)  
President, The Knee Society

7:55 am – 8:00 am  
**WELCOME**  
Vincent D. Pellegrini, Jr, MD (Charleston, SC)  
President, The Hip Society

8:01 am – 8:40 am  
**Symposium I: Non-Operative and Non-Arthroplasty Options for Management of Knee OA**  
**Moderator:** William L. Griffin, MD (Charlotte, NC)

8:00 am – 8:40 am  
**Symposium I: Surgical Approach for Primary Total Hip Arthroplasty**  
**Moderator:** Daniel J. Berry, MD (Rochester, MN)

8:02 am – 8:07 am  
**Oral Agents: What’s the Evidence**  
Jay R. Lieberman, MD (Los Angeles, CA)

8:00 am – 8:06 am  
**Direct Anterior Approach: Safe and Effective**  
Joel M. Matta, MD (Santa Monica, CA)

8:08 am – 8:13 am  
**Injectables: Now and In the Future**  
William J. Maloney, III, MD (Redwood City, CA)

8:06 am – 8:12 am  
**Direct Anterior Approach - A Senior Surgeon’s Experience: It’s Not Too Late but is it Better?**  
Bernard N. Stulberg, MD (Cleveland, OH)

8:14 am – 8:19 am  
**Bracing and Shoe Wear: What’s the Evidence it Helps**  
Richard Iorio, MD (New York, NY)

8:12 am – 8:18 am  
**Anterolateral Approach**  
Adolph V. Lombardi, Jr, MD, FACS (New Albany, OH)

8:20 am – 8:25 am  
**Osteotomy: Current Role in our Armamentarium**  
Stephen J. Incavo, MD (Houston, TX)

8:18 am – 8:24 am  
**Posterior Approach: Is it the Gold Standard?**  
Mark W. Pagnano, MD (Rochester, MN)

8:26 am – 8:31 am  
**Arthroscopic Debridement: Can it Delay the Inevitable**  
W. Norman Scott, MD (New York, NY)

8:24 am – 8:40 am  
**Case-Based Discussion and Audience Response Panel:**  
Joel M. Matta, MD  
Bernard N. Stulberg, MD  
Adolph V. Lombardi, Jr, MD, FACS  
Mark W. Pagnano, MD

8:32 am – 8:40 am  
**Discussion**

8:41 am – 9:43 am  
**Symposium II: Unicompartmental Knee Replacement**  
**Moderator:** David G. Lewallen, MD (Rochester, MN)

8:40 am – 8:46 am  
**Short Stems Do Work**  
Roger H. Emerson, MD (Plano, TX)

8:42 am – 8:48 am  
**Patient Selection: Past and Present**  
Richard D. Scott, MD (Boston, MA)

8:46 am – 8:52 am  
**20 Years of Experience: Tapered Stems**  
John B. Meding, MD (Mooresville, IN)

8:49 am – 8:55 am  
**Why Unicompartmental Knee Replacement Fails?**  
Michael E. Berend, MD (Mooresville, IN)

8:52 am – 8:58 am  
**Extensively Coated Stems**  
C. Anderson Engh, MD (Alexandria, VA)

8:56 am – 9:11 am  
**Debate I: Mobile Bearing vs. Fixed Bearing: It Makes a Difference**

8:58 am – 9:04 am  
**35 Years of Experience with Cemented Stems**  
John J. Callaghan, MD (Iowa City, IA)

8:56 am – 9:04 am  
**Affirm**  
David W. Murray, MD, FRCS (Oxford, United Kingdom)

8:04 am – 9:10 am  
**Uncemented Acetabular Components**  
Aaron G. Rosenberg, MD (Deerfield, IL)

9:05 am – 9:11 am  
**Oppose**  
Craig J. Della Valle, MD (Chicago, IL)

9:16 am – 9:30 am  
**Case-Based Discussion and Audience Response Panel:**  
Roger H. Emerson, MD  
John B. Meding, MD  
C. Anderson Engh, MD  
John J. Callaghan, MD  
Aaron G. Rosenberg, MD  
J. Dennis Bobyn, PhD

9:12 am – 9:32 am  
**Newer Technologies**

9:16 am – 9:30 am  
**Achieving Bone Ingrowth and Cup Stability**  
J. Dennis Bobyn, PhD (Montreal, QC Canada)

9:12 am – 9:18 am  
**Video: Custom Implants**  
Thomas S. Thornhill, MD (Boston, MA)

9:30 am – 9:40 am  
**Break**

9:19 am – 9:25 am  
**Video: Patient Specific Instrumentation**  
Keith R. Berend, MD (New Albany, OH)

9:40 am – 10:20 am  
**Symposium III: Preventing Hospital Readmissions and Managing Complications**  
**Moderator:** Vincent D. Pellegrini, Jr, MD (Charleston, SC)
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<thead>
<tr>
<th>Time</th>
<th>Event</th>
<th>Speaker(s)</th>
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<tbody>
<tr>
<td>9:26 am – 9:32 am</td>
<td>Video: Robotic Assisted Implantation</td>
<td>Andrew D. Pearle, MD (New York, NY)</td>
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<tr>
<td>9:33 am – 9:43 am</td>
<td>Audience Response and Discussion</td>
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<tr>
<td>9:44 am – 9:59 am</td>
<td>Symposium III: Perioperative Management of the TKA Patient</td>
<td>Daniel J. Berry, MD (Rochester, MN)</td>
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<td>Panel Discussion and Audience Response:</td>
<td>William L. Healy, MD (Newton, MA)</td>
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<td></td>
<td>Panel: Steven J. MacDonald, MD, FRCSC (London, ON Canada)</td>
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<td>Panel: Kevin J. Bozic, MD, MBA (San Francisco, CA)</td>
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<td>Panel: Thomas P. Sculco, MD (New York, NY)</td>
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<td>Panel: C. Lowry Barnes, MD (Little Rock, AR)</td>
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<td>10:00 am – 10:15 am</td>
<td>Break</td>
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<td>10:15 am – 11:39 am</td>
<td>Symposium IV: The Primary TKA-Optimizing Outcome</td>
<td>Steven J. MacDonald, MD, FRCSC (London, ON Canada)</td>
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<td>10:15 am – 10:20 am</td>
<td>Patient Satisfaction After TKA: There's Room for Improvement</td>
<td>Michael J. Dunbar, MD, FRCSC, PhD (Halifax, NS Canada)</td>
<td>34</td>
</tr>
<tr>
<td>10:21 am – 10:26 am</td>
<td>Risks Factors for a Poor Outcome</td>
<td>Thomas P. Vail, MD (San Francisco, CA)</td>
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<td>10:27 am – 10:32 am</td>
<td>Why Total Knees Fail</td>
<td>Kevin J. Bozic, MD, MBA (San Francisco, CA)</td>
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<tr>
<td>10:33 am – 10:38 am</td>
<td>Alignment: What's the Target</td>
<td>Johan Bellemans, MD, PhD (Pellenberg, Belgium)</td>
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<tr>
<td>10:39 am – 10:44 am</td>
<td>Impact of Alignment on Outcome</td>
<td>Ormande M. Mahoney, MD (Athens, GA)</td>
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<tr>
<td>10:45 am – 10:53 am</td>
<td>Discussion</td>
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<td>10:54 am – 11:30 am</td>
<td>Alignment: How Do We Get it Right</td>
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<tr>
<td>10:54 am – 11:00 am</td>
<td>Conventional Instruments: The Gold Standard</td>
<td>Kevin L. Garvin, MD (Omaha, NE)</td>
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<tr>
<td>11:01 am – 11:12 am</td>
<td>Debate II: Computer Assisted Surgery: Finally Ready for Prime Time</td>
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<tr>
<td>11:07 am – 11:12 am</td>
<td>Oppose</td>
<td>Henry D. Clarke, MD (Phoenix, AZ)</td>
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<tr>
<td>11:13 am</td>
<td>Affirm</td>
<td>Robert L. Barrack, MD (Saint Louis, MO)</td>
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<tr>
<td>11:25 am</td>
<td>Robotic TKA: A Future Reality</td>
<td>Harry E. Rubash, MD (Boston, MA)</td>
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<td>11:52 am</td>
<td>Audience Response and Discussion</td>
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<td>11:40 am</td>
<td>Symposium V: The Knee Society Awards</td>
<td>William L. Healy, MD (Newton, MA)</td>
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<td>11:40 am</td>
<td>The John Insall Award</td>
<td>Michael A. Kelly, MD (Hackensack, NJ)</td>
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<td>11:42 am</td>
<td>Morbid Obesity and TKA: A Matched-Control Study</td>
<td>James A. Browne, MD (Charlottesville, VA)</td>
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<td>11:47 am</td>
<td>The Chitranjan Ranawat Award</td>
<td>Paul F. Lachiewicz, MD (Chapel Hill, NC)</td>
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<td>11:49 am</td>
<td>Randomized Clinical Trial Comparing Femoral &amp; Sciatic Blocks to Periarticular Injection for Pain Management after TKA</td>
<td>Mark J. Spangehl, MD (Scottsdale, AZ)</td>
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<td>11:54 am</td>
<td>The Mark Coventry Award</td>
<td>Robert T. Trousdale, MD (Rochester, MN)</td>
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<td>11:56 am</td>
<td>At 5 Years Highly-Porous-Metal Tibial Components Were Durable and Reliable in Primary Total Knee Arthroplasty: A Randomized Clinical Trial</td>
<td>Luis Pulido, MD (Rochester, MN)</td>
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<td>12:01 pm</td>
<td>Discussion</td>
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<td>12:06 pm</td>
<td>Lunch</td>
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<td>1:00 pm</td>
<td>Symposium VI: My Worst Case Competition</td>
<td>Leo A. Whiteside, MD (Saint Louis, MO)</td>
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<td>Arlen D. Hanssen, MD (Rochester, MN)</td>
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<td>Robert E. Booth, Jr, MD (Philadelphia, PA)</td>
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<tr>
<td>1:13 pm – 1:18 pm</td>
<td>Aaron G. Rosenberg, MD, FACS (Deerfield, IL)</td>
<td>KNEE (Theater B) Case-Based Discussion and Audience Response Panel:</td>
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<tr>
<td>1:19 pm – 1:24 pm</td>
<td>William J. Hozack, MD (Philadelphia, PA)</td>
<td>KNEE (Theater B) Symposium VII: Metallosis: Getting It Correct</td>
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<tr>
<td>1:25 pm – 1:28 pm</td>
<td>Audience Voting and Crowning of the New Champion</td>
<td>KNEE (Theater B) The Diagnosis of Metallosis-Not Infection: Getting It Correct</td>
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<tr>
<td>1:34 pm – 2:25 pm</td>
<td>Symposium VII: Performing A Primary TKA</td>
<td>KNEE (Theater B) Revision for Metallosis: Results of Revision for Failed THA</td>
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<tr>
<td>1:34 pm – 1:39 pm</td>
<td>Douglas A. Dennis, MD (Denver, CO)</td>
<td>KNEE (Theater B) AAOS Update</td>
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<td>1:40 pm – 1:45 pm</td>
<td>Giles R. Scuderi, MD (New York, NY)</td>
<td>KNEE (Theater B) 2014 Contestants:</td>
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<tr>
<td>1:46 pm – 1:51 pm</td>
<td>Aaron A. Hofmann, MD (Salt Lake City, UT)</td>
<td>KNEE (Theater B) Panel Discussion</td>
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<tr>
<td>1:52 pm – 1:57 pm</td>
<td>Considerations in the Varus Knee - Sequential Releases: Surgical Technique</td>
<td>KNEE (Theater B) Symposium IX: Revision Total Hip Arthroplasty (including video and surgical technique)</td>
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<tr>
<td>1:58 pm – 2:03 pm</td>
<td>Implant Constraint: Indications and Outcome with more Constrained Designs</td>
<td>KNEE (Theater B) Femoral Revision: Lessons Learned</td>
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<tr>
<td>2:04 pm – 2:09 pm</td>
<td>Balancing the Valgus Knee: Surgical Technique Video</td>
<td>KNEE (Theater B) Femoral Revision: Lessons Learned</td>
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<tr>
<td>2:10 pm – 2:15 pm</td>
<td>The Ankle in TKR</td>
<td>KNEE (Theater B) Femoral Revision: Lessons Learned</td>
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<tr>
<td>2:16 pm – 2:25 pm</td>
<td>Discussion</td>
<td>KNEE (Theater B) Femoral Revision: Lessons Learned</td>
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<td>2:26 pm – 2:40 pm</td>
<td>Break</td>
<td>KNEE (Theater B) Femoral Revision: Lessons Learned</td>
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<tr>
<td>2:40 pm – 3:23 pm</td>
<td>Symposium VIII: The Patella and Extensor Mechanism</td>
<td>KNEE (Theater B) Femoral Revision: Lessons Learned</td>
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<tr>
<td>2:40 pm – 2:46 pm</td>
<td>The Patella: To Replace or Not to Replace – What do the Registries Tell Us</td>
<td>KNEE (Theater B) Femoral Revision: Lessons Learned</td>
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<tr>
<td>2:47 pm – 2:53 pm</td>
<td>Patello-Femoral Arthroplasty: Indications and Outcomes</td>
<td>KNEE (Theater B) Femoral Revision: Lessons Learned</td>
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<tr>
<td>2:54 pm – 3:00 pm</td>
<td>Patello-Femoral Arthroplasty: How I Do It Video</td>
<td>KNEE (Theater B) Femoral Revision: Lessons Learned</td>
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<td>2:10 pm – 2:25 pm</td>
<td>Case-Based Discussion and Audience Response Panel</td>
<td>HIP (Theater A) Symposium VII: Metallosis</td>
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<tr>
<td>2:25 pm – 2:31 pm</td>
<td>Symposium VII: Metallosis</td>
<td>HIP (Theater A) The Diagnosis of Metallosis-Not Infection: Getting It Correct</td>
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<td>HIP (Theater A) Femoral Revision: Lessons Learned</td>
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<td>4:21 pm – 4:27 pm</td>
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Bassam A. Masri, MD, FRCSC (Vancouver, BC Canada) | 94   |
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Financial disclosures for The Hip Society Program are on pages: 98 - 101
In October 1993, The Knee Society’s Executive Board established an award program to recognize meritorious presentations at the annual Specialty Day meetings. In 1995, the Board designated three awards to be presented annually, in honor of The Knee Society members Mark Coventry (for the best Basic Science Paper), Chitranjan Ranawat (for the best work on a Surgical Technique), and John Insall (for the best work on a Clinical Subject or Outcomes Report).

This year’s recipients are:

**John Insall Award Paper**

*Morbid Obesity Alone Affects TKA Complications Mortality and Resource Utilization: A Matched-Control Study*

Presenter: James A. Browne, MD  
Co-Authors: Michele R. D’Apuzzo, MD and Wendy M. Novicoff, PhD

**Chitranjan Ranawat Award Paper**

*Randomized Clinical Trial Comparing Femoral & Sciatic Blocks to Periarticular Injection for Pain Management after TKA*

Presenter: Mark J. Spangehl MD  
Co-Authors: Henry D. Clarke, MD; Joseph G. Hentz, BS; Lopa Misra, MD; Joshua L. Blocher, PA-C and David P. Seamans, MD

**Mark Coventry Award Paper**

*At 5 Years Trabecular Metal Tibias Were Durable and Reliable in Total Knee Arthroplasty: A Randomized Clinical Trial*

Presenter: Luis Pulido, MD  
Co-Authors: Matthew P. Abdel, MD; David G. Lewallen, MD; Michael J. Stuart, MD; Joaquin Sanchez-Sotelo, MD, PhD; Arlen D. Hanssen, MD and Mark W. Pagnano, MD

Congratulations to all award recipients and their co-authors!
THE 2011 KNEE SOCIETY SCORE©

If you are a member of The Knee Society, please email knee@aaos.org to request your copy of The 2011 KS Score ©. You will be asked to sign a licensing agreement.

If you are a non-member physician or represent an academic institution or industry, please complete our online questionnaire. The link can be found on our website at: www.kneesociety.org/Outcomes. Upon completion, you will be advised of further steps. If you have any questions about The 2011 KS Score ©, please contact The Knee Society by email knee@aaos.org or tel (1) 847.698.1632.

SUPPORT THE KNEE SOCIETY THROUGH OREF

Under OREF’s new sharing plan, donors contributing less than $1,000 to the OREF annual campaign may now choose to designate 50% of their gifts to The Knee Society, with 50% directed to OREF. OREF has made this important enhancement to the 2011 OREF annual giving program in an effort to respond to frequent requests for a lower sharing level for donors and to increase the funds raised for The Knee Society, and for all the organizations that participate in the OREF designated giving program. This change invites broader participation by donors to The Knee Society at all gift levels. As in past years, donors contributing $1,000 or more (Order of Merit) will also have the opportunity to designate a portion of their gifts to The Knee Society, with a minimum of $500 directed to OREF. The Knee Society members can make secure online gifts to OREF and The Knee Society at www.oref.org/ks.
**AAOS/AAHKS/POSNA Open and Arthroscopic Techniques for Adolescent and Young Adult Hip Preservation/Disorders**

**July 24 (Evening) – 25, 2014 • Rosemont, IL**

Young-Jo Kim, MD, PhD, and Christopher M. Larson, MD

Course Directors

FAI/dysplasia thought-leaders. Concentrated hands-on training. One essential course!

**Course highlights include:**
- Spend **one full day in the hands-on lab** learning advanced open and arthroscopic treatment methods
- Learn from and interact with primary investigators in controversial topics
- Experienced faculty provide individualized instruction

**AAOS/AAHKS Advanced Surgical Techniques for Management of Knee Arthritis**

**October 10 – 11, 2014 • Rosemont, IL**

Keith R. Berend, MD, and Michael Bolognesi, MD

Course Directors

This highly-interactive course presents proven surgical techniques to treat knee arthritis and prevent and manage complications associated with primary and revision TKA.

**Course highlights include:**
- Spend the majority of your time in the cadaver lab working side-by-side with expert faculty
- Challenge the faculty and review problematic cases during lively panel discussions

Details & Registration

[www.aaos.org/3644](http://www.aaos.org/3644)

[www.aaos.org/3055](http://www.aaos.org/3055)
The International Society of Arthroplasty Registries in conjunction with The American Joint Replacement Registry and Massachusetts General Hospital present

3rd International Congress of Arthroplasty Registries
Hyatt Regency Cambridge, Overlooking Boston
May 31 - June 2, 2014

Online Registration Now Open and Preliminary Program Available Visit www.ajrr.net for more details.
Symposium I: Non-Operative and Non-Arthroplasty Options for Management of Knee OA

8:02 am – 8:07 am

Oral Agents: What’s the Evidence?
Jay R. Lieberman, MD

I. Oral Treatment Options
A. Non-steroidal anti-inflammatory agents (NSAIDs)
B. Acetaminophen
C. Opioids
D. Tramadol
E. Nutraceuticals
   1. Glucosamine
   2. Chondroitin sulfate

II. AAOS Guidelines – “Treatment of Osteoarthritis of the Knee”
A. Guidelines Recommendations
   1. Strong, Moderate, Limited, Inconclusive
B. Recommended Oral Agents – Symptomatic OA of Knee
   1. NSAIDs (strong)
   2. Tramadol (strong)
C. Inconclusive Recommendation
   1. Acetaminophen
   2. Opioids
D. Oral Agents – Not Recommended
   1. Glucosamine (strong)
   2. Chondroitin sulfate (strong)

III. Osteoarthritis Research International (OARSI Guideline) 2009
A. NSAIDs
   1. More effective than acetaminophen for pain relief
   2. Selective Cox inhibition plus PPI – avoid bleeding
B. Opioids
   1. Moderate to large effect size for reduction in pain
   2. Small to moderate effect size for improvement in physical function
   3. Frequent side effects – nausea, constipation, dizziness, vomiting
C. Glucosamine
   1. When eliminating studies with publication bias and poor quality the efficacy is equivocal.
   2. The evidence for a structure modifying effect is equivocal
D. Chondroitin Sulfate
   1. High quality studies – no evidence of significant pain relief
   2. Structure modifying effect – significant reduction in the rate of decline of joint space narrowing (Hochberg et al, 2008)
E. Acetaminophen
   1. Recommended as an analgesic (less than 4 g/day)
2. No significant effect on stiffness or physical function

IV. **American College of Rheumatology Guidelines (2012)**

A. Types of Recommendations
   1. Strong recommendation to use or not use
   2. Conditional recommendation
   3. No recommendation

B. Conditional Recommendations to Use
   1. Oral NSAIDs
   2. Tramadol
   3. Acetaminophen

C. Conditional Recommendation: Not to Use
   1. Chondroitin Sulfate
   2. Glucosamine

D. No recommendation
   1. Opioid analgesics

V. **Summary**

There is general agreement among the guidelines that NSAIDs and Tramadol are effective for the initial management of knee OA. Some guidelines suggest use of opioids for patients who have not had an adequate response to pharmacologic or nonpharmacologic agents and are either not candidates or unwilling to have a TKA.

**REFERENCES**


Injectables: Now and In the Future
William J. Maloney, III, MD

Given that osteoarthritis is one of the single most significant causes of disability and burden on healthcare systems, there is significant interest in understanding and mitigating this disease process. There has recently been an increasing emphasis on non-operative treatment modalities to ameliorate the symptoms and slow the progression of osteoarthritis.

The pathophysiology of osteoarthritis is characterized by mechanical and chemical destruction of hyaline cartilage. Currently, there are a number of injectable non-operative treatments that aim to mitigate the inflammatory process associated with cartilage degradation and others that aim to provide a restorative environment for cartilage maintenance or regeneration.

Corticosteroids have had the longest history as an injectable intra-articular treatment for osteoarthritis. Since the 1950s, steroids have been used to provide joint pain relief by prostaglandin synthesis and decreasing the activity of collagenase and other destructive enzymes. However, there is no evidence that intra-articular steroids slow disease progression and their ability to treat symptoms seems attenuate over 3 months and requires repeated administration to provide significant relief.

Hyaluronic acid has also been used since the 1960s in an effort to restore the viscosity of synovial fluid in degenerative joints. The majority of commercial formulations are purified from the combs of chickens and undergo chemical crosslinking to increase viscosity and prolong their half-life. In general, 2mL is injected into the affected joint once a week for 3-5 weeks. There has been a range of outcomes in clinical trials with the most recent meta-analyses demonstrating either no significant effect (Lo et al. and Arrich et al.) versus a significant improvement (Wang et al. and Bellamy et al.) in pain and function compared to placebo.

Platelet right plasma (PRP) has been utilized since the 1990s to provide high concentrations of growth factors intra-articularly to increase the synthetic capacity of chondrocytes. There are a variety of techniques and commercial kits available to create PRP, but in general, it requires 10-60mL of whole blood that is centrifuged and the PRP layer is then extracted and injected. Some clinical studies have demonstrated superiority of PRP vs HA (Kon et al. and Say et al.); however, there are no randomized controlled studies comparing PRP to other injectables or placebo that demonstrate clear superiority. In contrast, there is some concern that some increased concentrations of growth factors in PRP, such as VEGF may actually impair the reparation of hyaline cartilage.

Orthokine or Rengenokine as it is known in the United States was developed in the 1990s and approved for clinical use in 2003 in Germany. It involves the extraction of ~60mL of whole blood that is heated and incubated for 24 hrs on etched glass beads to increase the concentration of IL1-Ra, IL-4 and IL-10 which is then centrifuged, filtered and injected intra-articularly weekly for up to six weeks. One prospective randomized double-blinded placebo-controlled study has demonstrated superiority of Orthokine compared to hyaluronan or placebo (Balzer et al.).

Regenexx is another new injectable treatment that was developed in 2005 in the US that involves aspiration of bone marrow from the PSIS and subsequent laboratory isolation of mesenchymal stem cells that are either re-injected the same day or cultured for two weeks prior to injection. While the developers of this technique have reported good safety outcomes and MRI evidence of significant cartilage growth with concomitant improvement in pain, there have been no other clinical studies comparing this treatment to placebo or other existing injectables.

Lastly, recombinant IL-1Ra has recently come to market as Kineret by Amgen as an intra-articular treatment for rheumatoid arthritis. Although efficacy has been shown in canine models, there
has only been a small series (Chevalier et al.) that demonstrated no adverse events and ~40% improvement in clinical scores at 3 months post injection.

In summary, there are a variety of synthetic or autologous blood and bone marrow-manipulated products available for intra-articular injection to treat osteoarthritis. While some of these treatments have demonstrated efficacy in treating the symptoms of osteoarthritis, there is a significant lack of rigorous scientific data demonstrating the superiority of any one treatment.
Nonoperative treatments for unicompartmental degenerative arthritis of the knee include oral and injectable medications, weight loss, exercise, physical therapy, canes, crutches, braces, and orthoses.

**Braces**

Three types of knee braces are commercially available for treatment of a knee with degenerative arthritis: compression knee sleeves, supportive knee braces, and unloading knee braces. Polypropylene, neoprene, or elasticized knee sleeves may minimize swelling and provide a feeling of increased support and warmth about the knee without changing limb alignment, joint stability, or mechanical function. Some patients report a feeling of security with a knee sleeve, possibly because of enhanced proprioceptive feedback. Supportive knee braces include hinged braces (for varus-valgus instability), anterior cruciate insufficiency braces (for anteroposterior and rotatory instability), and patellofemoral braces (for patellofemoral malalignment or instability). Unloading braces are designed to apply a varus or valgus force at the knee and relieve pain during activity by distracting the joint space of the involved compartment during weight-bearing and activity. A fluoroscopic gait study demonstrated that condylar separation of the medial tibiofemoral joint space can be achieved with an unloading knee brace in patients with medial unicompartmental arthritis. All patients (twelve of fifteen) in whom condylar separation was achieved during gait in that study had a decrease in symptoms. Failure of the unloading knee brace was associated with obesity and a poor fit of the brace. Other studies have demonstrated similar efficacy of unloading knee braces. However, patient compliance and high cost have been mentioned as problems with unloading knee braces. They are difficult to wear for extended periods of time because of their size and because of the degree of force imparted to the limb to alter alignment. The use of varus stress producing devices on valgus knees with lateral compartment arthritis has not yet been validated.

**AAOS EBM Guidelines on Treatment of OA of the knee**

4. We are unable to recommend for or against the use of a valgus directing force brace (medial compartment unloader) for patients with symptomatic osteoarthritis of the knee.

**Strength of Recommendation: Inconclusive**

*Description:* An Inconclusive recommendation means that there is a lack of compelling evidence that has resulted in an unclear balance between benefits and potential harm.

*Implications:* Practitioners should feel little constraint in following a recommendation labeled as Inconclusive, exercise clinical judgment, and be alert for emerging evidence that clarifies or helps to determine the balance between benefits and potential harm. Patient preference should have a substantial influencing role.

**RATIONALE**

This recommendation is based on three separate studies; one high-strength study compared a valgus producing brace plus usual care to a neoprene sleeve brace plus usual care and to usual care alone. A second high-strength study compared a valgus directing force brace to a lateral wedge foot orthotic. The third study of moderate-strength compared a valgus directing force brace plus usual care to usual care alone. Therapies were compared with respect to how much they improved pain, stiffness, self-reported functional capacity, and physical performance measures (observed walking distance and number of stairs climbed in 30 seconds). Improvement using the varus producing brace was not consistently significant across the four studies. For all statistically significant comparisons, the clinical significance of the improvements in pain and physical function were unclear. Based on a lack of appropriate studies, the use of a varus directing force brace was not evaluated.
Footwear Modification and Orthotics
Well-padded, energy-absorbing shoe soles or orthotic devices can decrease the load across the knee joint during heel strike. Deformity of the ankle, hindfoot, or midfoot leading to limb malalignment can exacerbate tibiofemoral arthritic symptoms. Orthotic correction and supportive, adaptive footwear with a medial longitudinal arch support, a calcaneal cushion, and a rigid last can improve alignment of the foot. An ankle-foot orthosis may be necessary for severe ankle deformity, which can aggravate preexisting degenerative arthritis of the knee17,26. Heel and sole wedges can realign the foot 5° to 10° in either the varus or the valgus plane. With a lateral wedge and insole, the shift in alignment reduces medial joint-space loading52. Keating et al. evaluated 121 knees with medial unicompartmental arthritis in eighty-five patients who were treated with a lateral heel and sole wedge. Sixty-one of the 121 knees had a good or excellent result after four to twenty-four months of treatment. Knees with all grades of arthritic involvement showed improvement. Patients with stage-II disease according to the modified Outerbridge classification had the most improvement. A recent meta-analysis from Parkes et al questioned the efficacy of lateral heel wedges. Studies that compared the use of orthotics vs. neutral inserts consistently demonstrated no significant or clinically important impact. However, meta-analytic pooling of all studies showed a statistically significant association between use of lateral wedges and lower pain in medial knee osteoarthritis. The use of heel and sole wedges for patients with arthritis of the lateral compartment of the knee has not been reported, to our knowledge. Biomechanical manipulation of an osteoarthritic gait deviation through orthotic treatment has also shown some promise and awaits more rigorous clinical testing.

AAOS EBM Guidelines on Treatment of OA of the knee
RECOMMENDATION 5
We cannot suggest that lateral wedge insoles be used for patients with symptomatic medial compartment osteoarthritis of the knee.
Strength of Recommendation: Moderate
Description: A Moderate recommendation means that the benefits exceed the potential harm (or that the potential harm clearly exceeds the benefits in the case of a negative recommendation), but the quality/applicability of the supporting evidence is not as strong.
Implications: Practitioners should generally follow a Moderate recommendation but remain alert to new information and be sensitive to patient preferences.

RATIONALE
This recommendation is based on five studies. Four studies, one of high-strength and three of moderate-strength, compared outcomes using lateral wedge insoles to neutral insoles. No significant changes in pain, self-reported physical function, or Patient Global Assessment scores were seen between the two types of insoles. A fifth low-strength study compared urethane lateral wedge insoles to rubber lateral insoles, and found a statistically significant improvement in Lequesne score for urethane insoles, but this outcome was of uncertain clinical significance.

REFERENCES
- David S. Jevsevar, MD, MBA; Gregory Alexander Brown, MD, PhD; Dina L. Jones, PT, PhD; Elizabeth G. Matzkin, MD; Paul A. Manner, MD, FRSCSC; Pekka Moor, MD; John T. Schousboe, MD, PhD; Steven Stovitz, MD; James O. Sanders, MD; Kevin J. Bozic, MD, MBA; Michael J. Goldberg, MD; William Robert Martin, III, MD; Deborah S. Cummins, PhD; Patrick Donnelly, MA; Anne Woznica, MLIS; Leeaht Gross, MPH. The American Academy of Orthopaedic Surgeons Evidence-Based Guideline on: Treatment of Osteoarthritis of the Knee, 2nd Edition J Bone Joint Surg Am, 2013 Oct 16;95(20):1885-1886.
- Matthew J. Parkes, BSc1; Nasimah Maricar, MSc1; Mark Lunt, PhD1; Michael P. LaValley, PhD2; Richard K. Jones, PhD1,3; Neil A. Segal, MD4; Kayoko Takahashi-Narita, ScD5; David T. Felson, MD, MPH1,6,7. Lateral


Introduction: Degenerative arthritis isolated to one compartment is increasingly treated with unicompartmental arthroplasty. As this popular procedure continues to be refined, the utility of periarticular osteotomy is questioned. Joint preservation is, however, desirable for patients and surgeons alike. In this light, it is important to identify the ideal patient candidate for osteotomy.

Recent findings: The biomechanical principle - that compartment overload due to malalignment leads to degeneration of the articular surface, leading to further malalignment - has been well documented radiographically (1,2). Furthermore, the risk of medial compartment disease progression is substantially greater with higher Kellgren/Lawrence grade. For example, K-L grade 3 medial disease is five times more likely to progress than grade 0 or 1 disease. Similar, but less pronounced, findings are seen in lateral disease (3). This highlights the point that cartilage degeneration is much more likely slowed in early stage arthritis. Clinical studies have also identified advanced disease and obesity as two important factors leading to poor results after high tibial osteotomy, HTO (4,5).

Indications: Based on this information and clinical experience three separate patient groups can be identified for this procedure. A small group of patients to be considered for osteotomy are fracture patients, who present with malunion leading to varus or valgus knee deformity. A second patient group includes those undergoing a cartilage restoration procedure, meniscal transplant or anterior cruciate ligament (ACL) reconstruction if deformity is present. Increasingly, HTO (medial opening) is performed simultaneously to unload the damaged compartment in these patients. Definitive data on the utility of these procedures is still forthcoming. This will likely be the most common indication for HTO in the future. The third group consists of “young” patients in whom it is desirable to prevent arthritis progression. The best candidate for HTO is a young (<50), active, normal weight (BMI < 28-30) patient with localized pain and deformity with minimal radiographic arthritis (K-L 0, 1). If patient selection is within these parameters, it is likely that knee arthroplasty can be delayed for 8 – 10 years or longer.

Lateral compartment arthritis is best treated with a varus producing distal femoral osteotomy (DFO). In fact, results of this procedure, in terms of knee joint survivorship, can be superior to HTO (6). Newer locking plates are available for opening lateral wedge osteotomy to avoid the more complicated plate fixation of a medial closing wedge osteotomy.

The “preferred” amount of correction is a frequently debated issue. Many authors have recommended shifting the weight bearing axis to the junction of the medial two-thirds and lateral one-third of the tibial plateau. In a knee with minimal deformity, this makes sense. But if the patient has significant constitutional varus and is having unilateral HTO, I recommend four to five degrees more valgus than the normal knee. More than this will cause an undesirable cosmetic, and possibly functional, deformity.

My Preferred Technique: For medial compartment/varus knee deformity, the superiority of tibial medial opening wedge or lateral closing wedge is not apparent from our literature. I perform medial opening wedge osteotomy because it is less deforming to the proximal tibia, involves a single saw cut, avoids the lateral compartment muscles and peroneal nerve and does not alter the medial-lateral ligament balance of the knee. There is no need to cut the MCL, as it can be elevated and retracted posteriorly. The bone cut can be made just proximal to the patellar ligament insertion on the tibial tubercle and angled toward the fibular head, staying at least one centimeter distal to the joint surface. The osteotomy can be carefully hinged open when the cut is within 5 – 10 mm of the lateral cortex.

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Medial opening wedge osteotomies, however, are more prone to nonunion and loss of correction. To avoid this, grafting of the opening wedge should always be performed. (Autogenous iliac crest graft is not necessary.) A variety of plates are available and all appear satisfactory if the lateral cortex remains intact. If there is disruption of the lateral cortex, more secure fixation such as a medial locking plate or the addition of a small plate laterally is necessary.

Finally, it is likely that most osteotomy patients will eventually undergo knee arthroplasty. To facilitate future surgery when performing osteotomy the following suggestions are helpful:

1.) Minimize tibial bone deformity using an opening medial wedge
2.) Correction of more than 12 degrees is difficult to achieve. In the rare case that more angular correction is desired, consider a different osteotomy technique
3.) Use a longitudinal incision near the midline
4.) Remove the hardware after the osteotomy is healed

REFERENCES

Arthroscopic debridement, if done for the correct indication, can delay the inevitable, an eventual total knee arthroplasty (TKA)

There is a rather broad definition of “Debridement “and this lack of clarity adds to the confusion in interpreting the literature. In the vernacular, as contrasted to CPT codes, a debridement includes a meniscectomy, loose body excision (mechanical issues), a chondroplasty, which is rarely an elimination of a mechanical impingement, and a synovectomy which is almost never quantified.

It would be ideal to cite Evidence Based Data (EBD) comparable to the knee arthroplasty literature in defending arthroscopic debridement procedures but I can’t accomplish that due to the limited studies. But neither can other non-operative modalities that you just heard about. In fact the AAOS Guidelines¹ state that there is NO indication for injectables, valgus bracing, and osteotomies.

In discussing debridement, the AAOS guidelines “Strong” recommendations against recommending debridement does not apply if the primary diagnosis is meniscal tear, loose body or other mechanical derangement. The controversy surrounding an arthroscopic debridement began in 2002 with the publication by Mosley et al in the New England Journal of Medicine². The criticisms of that report have been numerous and included selection bias, lack of sufficient pathological descriptions, especially of types of meniscus tears which, for humane reasons, were performed in two of the three contrasted groups: 1. Lavage and meniscectomy, 2. Lavage, menisectomy, debridement chondroplasty, and 3. The placebo group, where no instruments were used. This low powered Mosley group did not focus on the patients who were candidates for total knee replacement (TKR).

There are, however, two studies that did focus on the concept of a patient delaying a TKR because of an arthroscopic debridement. In 1999, McGinley, Cushner, and Scott³, found that of 91 patients who were candidates for a TKR, only 33% of the patients in a mean 13 year follow up, underwent a TKR.

More recently in 2013, Steadman et al⁴ reported that 40% of his 72 patients who were candidates for a TKR but wanted to defer, delayed their TKR for a 10 year minimum. These results seem compatible with both the McGinley study and a report by Aaron in 2006⁵ where the severity of the knee arthritis was somewhat helpful in delineating arthroscopic results.

Thus, arthroscopic debridements of intra articular mechanical problems do have a role in delaying an eventual TKR⁶. Patient selection includes the patient not being desirous of a replacement, has acute on chronic symptoms, a significant torn meniscus or loose body, good range of motion, no fixed deformity and unilateral not bilateral symptoms.

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5: Arthroscopic Débridement for Osteoarthritis of the Knee

6: What, if Any, Are the Indications for Arthroscopic Debridement of the Osteoarthritic Knee?
In 1989, S. Kozinn and I reported on the “classic indications” for unicompartmental arthroplasty. Criteria included an elderly patient, noninflammatory osteoarthritis, a mechanical axis deformity of less than 10 degrees of varus or 5 degrees of valgus, an intact anterior cruciate ligament (ACL) without mediolateral subluxation, a flexion contracture less than 15 degrees, a body weight less than 80 to 90 kg, and patellofemoral changes not greater than grade II or III. Several years later, Stern and colleagues studied their osteoarthritic patient population and found that 6% of patients fulfilled all these selection criteria. Coincidentally, approximately 6% of the knee arthroplasty market received unicompartmental replacement. This percentage remained relatively stable until the advent of minimally invasive surgery at the beginning of the 21st century. The advantages of this technique include less time in hospital with a faster recovery and faster return to work and recreational activities. Enthusiasm for the procedure began to grow quickly, perhaps to a point where some perspective was lost regarding indications for the procedure. Poor early survivorship began to be reported.

My own perspective changed somewhat when we examined our second decade survivorship in unicompartmental devices implanted in the mid-1970s. Although the reoperation rate progressed for the first decade at an acceptable 1% per year of follow-up, the need for revision surgery appeared to grow faster in the second decade than that seen for bicompartmental replacement. This made me question the advisability of performing UKA in patients with approximately 15 to 20 years of life expectancy. These patients would have a greater statistical chance of requiring no further surgery throughout the remainder of their lifetime with TKA rather than UKA. Using this rationale, I began to stratify my UKA candidates into two categories. The first would be a middle-aged patient, especially female, and the second would be an octogenarian. I began to think about the procedure as the first arthroplasty in middle-aged patients that would buy them 10 or more years of longevity with an easy conversion to TKA when that was inevitably necessary in later life. They would benefit from a high initial success, few early complications relative to high tibial osteotomy (HTO), an acceptable cosmetic appearance relative to HTO, preservation of both cruciate ligaments relative to TKA, and an easier revision in comparison with both HTO and TKA.

Advantages for the octogenarian would include faster recovery, less blood loss, less medical morbidity, and a less expensive procedure to be borne by the health care system. Given the life expectancy and activity level of octogenarians, the UKA would be unlikely to require revision in their lifetime.

More recent reports on survivorship of UKA in the second decade using better surgical technique and prosthetic components along with improved polyethylene now make UKA an attractive alternative in all age groups who fulfill today’s selection criteria. Inflammatory arthritis, severe deformity and a flexion contracture remain contra-indications. A deficient ACL may not be a contra-indication for the use of a fixed bearing as long as the tibial wear pattern remains in the anterior 2/3s of the plateau. In these cases tibial posterior slope should be limited to zero to 5 degrees. Excessive body weight is no longer an absolute contra-indication. There is more concern with survivorship in middle-aged mesomorphic male patients than in obese sedentary patients. Finally, the condition of the patellofemoral joint remains a controversial factor in selection with most surgeons avoiding UKA in the presence of grade IV changes anywhere in this compartment while the Oxford group is concerned only when the eburnated bone involves the lateral patellar facet and trochlea.
Partial knee arthroplasty is making resurgence as many patients and surgeons are realizing that there are good options for preserving normally functioning knee tissues when facing end-stage knee OA without having to automatically proceed to TKA. What are potential advantages of this type of reasoning and could “less be more”? “Failure” of a knee arthroplasty is far beyond revision to a TKA as reported in many registries to be higher for UKA compared to TKA.

TKA is not a benign treatment for isolated unicompartmental knee disease. A multicenter study examining 2,919 TKA’s and UKA’s found lower rates of overall complications at 11% for TKA’s and 4.3% for UKA’s.[1] Significant variables for TKA included longer length of stay, more patients sent to an ECF, higher manipulation rate, higher readmission, ICU admission, and transfusion rates. Bolognesi, et al examining 68,790 TKA and UKA, reproduced these results with lower DVT/PE, deep infection rates and lower death rates. The 1 year and 5 year revision rates were higher for UKA’s and have been hypothesized to be lower thresholds for revision of dissatisfied UKA vs a TKA with well-fixed implants.[2]

Functional improvements may be better for UKA vs TKA [3] further substantiating the evidence that “less is more” for the surgical treatment of isolated compartmental disease of the knee. We conducted a multicenter independent survey of 1,263 patients (age 18-75) undergoing primary TKR and PKR for non-inflammatory knee DJD. We examined 13 specific questions regarding pain, satisfaction, and residual symptoms after knee arthroplasty.

Univariate analysis revealed PKR patients were more likely to be younger, male, and have an income greater than $25,000 compared to TKR patients. Multivariate analysis showed that mobile bearing PKR patients were 1.81 times more likely to report that their operative knee felt “normal” (p = 0.0109) and 2.69 more likely to report satisfaction with ability to perform activities of daily living than TKR recipients (p = 0.0058).

This study demonstrated that patient satisfaction is higher for PKR than TKR with patients more likely reporting the knee to feel normal and that they were more able to perform activities of daily living.

TKA’s are more likely to be revised for infection and less likely to be revised for pain compared to well fixed UKA’s with satisfactory x-ray findings. The definition of failure in knee arthroplasty should be carefully weighed when comparing UKA and TKA results.

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Unicompartmental knee replacements (UKR) have many advantages compared to Total replacements (TKR), including better function and satisfaction, a faster recovery with fewer complications, lower morbidity and mortality and improved cost-effectiveness. They do however have a higher failure rate, which needs to be addressed. The failure rate of UKR is heavily influenced by surgical experience. Surgeons that do small numbers tend to have very high failure rates whereas those who do large numbers have low failure rates. As surgeons have little control over the size of their knee replacement practice, the only way they can increase their UKR numbers is by using broad indications and therefore increasing the proportion of their knee replacements that are UKR. The most important difference between mobile and fixed bearing UKR relates to the indications and contraindications. With fixed bearing UKR there are many contraindications such as young age, high activity, high weight and damage to the patella-femoral joint, so only a small proportion of knee replacements are considered to be appropriate. In contrast with mobile bearing UKR, these contraindications do not apply as they do not compromise the long term outcome, so the optimal usage is between 25% and 50% of knee replacements. With these high levels of usage the re-operation rates of mobile bearing UKR and TKR are similar, so the only disadvantage of UKR compared to TKR has been addressed.

The reason why the contraindications for fixed bearing UKR do not apply to the mobile relate to the implant design. With the mobile bearing linear wear is nearly an order of magnitude lower than with the fixed so the device performs well in the long term in young, active or heavy individuals. With time, in fixed bearing devices, the femoral component wears a divot in the polyethylene which may compromise the kinematics. This and impingement of the front of the fixed bearing femoral component may cause problems with the patella-femoral joint. The wear in the fixed polyethylene may also cause shear stresses at the bone-implant interfaces which may contribute to loosening. For optimal load transmission to the tibia, to minimise pain and loosening, metal backing and limited bone resection are essential. This can be achieved with mobile bearing devices as thin polyethylene is used. In contrast it cannot be achieved with fixed bearing devices as all polyethylene tibial components do not have metal backing and metal backed components require thick polyethylene and therefor deep resections.
Fixed bearing unicompartmental knee arthroplasty (UKA) has a long history that extends back nearly as far as the first tricompartmental designs. While initial results were erratic, with a greater understanding of patient selection and surgical techniques, more consistent and favorable results have been reported with survivorship that rivals that of TKA. In the most recent review of our initial series of 62 medial UKA, survivorship was 90% at 20 years. Despite the recent popularity of mobile bearing UKA, there are several compelling reasons to select a fixed bearing design.

Among the primary advantages of a fixed bearing design is a surgical technique that is straightforward, familiar and forgiving. When a mobile bearing design is utilized, there is a risk of bearing dislocation unless the flexion and extension gaps are precisely balanced. Comparative studies of fixed and mobile bearing UKA show that mobile bearing UKA has a higher rate of early complications compared to a fixed bearing design. Further, in an effort to avoid bearing dislocation, the surgeon may be tempted to utilize a thicker bearing that can predispose to contralateral compartment arthritis. Finally, mobile bearing designs are not presently available for implantation on the lateral side of the knee, as prior studies have shown an unacceptable risk of bearing dislocation.

The theoretical advantages of a mobile bearing design include lower wear and a lower risk of loosening secondary to decreased stress at the implant interfaces. Interestingly, in most series of fixed bearing designs, wear is a relatively uncommon cause of failure while loosening is a not uncommonly reported mode of failure of mobile bearing designs. While both mobile bearing and fixed designs can be associated with excellent outcomes, the theoretical advantages of lower wear and implant stresses must be weighed against the relative complexity of the mobile bearing surgical technique and risk of bearing dislocation.

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The term custom implants in unicompartmental knee replacement (UKA) is best referred to as patient-specific implants. In the systems available patient-specific implants are combined with patient-specific instruments. The implant and instruments are fabricated using a CT based technology that allows for alignment, sizing, component positioning and implantation. The system is available as a medial UKA, lateral UKA or a medial or lateral Duocondylar replacement. This discussion will be limited to medial and lateral UKA.

The advantage of a patient-specific medial UKA is there is generally excellent coverage provided by the component and potentially the patient-specific instruments may make implantation easier for the surgeon. The concern of patient-specific medial UKA is that there are limited component sizing options that would allow intraoperative decision making and there are only 2 polyethylene thickness provided. Moreover, the amount of tibial bone with current systems tends to be a greater resection depth compared to standard UKAs.

Most unicompartmental designs are fabricated for use on the medial side of the knee. The lateral compartment is, in fact, quite different in terms of the relationship between the femur and the tibia, the geometry itself as well as the lateral patellar facet and the transition between the lateral trochlea and the implant. For this reason use of a standard medial UKA is more difficult to implant on the lateral side of the knee.

Lateral UKA with the patient-specific implants is in this author's opinion preferable to standard UKAs. It generally allows us ideal coverage on the tibial side and the anterior portion of the femoral component has a substantially better articulation with the lateral facet of the patella.

In the decision making process, the patient is generally consented for either a unicompartmental or total knee arthroplasty. In a patient-specific UKA, if the intraoperative findings determined that a TKA is needed, then the UKA is wasted. To limit this possibility, an arthro CT knee rather than a CT alone is used both to fabricate the implant and the instruments as well as to have a better evaluation of the articular cartilage on the 2 uninvolved articulations. A template is provided indicating the position of osteophytes that must be removed.

Technically, the exposure for a patient-specific UKA is more easily done with a medial arthrotomy on the medial side and a lateral arthrotomy on the lateral side. Osteophytes will need to be removed and are indicated on the template that accompanies the implant and instruments. The femoral guide is placed once the osteophytes are removed and the outline of the implant is marked. Any remaining articular cartilage is then carefully removed from the entire component coverage area surface on the femur and tibia. At this point the balancer chip is placed to determine soft tissue tension and angular correction. There are 4 balancer chips provided and it is essential to understand that the thicker the balancer chip, the less tibial bone is resected. Once the proper balancer chip is selected, the tibial cutting guide is placed and the resection performed. A key measurement is the amount of posterior bone that should be resected and this is also provided by the template. Using an L guide, the tibial surface is linked to the femoral surface, both in terms of orientation and level of resection. At this point, the femoral and tibial fixation lugs are determined and implantation is similar to all UKA systems.
Newer Technologies

Patient Specific Guides for Unicompartmental Knee Arthroplasty

Keith R. Berend, MD

Patient specific guides (PSG) have been used for several years in total knee arthroplasty, and recently have been introduced for use with medial unicompartmental knee arthroplasty. The guides facilitate component sizing, and individual position of the femoral and tibial components aligned with the mechanical axis as well as medial-lateral position, rotation, femoral flexion, and tibial posterior slope. The tibial positioning guide provides a captured slot to optimize the vertical cut.

### Current UKA Platforms for Patient-Specific Alignment Guides

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<tr>
<th>Manufacturer</th>
<th>Product</th>
<th>Imaging</th>
<th>US Launch</th>
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<tr>
<td>Biomet; Warsaw, IN</td>
<td>Signature™</td>
<td>MRI</td>
<td>10/2011</td>
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<tr>
<td>Zimmer; Warsaw, IN</td>
<td>Patient Specific Instruments</td>
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To validate one manufacturer’s system, 5 cadaveric knees were scanned using MRI, and PSG were developed to place the medial mobile-bearing UKA device. Partial knee arthroplasty was then performed using these PSG and radiopaque dowels were placed into the pin positions as directed by the PSG. A CT of the cadaver limb was then obtained to determine the accuracy of PSG construction and design for placing the pins and performing the bony resections. The operative technique for the mobile-bearing medial partial knee utilized describes acceptable alignment for the femoral component to be +/- 10° varus/valgus; <10° flexion and <5° extension. For the tibial component, acceptable alignment is within +/-5° varus/valgus and 2° - 13° of posterior slope. Utilizing these parameters, there were no outliers in any alignment measure in any knee. The mobile-bearing medial partial knee offers the thinnest construct of any metal backed UKA with 3.5mm of polyethylene and 3mm of metal backing. The recommendation is to perform a conservative tibial resection and the tibial PSG are designed to accurately guide resection of 7mm of tibia, allowing for either a 3 or 4mm bearing. Of the five cadaver knees, there was one resection at 8mm, the remainder being 7mm or less. While further study is necessary to prove the effectiveness and accuracy of PSG in medial mobile-bearing UKA, this cadaveric study demonstrates that the procedure is accurate at placing the guides within the acceptable alignment 100% of the time and conservative on tibial resection depth to within 1mm of the planned amount 100% of the time.

The second manufacturer estimates that 2000 PSG-UKA have been performed worldwide with their system since its launch in February 2012, representing 10% of all UKA procedures using their implants.

The utilization of PSG in knee arthroplasty has several benefits. They facilitate preoperative planning, obviate the need for violation of the intramedullary canals, reduce operating times and improve OR efficiency, decrease instrumentation requirements and thereby reduce potential for perioperative contamination. Most importantly, PSG facilitate accurate alignment, which ultimately has been shown to enhance long-term survivorship in knee arthroplasty.
Newer Technologies

Robotic Partial Knee Replacement:
Enhanced Control of Implant Position, Lower Limb Alignment, and Soft Tissue Balance
Andrew D. Pearle, MD

Computer assisted surgery utilizes digital tools for surgical planning and intraoperative execution. The rationale for using these tools is to enhance the surgeon’s control of technical variables that influence surgical outcome. Current forms of robotic partial knee replacement (PKR), an advanced iteration of computer assisted surgery, utilize CT imaging and kinematic analysis for 3D planning, and haptic guided robotic techniques for implementation of the plan.

Since the robotic tool in PKR is simply an instrument to enhance the surgeon’s control over technical variables, it is essential to define the surgical variables that impact patient outcome in this procedure. The purpose of this lecture is to explore the surgical variables that impact outcome after PKR and to delineate the variables that are controlled by the robot, as well as those variables that are independent of the robotic technique. Specifically, the talk will discuss how the robotic tool can help control implant position, soft-tissue balance, and lower limb alignment with data that explores the efficacy of this robotic control. Additionally, the talk will highlight the variables that are independent of the robotic tool such as implant design, fixation, and patient selection.

Teaching Goals

- Discuss the surgical variables that influence outcome after PKR
- Establish variables that are controlled by the robotic technique as well as the variables that are independent of the robotic tool
- Demonstrate the surgical technique focusing on how the robotic tool controls certain surgical variables
- Present data evaluating the precision of the robotic tool in controlling surgical variables
- Present multicenter data on 2 year survivorship and patient satisfaction after robotic PKR
Satisfaction is increasing employed as an outcome measure for a successful Total Knee Arthroplasty (TKA). As an outcome metric post TKA, satisfaction encompasses many different intrinsic and extrinsic factors related to a person’s experience with the TKA experience. The Swedish Knee Arthroplasty Register has previously demonstrated on a large population study that 17 percent of TKA recipients are dissatisfaction with their TKA outcome. This finding has been replicated in other countries with similar rates of dissatisfaction. Furthermore, similar significant factors emerged from these registry studies that were predictive of and related to satisfaction after TKA.

Satisfaction after TKA correlates most strongly with relief of pain, followed by improvement in physical function. Satisfaction is a function of the chronicity of disease process leading to TKA, with patients with long standing disease states reporting higher rates of satisfaction than those with acute onset pathologies, such as avascular necrosis. Importantly, unmet pre-operative expectations are a significant and strong predictor for dissatisfaction after TKA, much more so than complications resulting from TKA.

With the above in mind, several strategies to improve rates of satisfaction emerge. Firstly, every effort should be made to understand the nature and drivers of a patient’s pain, including its chronicity, and embrace multi-modal strategies to address peri-operative pain. Secondly, research into methods to improve physical function after TKA should be continued. Finally, efforts should be made to understand a patient’s specific expectations of the outcome of the TKA and counsel them appropriately about the limitations of TKA.

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Risks Factors for a Poor Outcome
Thomas P. Vail, MD

Understanding risk factors for a poor outcome after total knee arthroplasty is extremely important in order to minimize the risk of a poor outcome and properly risk adjust to accurately assess the value of care provided. A complete assessment of risk takes into account patient factors, surgeon factors, and the health care environment where surgery is performed. Analysis of the Medicare population reveals that chronic pulmonary disease, depression, alcohol abuse, drug abuse, renal disease, hemiplegia or paraplegia, and obesity are all independent risk factors for early revision. Registries are able to detect higher than anticipated revision rates by stratifying based upon patient characteristics such as age, gender, site of care, and surgeon experience. While the information that is derived from these administrative databases is extremely helpful, it may not provide a comprehensive picture of “orthopaedic risk factors” and patient reported outcome. A survey of Knee Society membership identified additional risk factors including previous infection, angular deformity ≥15°, extensor mechanism deficiency, limited range of motion, need for ambulatory support, retained hardware, post-traumatic arthritis, previous open surgery, inflammatory arthritis, and flexion contracture as hazards that must be accounted in risk adjustment models. Other general conditions that affect outcome include a history of DVT/PE, obesity, psychiatric conditions, diabetes, chronic pain management, system musculoskeletal conditions, peripheral vascular disease, workman’s compensation status, socioeconomic status, immune compromising conditions, cardiac disease, nutritional status, smoking, age, and pre-operative functional status. Finally, patient reported outcome (PRO) and satisfaction is a separate and evolving art and science. PRO may be related to functional status after surgery, but will also be a function of the patients’ expectations and magnitude of change from the pre-operative condition.
Why Total Knees Fail
Kevin J. Bozic, MD, MBA

Background: Despite the success of primary total knee arthroplasty (TKA), an increasing number of revision TKA procedures are being performed. Identifying the mechanisms of failure in revision TKA is critical to guiding efforts to improve clinical outcomes. The purpose of this study was to characterize the epidemiology of revision TKA in the United States with respect to patient, hospital, geographic, and payer characteristics.

Methods: The Nationwide Inpatient Sample was used to evaluate the cause of failure for 301,718 revision TKA procedures performed between Q4 2005 and 2010. Patient characteristics, procedure information, and resource utilization were compared across revision TKA procedures, and trends in revision burden and cause of revision were compared across time points.

Results: The number of revision TKA procedures increased from 48,260 in 2006 to 67,534 in 2010, and an increase in revision burden (# of revision TKA procedures/total # of (primary + revision) procedures) from 8.9% to 9.3%. Revision TKA procedures were more common in women (58%), and were most commonly performed in 65-74 year olds. A Moderate severity of illness score was recorded in >60% of patients. Periprosthetic joint infection (PJI) (25%) and mechanical loosening (18.5%) were the most common reasons for revision; osteolysis (2.9%) and periprosthetic fracture (1.6%) were least common. All-component revision accounted for 37% of all revisions in 2010, while arthrotomy/removal of prosthesis accounted for 13%, isolated tibial insert revision accounted for 12%, tibial component revisions 10%, patellar component revisions 5%, and femoral component revisions accounted for 4%. Medicare payer status accounted for >50% of revisions. Revision TKA procedures were more common in large, urban non-teaching hospitals and in the South and Midwest regions. PJI and periprosthetic fracture were associated with the longest length of stay (>7 days). The highest average hospitalization costs were for periprosthetic fracture (~$35,000).

Conclusions: The burden of revision TKA is growing, a nearly 40% increase in the number of hospitalizations for revision TKA was observed from 2006 to 2010. Elderly and female patients with a moderate number of comorbidities represent a large proportion of the revision TKA population. PJI and mechanical loosening are the most common causes of revision TKA. Revisions for PJI and periprosthetic fracture are the most resource intensive. Future efforts should be focused on reducing the risk of PJI in patients undergoing TKA procedure.

REFERENCES

Restoration of neutral mechanical alignment is since a long time considered as one of the key factors for successful total knee replacement. The fact that neutral mechanical alignment is associated with improved implant durability when compared to knees that have not been restored to neutral is well documented in literature. Several published series from the eighties and nineties have indeed shown increased polyethylene wear, osteolysis, and implant loosening in knees that were not restored to neutral. (1-7) It is generally accepted that these adverse events occur due to the fact that deviations from neutral mechanical alignment lead to increased mechanical loads on the implant as well as the bone-prosthesis interface, leading to subsequent implant and/or fixation failure.

In recent years however, material properties, polyethylene quality as well as implant fixation have improved significantly, to such an extent that modern TKA might be less subject to these issues that were of concern in the past. Recent literature seems to confirm this. (8-11) Several recent studies have indeed failed to demonstrate an inferior outcome for so-called malaligned versus neutrally aligned knees when modern implants and a contemporaray surgical technique was used.

As a consequence of this, the concept of restoring anatomic rather than mechanical alignment has gained interest. In this philosophy the natural alignment of the knee is restored to its original state that was reached at skeletal maturity, before the disease or damage had occurred. The authors have defined this as the patient’s constitutional alignment. (15)

Such approach would not necessarily restore the alignment to neutral; it was indeed recently demonstrated that a significant number of patients have a constitutional alignment that deviates from neutral. For example, the proportion of individuals with constitutional varus (≥3°) was as high as 32% in males and 17% in females in the author’s study. (15) This number may seem relatively high at first sight and underrecognised in the past. The reason for this is that many of the classic alignment studies have been flawed with several shortcomings, such as a limited number of participants, a large variability in the subject’s age, recruitment in a hospital setting, lack of stratification and selection bias of the subjects.

Patients with constitutional varus have since their end of growth always had varus alignment. It is logical to assume that restoring neutral alignment in these patients would feel abnormal to them, and moreover, this would almost per definition require some degree of surgical medial soft tissue release (14-15). Restoring the knee to its constitutional alignment by leaving it in in slight varus and in harmony with its surrounding soft issue sleeve could therefore be a more logical option. Recently published studies seem to confirm this. (12-14) Vanlommel et al noted that preoperative varus knees that were corrected to their constitutional alignment did perform better both functionally as well as subjectively when compared to those knees that were restored to neutral mechanical alignment. (12)

The debate continues however on which is the most optimal method to restore constitutional alignment. In theory several options exist. One could leave the femoral and/or tibial component slightly undercorrected, or one could aim for full anatomic restoration, including the obliquity of the joint line.

The latter has been popularized as kinematic alignment reconstruction, during which the eroded or damaged parts of the knee are resurfaced to its original anatomic contours. Today it remains however undetermined whether one of these strategies is to be considered superior in terms of functional and subjective outcome, and whether an evenly durable implant survivorship can be obtained as compared to the classical concept of mechanical alignment restoration. (16) Further clinical research in this domain will be necessary to clarify this.
REFERENCES


Failure to Restore Mechanical Axis Increases Risk of Aseptic Loosening 
After Total Knee Arthroplasty 
Ormande M. Mahoney, MD and Tracy L. Kinsey, MSPH

Background: Restoration of a neutral mechanical axis has been a widely held tenet of primary total knee arthroplasty, however new technologies are recently being marketed which claim correction of alignment deformity is unimportant. This study was undertaken to determine whether the outcome of aseptic loosening was associated with post-operative mal-alignment of the mechanical axis.

Methods: Ten cases of aseptic loosening occurred within a cohort of 1,030 consecutive cemented posterior stabilized total knee arthroplasties followed for 7 to 11.5 years (average 9 years). Nine controls were matched to each loosened case by age and minimum time in situ. Post-surgical mechanical alignment was determined using retrieved long leg radiographs. Validity and reliability of the method of measurement were established prior to the study. Age-adjusted relative risk of aseptic loosening was estimated using conditional logistic regression.

Results: Radiographs revealed eight of the ten loosened cases had been placed in 3 or more degrees varus mechanical alignment (range, 2° varus to 7° varus), compared to only four of the ninety age-matched controls (range, 4° valgus to 4° varus). A single degree change of mechanical alignment in the varus direction was associated with a more than 4-fold increase of risk of loosening (odds ratio 4.6, 95% confidence interval 1.7-12.7; p=0.0035). The relative risk for mechanical alignment >= 3° varus compared to <= 2° varus (dichotomous variable) was 69.2 (95% confidence interval 8.1-589; p=.0001). Body mass index, gender, and pre-op deformity were not significant.

Conclusions: These results suggest that avoidance of varus post-operative alignment is an extremely important determinant of total knee arthroplasty fixation durability.

Level of Evidence: Prognostic study, Level III, Case-control study investigating the effect of a patient characteristic on the outcome of a disease.
Restoration of anatomic limb alignment during total knee arthroplasty is one of the primary goals for orthopaedic surgeons. The importance of limb alignment in predicting long-term success was established nearly four decades ago. At that time, several investigators determined that anatomic restoration of the limb was one factor that correlated with long-term success. Improved instrumentation and a better understanding of knee kinematics helped the success of total knee arthroplasty.

Using computerized instruments is a newer surgical technique to further improve limb alignment by reducing the number of “outliers” with malaligned limbs. Since 2001, nearly 1,500 articles have been published on limb alignment using image based and non-image based computer navigation assisted surgery, robotic-assisted surgery and CT- or MRI-based patient matched jigs. Measurable success with these technical changes has been difficult to quantify. It is even more difficult to show utility and cost effectiveness.

The techniques have not shown an improvement in the outcome of patients as measured by fewer complications or fewer revisions. Part of the difficulty may have been the conflict between overall end points to improve and observe (namely longevity and function of a TKR) versus surrogate end points such as better aligned bone preparation/osteotomies intra-operatively, and overall alignment of an inserted implant immediately postoperatively. The former is difficult to accurately measure and compare; and the level of influence of the latter on the overall success of a TKR has been debated.

Major obstacles to the routine use of the computer assisted techniques include the cost, requirement for reference frame pin placement, registration, surgical complexity, extra time and potential failure due to technical issues.

The purpose of this presentation is to provide information to support that the gold standard remains for now conventional instrument use during total knee arthroplasty. At a time when we are held accountable for evidence-based and cost-effective healthcare, the development of new surgical techniques and implants like computer-assisted surgery should first be performed in a prospective manner by select institutions that are not conflicted (the developers). Meanwhile, the results of total knee arthroplasty utilizing the standard instruments are excellent. The failure of modern total knee arthroplasty can be primarily attributed to infection, surgical error, instability and loosening. The number of revisions having the potential to be reduced by navigation and robotic surgery remains currently unknown.

REFERENCES

Introduction: Computer assisted surgery (CAS) has been shown to reduce outliers in component position and improve functional outcomes in total knee arthroplasty (TKA). However, its adoption has been limited by increased cost and surgical time. Recently, streamlined CAS protocols have utilized the benefits of CAS, while minimizing the negative aspects. Additional benefits have been postulated that include TKA blood conservation, which has received substantial attention in recent years.

Methods: A retrospective cohort study of 100 consecutive patients was performed comparing an abbreviated and modern CAS protocol versus conventional IM instrumentation. All TKAs utilized an identical surgical technique without any hemostatic agent. Blood loss was determined using drain output, change in hemoglobin, and calculated blood loss. Tourniquet times were recorded as an indicator of procedural efficiency. A cost analysis compared the CAS protocol to the cost associated with tranexamic acid (TXA) to reduce blood loss and long-leg alignment radiographs to optimize component position.

Results: Height, weight, BMI, and preoperative hemoglobin were similar between groups. The CAS group demonstrated a decrease in average hourly drain output (CAS 33.8ml; conventional 40.5ml; p = 0.024), decreased change in hemoglobin (CAS 2.2; conventional 3.1; p < 0.001), and estimated total blood loss (CAS 925 ml; conventional 1327 ml; p < 0.001) compared to conventional instrumentation. No patients in either group required a blood transfusion. In non-teaching cases, there was a mean increase of 5 minutes surgical time in the CAS group. Cost-analysis demonstrated CAS was less expensive than using TXA and long-leg alignment radiographs, with a savings of $564 for 200 TKAs annually and $284 for 100 TKAs annually.

Conclusion: Abbreviated CAS is effective in reducing blood loss in TKA comparable to TXA, likely due to avoidance of the femoral IM canal, with minimal effect on surgical efficiency. Along with proven advantages of accurate component placement and improved functional outcome after TKA, the additional blood conservation supports CAS providing value in healthcare and obviates the need for advanced preoperative imaging and TXA, and can be used in patients regardless of cardiac or thromboembolic risk. In summary, TKA utilizing CAS has finally been refined to provide value in the modern healthcare environment.

REFERENCES

Computer navigation has been used during TKA to align the distal femoral and proximal tibial bone cuts for over 15 years. Without doubt, in 2014 over-whelming data exists to support the superiority of this tool over standard mechanical instruments for achieving post-operative limb alignment within the desired target range. Despite being more accurate for achieving the desired limb alignment, computer navigation has not been widely adopted. Indeed, information suggests that fewer than 15% of arthroplasty surgeons use this tool as part of their standard practice during primary TKA. This failure to achieve widespread clinical use is the result of many factors. Traditional concerns have included: the added expense of the hardware & software systems; increased operative time; and complications that are unique to this modality, such as post-operative fractures at the pin sites. In addition to these largely technical and efficiency concerns that may have limited early adoption of computer navigation, two other important recent factors may also be contributing. Firstly, despite 15 years of clinical experience, use of computer navigation has not been conclusively proven to produce better short-term, or long-term outcomes after TKA. Recent information suggests that one explanation for this lack of clinical superiority may be that the premise has been wrong; alignment of the femoral and tibial components along the neutral mechanical axis of the limb may not lead to better post-operative function, or long-term prosthesis survival, in all patients. A second recent factor possibly limiting the adoption of traditional computer navigation is the development of competing technologies including: viable robotic systems: patient specific cutting blocks; and hand-held accelerometer based tools. With the increasing number of alternatives to standard mechanical instruments that are currently being investigated, the value of computer navigation has become less clear, especially in light of the controversy regarding whether any clinical benefits are derived from achieving neutral post-operative limb alignment.

In summary, in 2014, while computer navigation has demonstrated clear benefits for achieving the desired target for component alignment in the coronal plane, the disadvantages of the technology, and lack of clinical advantages, should limit its use to cases where traditional instrumentation will not all work, or in research protocols. However, in the future if very specific targets for component orientation, and alignment are proven to result in better function, or prosthesis survival, computer navigation may be important for achieving these goals.

REFERENCES


Debate III: Patient Specific Instrumentation: The Way of the Future

Affirm

Adolph V. Lombardi, Jr, MD, FACS

Patient specific instruments have been developed in response to the conundrum of limited accuracy of intramedullary and extramedullary alignment guides and chaos caused by computer assisted orthopaedic surgery. This technology facilitates preoperative planning by providing the surgeon with a three dimensional (3-D) anatomical reconstruction of the knee, thereby improving the surgeon’s understanding of the preoperative pathology. Intramedullary canal penetration of the femur and tibia is unnecessary, and consequently, any potential for fat emboli is eliminated. Component position and alignment are improved with a decrease in the number of outliers. Patient specific instruments utilize detailed magnetic resonance imaging (MRI) or computed tomography (CT) scans of the patient’s knee with additional images from the hip and ankle for determination of critical landmarks. From these studies a 3-D model of the patient’s knee is created and with integration of rapid prototyping technology, guides are created to apply to the patient’s native anatomy to direct the placement of the cutting jigs and ultimately the placement of the components.

The steps in considering utilization of patient specific guides are as follows: 1) the surgeon determines that the patient is a candidate for TKA, 2) an MRI or CT scan is obtained at an approved facility in accordance with a specific protocol, 3) the MRI or CT is forwarded to the manufacturer, 4) the manufacturer creates the 3-D reconstructions, anatomical landmarks are identified, implant size is determined, and ultimately femoral and tibial component implant placement is determined via an algorithm, 4) the surgical plan is executed, 5) the physician reviews and modifies or approves the plan, 6) the guides are then produced via rapid prototyping technology and delivered to the hospital for the surgical procedure.

Guides generated from MRIs are designed to uniquely register on cartilage surface whereas guides produced from CT scans must register on bony anatomy. There are currently two types of guides produced: those which register on the femur and tibia and allow for the placement of pins to accommodate the standard resection blocks; and those produced by some manufacturers which accommodate the saw blade and therefore are a combination of resection and pin guides. The utilization of patient-specific positioning guides in TKA has several benefits. They facilitate preoperative planning, obviate the need for violation of the intramedullary canals, reduce operating times and improve OR efficiency, decrease instrumentation requirements and thereby reduce potential for perioperative contamination. They are easier to use than computer navigation with no capital equipment purchase and no significant learning curve. Most importantly, patient-specific guides facilitate accurate component position and alignment, which ultimately has been shown to enhance long-term survivorship in total knee arthroplasty.

REFERENCES


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Purpose: A structured review of current literature was undertaken to determine: 1) Do patient-specific cutting blocks achieve a neutral mechanical alignment more reliably during total knee arthroplasty when compared to conventional methods? 2. Does patient-specific instrumentation provide a financial benefit through improved surgical efficiency? 3. Does the use of patient-specific cutting blocks translate to improved clinical results following total knee arthroplasty when compared to conventional instrumentation?

Results: Sixteen studies were identified and utilized in addressing this question. The majority of studies did not show an improvement in overall limb alignment when patient specific instrumentation (PSI) was compared to standard instrumentation. Mixed results were seen across studies, ranging in strength of evidence from level I-III, with regard to the prevalence of alignment outliers when PSI was compared to conventional cutting blocks, with some studies demonstrating no difference, some showing an improvement with PSI and a single study showing worse results with PSI.

Thirteen studies were identified and utilized in addressing this question, demonstrating mixed results regarding the effect of PSI on operative times. Decreased operative times were not uniformly observed, and when noted, they were found to be of minimal clinical or financial significance. PSI did reliably reduce the number of instrument tray required for processing perioperatively. The accuracy of the preoperative plan, generated by the PSI manufacturers, was found lacking with regard to its accuracy, often leading to multiple intraoperative changes, thereby disrupting the flow of the operation and negatively impacting efficiency.

Limited data exists with regard to the effect of PSI on postoperative function, improvement in pain, and patient satisfaction. Only 2 level III studies were identified which addressed this question and neither provided strong evidence to support an advantage favoring the use of PSI. No identified studies addressed survivorship of components placed with PSI compared to those placed with standard instrumentation.

Conclusion: Patient specific instrumentation for total knee arthroplasty has not reliably demonstrated improvement of postoperative limb or component alignment when compared to standard instrumentation. While decisive evidence exists to support that PSI requires fewer surgical trays, PSI has not clearly been shown to improve overall surgical efficiency or the cost-effectiveness of total knee arthroplasty. Mid- and long-term data regarding PSI’s effect on functional outcomes and component survivorship does not exist and short-term data is scarce. The available literature does not clearly support any improvement of post-operative pain, activity, function, or range of motion when PSI is compared to traditional instrumentation.

Significance: Patient specific instrumentation has not reliably demonstrated improvements in limb alignment, surgical efficiency, cost-effectiveness, or clinical outcomes when compared to standard instrumentation.

REFERENCES


© 2014 The Knee Society
While total knee arthroplasty (TKA) is considered a highly successful surgical procedure, it has shown diminished outcomes compared to total hip arthroplasty. Patient satisfaction following TKA ranges from 75-89% using a variety of patient reported outcome measures [1, 2]. TKA patients still experience substantial functional impairment [3]. Revision rates at 10-15 years are approximately 10% [4] compared to patient outcomes of total hip arthroplasty which approach 95% with revision rates measured at 30 years.

The inability of current total knee designs to restore relatively normal knee kinematics is presumed to contribute to these functional deficits [5]. There seems to be a design mismatch wherein the knee is forced to follow the implant kinematics as compared to an implant designed to guide the normal motion of the knee.

The motivation behind robotic assisted TKA is to improve surgical precision, advance articular surface design that allows for independent or interdependent compartmental resurfacing, optimizing position based on “normal” soft tissue function, and ultimately improve patient outcomes. Robotic assisted surgery achieves these goals by enhancing the surgeon’s ability to generate reproducible techniques through an individualized approach. Anatomic restoration with optimized soft tissue balancing, reproducible alignment, and restoration of more normal knee kinematics are already demonstrated advantages of robotically assisted partial knee surgery [6-9].

Robotic TKA utilizes pre-operative three-dimensional imaging resulting in a patient specific surgical plan that, in combination with intra-operative measurements of the soft tissue envelope, will optimize the ligamentous tension, and reconstruct individual knee kinematics. Robotic controlled devices will augment current cutting devices and instrumentation to position the implant according to the plan. The utilization of “Haptics” will allow precision with efficiency and accuracy. Intraoperative sensors will quantify forces and contact points across the joint to verify restoration of knee kinetics. The techniques of trialing components will be redefined with real time in vivo measurements that will allow kinetic optimization through refinements of bony cuts and soft tissue balancing.

The use of robotic assisted TKA will become a valuable tool to optimize patient specific implantation of innovative implants, which will be designed to fit the knee, instead of the current design philosophy of having the knee fit the implant. This will ultimately provide improved patient outcomes with a knee that feels identical to their previous healthy, native knee. The patient will have the sensation that “my knee feels normal.”

REFERENCES
Morbid Obesity Alone Affects TKA Complications Mortality and Resource Utilization: A Matched-Control Study
James A. Browne, MD; Michele R. D’Apuzzo, MD and Wendy M. Novicoff, PhD

Background: The role of morbid obesity as a risk for complications following total knee arthroplasty (TKA) continues to be debated. Obesity is rarely an isolated diagnosis and tends to cluster with other co-morbidities that may independently lead to increased risk and confound outcomes. It is unknown if morbid obesity alone affects outcomes and resource utilization following TKA.

Patients and Methods: The Healthcare Cost and Utilization Project (HCUP) Nationwide Inpatient Sample (NIS) database was used to identify patients undergoing primary TKA from Oct 2005 to Dec 2008. Morbid obesity (body mass index [BMI]>40) was determined using ICD-9-CM codes. In-hospital postoperative complications, mortality, costs, length of stay and disposition for morbidly obese patients were compared to non-obese patients. To control for potential confounders and comorbid conditions, each morbidly obese patient was matched to a non-obese patient using age, gender and all 28 comorbid-defined elements in the NIS database based on the Elixhauser Comorbidity Index.

Results: Of 1,777,068 primary TKA surgeries, 98,410 (5.5%) patients were categorized as morbidly obese. Of these, 90,045 patients (91%) were able to be matched 1-to-1 to a non-obese patient for the adjusted analysis. Morbidly obese patients had a statistically higher risk of postoperative in-hospital wound complications including dehiscence and infection as well as higher risk for anemia and genitourinary related complications (p<0.001). There were no differences in cardiovascular or thromboembolic related complications. Morbidly obese patients were at significantly higher risk of in-hospital death after primary TKA compared to non-obese patients (odds ratio 3.2, CI 2.0-5.2). Total hospital costs, length of stay, and rate of discharge to a facility were all statistically higher (p<0.01) in morbidly obese patients.

Conclusion: Morbid obesity itself appears to be associated with a significantly higher risk for a small number of select postoperative complications and in-hospital mortality even when matching for comorbid medical conditions linked to obesity. However, the comorbidities that often accompany morbid obesity, and not morbid obesity alone, appear to be responsible for some of the increased rates of systemic complications previously reported in the literature. Morbid obesity itself does appear to be associated with slightly higher costs, longer length of stay, and a lower rate of discharge to home after primary TKA.
Comparison of in-hospital postoperative complications after primary knee arthroplasty between morbidly obese and non-obese patients.

<table>
<thead>
<tr>
<th>Postoperative Complications</th>
<th>Primary Total Knee Arthroplasty</th>
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<tbody>
<tr>
<td></td>
<td>Non-Obese</td>
</tr>
<tr>
<td>Cardiac</td>
<td>642 (0.7%)</td>
</tr>
<tr>
<td>Peripheral vascular</td>
<td>197 (0.2%)</td>
</tr>
<tr>
<td>Respiratory</td>
<td>721 (0.8%)</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>377 (0.4%)</td>
</tr>
<tr>
<td>Genitourinary</td>
<td>406 (0.4%)</td>
</tr>
<tr>
<td>Central Nervous System</td>
<td>60 (0.1%)</td>
</tr>
<tr>
<td>Hematoma/Seroma</td>
<td>701 (0.8%)</td>
</tr>
<tr>
<td>Wound Dehiscence</td>
<td>74 (0.1%)</td>
</tr>
<tr>
<td>Infection</td>
<td>162 (0.2%)</td>
</tr>
<tr>
<td>Anemia</td>
<td>13,843 (15%)</td>
</tr>
<tr>
<td>Deep Vein Thrombosis</td>
<td>404 (0.4%)</td>
</tr>
<tr>
<td>Pulmonary Embolism</td>
<td>407 (0.5%)</td>
</tr>
</tbody>
</table>

OR: Odds Ratio.
NA: Not Applicable.
* p<0.05
Introduction: Multimodal pain management, apart from narcotic medications alone, has become the standard of care for pain management after knee replacement. This randomized clinical trial was undertaken to compare the outcome of two commonly used modalities: combined femoral and sciatic nerve block versus periarticular injection, as part of a multimodal pain protocol following total knee replacement.

Methods: 160 patients completed randomization into two treatment arms: 1) peripheral nerve blocks (n=79) with an indwelling femoral nerve catheter and a single shot sciatic block (peripheral nerve block group - PNB); or 2) periarticular injection (n=81) using ropivacaine, epinephrine, ketorolac and morphine (periarticular injection group - PAI). All patients received standardized general anesthesia and oral medications.

The primary outcome was post-operative pain, on a 0 – 10 scale, the afternoon of post-operative day 1 (POD 1). Secondary outcomes were narcotic use, quadriceps function, length of stay, hemoglobin changes, blood transfusions, peripheral nerve complications and patient satisfaction.

Results: Mean pain scores on the afternoon of POD 1 were similar between groups (PNB group: 2.9 (SD 2.4); PAI group 3.0 (SD 2.2) 95% CI: -0.8 – 0.6. p = 0.76). Mean pain scores taken at three times points on POD 1 and patient satisfaction were also similar between groups. Hospital length of stay was significantly shorter for the PAI group (2.44 days (SD 0.65) vs. 2.84 days (SD 1.34) for PNB group (p = 0.02). Narcotic consumption was significantly higher on the day of surgery for the PAI group, but thereafter no difference. Mean drop in hemoglobin and transfusion did not differ. Significantly more patients in the PNB group had sequelae of peripheral nerve injury (mainly dysesthesia) at 6 week follow-up (9(12%) vs 1(1%); p=0.009).

Conclusion: Patients receiving periarticular injections had similar pain scores and satisfaction with pain management, shorter lengths of stay, but greater narcotic use on the day of surgery compared to patients receiving peripheral nerve blocks.

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At 5 Years Trabecular Metal Tibias Were Durable and Reliable in Total Knee Arthroplasty: A Randomized Clinical Trial

Luis Pulido, MD; Matthew P. Abdel, MD; David G. Lewallen, MD; Michael J. Stuart, MD; Joaquin Sanchez-Sotelo, MD, PhD; Arlen D. Hanssen, MD and Mark W. Pagnano, MD

Introduction: Highly porous metals (HPM) have demonstrated excellent bone ingrowth properties and are an intriguing option for fixation in TKA. We performed a randomized clinical trial (RCT) to assess the durability and reliability of a highly porous metal tibia compared to a traditional modular cemented tibia.

Methods: From 2003 to 2006, 397 patients (age 67.8 +/- 8.7 years; 54 % female) were randomized to three groups; (1) traditional modular cemented tibia; (2) cemented highly porous-metal tibia (3) uncemented highly porous-metal tibia. The same posterior-stabilized femoral component and patella component were cemented in every case. Computerized randomization was done dynamically based on patient age, sex and BMI. Durability was judged by survivorship analysis at 5 years. Reliability was judged clinically: Knee Society scores, range of motion, and complications. Radiographic assessment included alignment, radiolucency, implant migration / loosening. Patients were followed until death, revision or for a minimum of 2 years (mean follow-up of 5.2 years (range 2 - 8.9 years). Four patients were lost to follow up prior to 2 years.

Results: Highly porous metal tibias (both uncemented and cemented) were as durable as a traditional cemented modular tibial modular tibial component as judged by survivorship at 5 years using a contemporary intention-to-treat analysis (96.8 % (1); 97.6 % (2); 96.7 % (3); p=0.59). A per-protocol analysis revealed that no highly porous metal tibia was revised for aseptic loosening. Highly porous metal tibias were as reliable as traditional cemented modular tibias in alleviating pain and improving outcome with no difference in clinical outcomes amongst the three groups.

Conclusion: At 5 years this large randomized clinical trial demonstrated that highly porous metal tibias provided durable fixation and reliable clinical outcomes compared to a traditional cemented modular tibia in contemporary total knee arthroplasty.

REFERENCES

Controversy persists regarding the most favourable method to determine accurate femoral component rotation during total knee arthroplasty (TKA). Some favour a measured resection technique in which bone landmarks (femoral epicondyles, posterior femoral condyles, or the anterior-posterior axis) are the primary determinants of femoral component rotation. Others recommend a gap balancing methodology in which the femoral component is positioned parallel to the resected tibia with each collateral ligament equally tensioned. Recent reports have demonstrated surgeon ability to accurately identify bone landmark is less than desired and the author favors a gap balancing technique.

GAP BALANCING OPERATIVE TECHNIQUE
Numerous methods exist to perform gap balancing during TKA. All utilize tensioning of the extension and flexion gaps with the goal of obtaining tension equality of the two gaps. Some techniques resect the distal femur first while others initially resect the proximal tibia. All methods require accurate bone resections, particularly of the proximal tibia, and soft tissue balancing when indicated. The technique described below is that currently utilized by the author.

1. Surgical exposure with limited soft tissue release.
2. Remove all osteophytes from the distal femur and proximal tibia as these can dramatically affect soft tissue tension and balance in some cases.
3. Distal femoral followed by proximal tibial resection resection.
4. Insert tensioning device into extension gap (tensioner vs. spacer block).
5. Assess extension gap width, tension, symmetry (medial vs. lateral) & limb alignment vs. the mechanical axis.
6. Fine tune soft tissue balance if the extension gap is asymmetric or if malalignment is present. Following this step, a well-balanced knee in extension should be present with good alignment along the mechanical axis.
7. Place the knee in 90 degrees of flexion.
8. Construct the transepicondylar & anterior-posterior axes. These two axes are typically perpendicular to each other and will be used as secondary landmarks when determining final rotation of the femoral component. They are not used as primary determinants of femoral rotation due to inability of the surgeon to accurately identify them in every case.
9. Equally tension the medial and lateral aspects of the flexion gap to a similar tension as was previously obtained in balancing the extension gap using laminar spreaders or other tensioning devices.
10. Assess the relationship of the transepicondylar and anterior-posterior axes vs. the surface of the resected proximal tibia. If the knee was balanced and well aligned in extension, the transepicondylar axis will typically run parallel to the resected proximal tibia while the anterior-posterior axis will run perpendicular to the resected proximal tibia.
11. If the relationship of the transepicondylar and AP axes substantially vary from the relationship described in item #10, numerous conditions may be present as listed below:
   a. The extension gap was not properly balanced with errors in soft tissue balancing.
b. The lower limb was not properly aligned along the mechanical axis as required in step #5.
c. The proximal tibial resection was not perpendicular to the mechanical axis.
d. Integrity of the superficial medial collateral ligament on the medial side or the lateral collateral ligament-popliteus tendon complex on the lateral side of the joint is not present. If these soft tissue structures are attenuated, tensioning of flexion gap will result in the flexion gap being excessively widened and errors in femoral component rotation will occur. If this occurs, the author uses the transepicondylar axis to determine femoral component rotation.

12. Place the anterior-posterior (AP) cutting block onto the resected distal femur and rotate it parallel to the proximal tibia with each collateral ligament equally tensioned using the tensioning device. This creates a rectangular flexion gap. In most cases, the position of the AP cutting block will be parallel to the transepicondylar axis and perpendicular to the AP axis.

13. Slide the AP cutting block posteriorly until the flexion gap width is similar to that obtained during establishing the extensor gap. Placement of a spacer block of desired width onto the anterior aspect of the proximal tibia and sliding the AP cutting guide distally to the level of the spacer block can be helpful in determining final AP positioning of the cutting block. Common errors in performing this step include:
   a. Placing excessive tension on the tensioning devices. This causes excessive anterior distraction of the femur and typically results in under-resection of the posterior femoral condyles and a flexion gap that is too tight.
   b. Positioning of the AP cutting block with the knee positioned in greater than 90 degrees of flexion. This typically creates the appearance that the flexion gap is wider than its true dimension and often results in placement of the AP cutting block too posterior with under-resection of the posterior femoral condyles and a tight flexion gap resulting.
   c. Positioning of the AP cutting block with the knee positioned in less than 90 degrees of flexion. This typically creates the appearance that the flexion gap is narrower than its true dimension and often results in placement of the AP cutting block too anterior with over-resection of the posterior femoral condyles and a loose flexion gap.

14. Pin the AP cutting block at the desired position, remove the tensioning devices, and complete the anterior and posterior femoral resections.

15. Insert spacer blocks or other tensioning devices into the extension and flexion gaps to assure gap balance is obtained. If not, reassess bone resection accuracy and ligamentous balance and make appropriate adjustments until gap balance is obtained.
The outcome of total knee arthroplasty is influenced by the restoration of the mechanical alignment and soft tissue balance. This is achieved by appropriate bone resection in the coronal and sagittal planes, appropriate rotational alignment and soft tissue management. Each knee has its own soft tissue identity, which needs to be identified such that the resultant flexion and extension gaps are equal, rectangular and balanced allowing for a well aligned and stable knee. Fixed deformities will require appropriate ligament releases. Studies have shown that a well-balanced knee will have the best outcome with restoration of normal knee kinematics and motion.
Despite the increasing use of metal augments, bone grafting remains a valuable tool for the treatment of bony defects in revision TKA. Common classifications systems for bone loss include the AORI classification [1] and the Clatworthy and Gross scheme [2], in which defects are initially classified as contained or uncontained.

For small contained defects, morselized autograft or allograft remains the standard and leads to a high rate of incorporation [3]. Dorr et al recommend bone grafting cystic defects that are more than 5 mm in diameter [4]. At our hospital, 5cc of cancellous bone chips cost $140 and a 30cc container costs $425.

In larger contained or cavitary defects, impaction grafting or bulk allograft can be used to restore bone stock. Multiple studies have shown high rates of graft incorporation and stable fixation with the impaction grafting technique [5-9]. Caution should be used with impaction bone grafting and hinged prostheses [10]. Bulk or structural allograft such as a femoral head can also be used to reconstruct contained defects involving more than 50% of the tibia plateau, and may provide greater initial support compared to morselized graft [4]. Stemmed implants are used to bypass the graft. Several groups have reported 77% to 87% good to excellent results at midterm follow-up (48-50 months) [11-13]. From a cost perspective, 45cc of cancellous allograft is $668 versus $1231 for a femoral head allograft.

Small uncontained defects are frequently treated with metal augments, but special consideration is needed in young patients in whom additional revision TKA is probable. In these patients, the use of bone graft is needed to reestablish bone stock. If the bone defect associated with the revision TKA is segmental, but involves less than 25% of the supporting cortical rim, impacted cancellous bone grafts can also be used [14]. More frequently, structural allografts are fashioned to fill smaller uncontained defects and have shown good survivorship in studies [15-16]. Average cost of porous metal augment is $1000, which, as stated above, is comparable to the cost of a femoral head allograft.

For massive uncontained defects, structural allografts can be used in lieu of large metal augments or megaprostheses if maintenance of bone stock is desired. However, this technique relies on adequate preparation of the host bone. Host bone must be cleared of soft tissue, and sclerotic bone must be removed to provide a well-vascularized host bed. In addition, the allograft must be shaped to maximize surface area contact and positioned so the trabeculae are parallel to the axial load. Rigid fixation is required and provided with long diaphyseal engaging stems and, if necessary, augmented with plates, screws, and wires [17]. Studies show encouraging survival of 87-92% at 5 years [12, 18]. An alternative is the use of wire mesh and impaction grafting for large uncontained defect [19]. Although a good option for restoration of bone loss, structural grafts carry the risk of disease transmission, infection, non-union, fracture, and late resorption [14, 20].

REFERENCES


Medial stability of the knee is a complex issue, and involves ligaments that behave differently in flexion and extension. The contracture and stretching that occur due to deformity and osteophytes affect these ligament structures unequally, and often cause different degrees of tightness or laxity in flexion and extension after the bone surfaces are resected correctly for varus-valgus alignment. The distortion of alignment landmarks also can cause varus-valgus alignment to differ in the flexed and extended positions, and the knee thus may require adjustment of portions of the medial stabilizing complex that affects stability either in flexion or extension.

In the presence of articular surface deformity the anatomic references are especially important for correct varus-valgus alignment. The usual reliable landmarks for varus-valgus alignment of the femoral component in flexion include the posterior femoral condyles, the long axis of the tibia, and the tensed supporting ligaments. If the posterior femoral condyle wears and the tibial plateau collapses on the medial side of the knee, these normally reliable landmarks cannot be used. Instead, the AP axis of the femur is used as a reference line for the femoral cuts and the long axis of the tibia is used for a reference line for the tibial cut so that the joint surfaces are cut perpendicular to these two reference lines. Once the joint surfaces have been resected correctly to establish normal varus-valgus alignment in flexion and extension, the trial components are inserted and ligament function is assessed in flexion and extension. The ligaments are released according to their function at each position. The medial collateral ligament (MCL) (deep and superficial layers) attaches to the medial epicondylar area through a broad band. The posterior oblique portion, which spreads posteriorly over the medial tibial flare and incorporates the sheath of the semimembranosus tendon, tightens in extension. The anterior portion of the ligament complex, which extends anteriorly along the medial tibial flare, tightens in flexion and loosens in extension. The posterior capsule is loose in flexion, and tightens only in full extension. With this information the medial ligament structures of the knee can be released individually according to the position in which excessive tightness is found.

The sequence in which the procedures are performed is important in total knee replacement. Resection of the femoral surfaces makes the tibial surfaces accessible. Resection of the tibial surface clears the way to remove the osteophytes. Removal of the osteophytes frees the ligaments so they may be assessed and released as needed. No ligament should be released until all the osteophytes are removed otherwise excessive laxity may occur. Extra bone should not be removed to correct a flexion contracture until all ligament balancing has been finished, otherwise inappropriate laxity in extension may occur once ligament release has been done.

The trial components are inserted before any ligament releases are done, and the knee is tested for stability in flexion and extension. With the trials in place, the knee is evaluated in flexion and extension to assess varus, valgus, rotational, anterior and posterior stability. Once the surgeon has determined with certainty which ligaments are contracted, limited releases can be done, releasing only tight ligaments and leaving alone those that are not.

**Tight Medially in Flexion, Loose Medially in Extension.** In some cases the medial structures are not contracted uniformly, and the knee may be tight medially only in flexion, but not in extension. The anterior portion of the MCL should be released first, leaving the posterior oblique portion intact to provide stability in flexion and extension.
**Tight in Extension, Balanced in Flexion.** In some cases the posterior medial structures are tight and the anterior MCL is normal after insertion of the trial components. These knees are tight in extension, but balanced normally in flexion. Knees that are tight only in extension after total knee arthroplasty first should have release of the posterior oblique fibers of the MCL, and release of the posterior capsule if medial contracture persists in extension. This procedure leaves the anterior portion of the MCL intact to stabilize the knee.

**Tight Medially in Flexion and Extension.** In many cases with a long-standing varus deformity and medial ligament contracture, the knee is tight medially both in flexion and extension. This indicates that the entire MCL is contracted. The posterior capsule and PCL also may be contracted, but the primary contracture is the MCL in these cases. The PCL and posterior capsule cannot be evaluated until the MCL contracture has been corrected. Knees that are tight in flexion and extension have release of the anterior and posterior portions of the MCL. This is done by first stripping the anterior portion of the MCL in line with the tibial long axis, then directing the osteotome posteriorly to release the posterior portion of the ligament. Those knees that remain tight in full extension after release of the posterior oblique MCL have release of the posterior medial capsule from the femur and tibia. If inappropriate posterior femoral rollback occurs, or if medial ligament tightness remains in flexion after release of the anterior portion of the MCL, the posterior cruciate ligament is released from its tibial attachment.

**Tight Popliteus Tendon.** Occasionally the popliteus tendon and its surrounding structures are tight in the varus knee after the medial side has been corrected. This often is difficult to detect, but rotational stability testing of the tibia demonstrates that the tibia is held anteriorly on the lateral side and pivots around the lateral edge of the tibial component. The popliteus tendon is released from its bone attachment when the knee is flexed. It is found just distal and posterior to the lateral collateral ligament (LCL) attachment, and care must be taken to avoid release of the LCL during this procedure.

**Compensatory Lateral Release—Extension Only.** Occasionally, after full MCL release, the knee is excessively loose on the medial side in extension, and tight laterally. Compensatory lateral release corrects the imbalance, and a thicker tibial component brings the knee to correct stability.

**Compensatory Lateral Release—Flexion and Extension.** In some cases after full release of the MCL, the secondary stabilizers are inadequate to provide medial stability in flexion and extension, and the knee is too loose medially after the tibial component has been sized to bring the lateral ligaments to their normal tension. In those cases the LCL and popliteus tendon are released to create more laxity both in flexion and extension, and a thicker tibial component is used to tension the medial structures.

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Implant Constraint: Indications and Outcome with more Constrained Designs

Paul F. Lachiewicz, MD

The use of non-linked, varus-valgus constrained components in primary total knee arthroplasty is unusual. Rarely is it necessary to use a prosthesis with more constraint than a posterior-stabilized post. The most common indication is a knee with a severe deformity, usually fixed valgus with an incompetent medial collateral ligament, and an inability to correctly balance the knee in both flexion and extension. The preoperative deformity is usually greater than 15-20° fixed valgus and may be associated with a severe flexion contracture. This is usually seen in an elderly female patient with advanced osteoarthritis. Those preoperative diagnoses more likely to require a constrained design include advanced rheumatoid arthritis, true neuropathic joint, and the “Charcot-like” joint due to bone loss or crystalline arthritis. Rarely, patients with periartricular knee Paget’s disease of bone may require more constraint following correction of a severe deformity through the knee joint. Beware those patients with a staple or screw at the medial epicondyle or those with severe heterotopic ossification at the medial joint line, as this may signify a serious prior injury to the medial collateral ligament. Finally, there is a possibility of inadvertent division of the medial collateral ligament intraoperatively. Although this situation may be treated with suture repair and bracing, my choice is to switch to more constraint and early unbraced motion.

There are over 20 designs of varus-valgus constrained components, with a variety of tibial post designs and many have the option of adding modular stems. Our experience with constrained, non-linked designs has been favorable with both the use of nonmodular and modular stem extensions. Longer-term survival analysis has shown a 96% survival at 10-years with these constrained components. However, the older designs frequently required a lateral retinacular release for proper patella tracking, and there were patella complications (fracture and osteonecrosis) in 16%. With a more modern design, over the past 12 years, the need for a lateral retinacular release and patella complications have been notably decreased. Varus-valgus constrained components have a small but important role in primary total knee arthroplasty for patients with severe deformity or an incompetent medial collateral ligament.

REFERENCES


Balancing the Valgus Knee: Surgical Technique Video
Daniel J. Berry, MD

I. Introduction:
The problems include contracted lateral soft tissue sleeve, stretched medial soft tissue sleeve, and shortened peroneal nerve.

II. General Principles of Treatment:
Restore correct limb alignment. Lengthen lateral soft tissue sleeve to equal medial soft tissue sleeve in flexion and extension. Use extra constraint if needed to provide internal splint that protects ligaments. Protect the peroneal nerve.

III. Pitfalls:
Under release of lateral side may lead to residual valgus. Over release of lateral side leads to instability and especially posterior knee dislocation in figure 4 position. Peroneal neuropathy.

IV. Avoiding Pitfalls:
Pay careful attention to optimal alignment with full length standing films preop. Optimal release technique (see below) maintains lateral sided stability in flexion (if possible keep the popliteus—a dynamic stabilizer in flexion). Use added constraint when needed, but not indiscriminately.

V. Principles of Insall’s Multiple Perforation Method:
Gradual, selective release of tight structures. Structures are allowed to stretch by partial rather than full release of each structure. Key stabilizer of knee in flexion (popliteus) is maintained. Iterative process: gradual release achieved as soft tissues stretch (similar to percutaneous tendo-achilles lengthening)

VI. Technique:
Tension lateral side with lamina spreads. Multiple perforations in IT band at different levels: 15 blade. Trial—stretch out tissues. If still tight, gentle release of LCL with tip of Bovie or #15 blade but don’t overdo it, do it sequentially. Stretches out gradually with trial implants in place. Use caution to avoid peroneal nerve damage. Repeat process until the knee is balanced. SAVE THE POPLITEUS.

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Lower extremity malalignment, particularly at the knee joint, will affect hindfoot orientation. Compensation can occur at three locations of the hindfoot (distal tibia, ankle, and subtalar joint) in response to altered lower extremity kinematics due to knee deformity. We have tried to elucidate the degree of compensation occurring at the three locations of the hindfoot (distal tibia, ankle, and subtalar joint) in patients with severe knee arthritis and deformity, in addition to ankle symptoms and deformity.

378 TKAs in 304 patients were evaluated. Standing full-leg-length AP and Saltzman hindfoot alignment view radiographs were used to determine the mechanical axis angle, degree of hindfoot malalignment, anatomic lateral distal tibial angle (aLDTA), and ankle joint line convergence angle (ankle JLCA). The relationship between knee deformity, as well as hindfoot deformity, and the aLDTA, ankle JLCA, and subtalar joint (STJ) were assessed for correlation. Intraclass correlation coefficients were used to evaluate intra- and interobserver reliability.

The mechanical axis angle correlated with aLDTA, ankle JLCA, and the STJ in the entire cohort and in a sub-group of patients with ≥ 10° knee deformity. The hindfoot angle correlated with aLDTA, ankle JLCA, and STJ in the entire cohort. The difference in aLDTA, ankle JLCA, and STJ between knees with varus and valgus deformity were significant in the ≥ 10° knee deformity cohort. The difference in aLDTA, ankle JLCA, and STJ between hindfeet with varus and valgus deformity were significant in the entire cohort. Intra- and interobserver reliability analysis showed excellent reliability in all measurements.

This study demonstrates that in patients with hindfoot malalignment, due to knee deformity, there exists a strong, significant correlation between the hindfoot angle and the subtalar joint. The majority of compensation within the hindfoot occurs through the subtalar joint while the aLDTA and ankle JLCA have a minimal role. These findings have direct implications for treating patients with both knee and foot/ankle problems, especially those with limited subtalar motion.

This presentation will demonstrate the clinical issues encountered by knee replacement surgeons when a patient presents with knee arthritis and also has ankle deformity. Numerous cases will be presented and pertinent videos and radiographic work up will be discussed.
Multiple studies, both RCTs and meta-analyses, have examined the role of the patella in total knee arthroplasty (TKA). Although the majority of these studies show either no difference or improved outcomes for resurfacing, advocates for selective resurfacing remain. Registries have the benefit of reporting outcomes for large numbers of patients operated on by numerous surgeons of varied experience, and may be a useful adjunct to examine this issue.

National registries vary widely in the reported prevalence of patellar resurfacing, from a low of 2.4% resurfaced in Norway in 2009 to a high of 80% resurfaced in Denmark the same year. In the US, a poll taken at the 2012 AAHKS meeting revealed that 84% of members resurfaced every TKA and an additional 8% resurfaced > 90% of cases. Is there registry evidence that supports these widely disparate practices?

Two community-based registries (HEJR and KP) in the US have reported on the issue of patellar resurfacing in their populations. In the HEJR study, 8693 patellar-resurfaced (PR) TKAs were compared to 655 non-resurfaced (NR) TKAs over 18 years. Following adjustment for confounders of age, gender and femoral component design, Cox regression analysis revealed a 7X greater risk of patellar revision in NR knees, and a 1.7X greater risk for ANY revision in NR knees. The KP study compared 39,286 TKAs, 696 (1.8%) of which were NR, with a median f/u of 24.5 months. Cox regression analysis revealed a 2.5X greater risk for revision in NR knees. The 6-year cumulative survivorship was 98.1% for PR knees vs. 93.6% in NR knees (p <.001).

The Australian Registry (AOANJR) reported on 134,799 TKAs done between 1999-2006, of which 57,359 (43%) were PR TKAs, as part of a published study of patellar resurfacing. The PR group had a lower cumulative revision rate (CRR) with a HR of 0.75 (p<.001) and revisions for patellofemoral pain were more common in the NR group (17% vs. 1%) as were “patella only” revisions (29% vs. 6%). A followup in the 2013 Annual Report with HR adjusted for age and gender revealed a great risk of revision of NR knees (HR=1.29, p<.001). The authors indicated that “most brands have a lower rate of revision when the patella is resurfaced.”

The Swedish Knee Arthroplasty Registry (SKAR) has followed this issue for some time. A study from 2001 revealed that 59% of all TKA revisions performed on NR knees between 1990-1996 were related to the patella (91% were patellar additions), whereas 44% of the revisions performed on PR knees were related to the patella. Subsequent annual reports noted that for the years 1991-2000, NR knees had a higher CRR (HR= 1.3), but for 2001-2010 there was NSD in the CRR between NR and PR TKAs. The authors are unsure whether this reflects more “patellar-friendly” designs or surgeons who are performing fewer revisions of NR knees for late patellar resurfacing because of the limited success of that procedure.

The Norwegian Arthroplasty Registry (NAR) analyzed 5 brands of TKAs in common usage with both PR and NR variants between 1994-2009 (n=11,887). After adjustment for confounders (age, sex, brand, prior operations, diagnosis), there was a lower risk of revision in PR knees (HR 0.84, p=.05). However, the overall survival after 15 years was 92% for PR and 91% for NR knees. PR knees had a significantly lower risk of revision due to pain alone (HR =0.1, p<.001) but did have a higher risk of
revision due to loosening of the tibial component (HR=1.3, p=.03). For all 5 brands, resurfacing offered the best survival performance, except for the LCS (metal-backed patellae).9.

The Registry of England & Wales has been collecting PROMs as well as Level 1 data for some time. They collected the Oxford Knee Score preop and postop (median f/u 199 days) of 15,290 PR knees and 8103 NR knees, looking specifically at 3 questions related to anterior knee pain and function. Preop scores for these questions were lower in the PR group, but there was NSD in improvement in any of the scores assessed between the two groups, or in the total OKS score.10

In summary, wide variations exist in patellar resurfacing among nations that cannot be explained by the results obtained solely in their respective registries. PR knees in general are associated with lower overall revision rates and revisions related specifically to the patella. However, one needs to be mindful of the bias inherent in late resurfacing of a painful NR knee as opposed to treating the painful PR knee.

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Patello-Femoral Arthroplasty: Indications and Outcomes
Jean Noël Argenson, MD, FRCS; Matthieu Ollivier; Sebastien Parratte, MD; Xavier Flecher and Jean-Manuel Aubaniac, MD

Introduction: Isolated osteoarthritis of the patello-femoral joint can be a cause of severe anterior knee pain and may limit daily activities such as standing up from a chair or climbing stairs. Patello-femoral arthroplasty (PFA), defined as resurfacing both sides of the patellofemoral joint, has been proposed as a treatment option in order to preserve the non-affected tibio-femoral compartments.

Indications: The etiologies of isolated osteoarthritis of the patella-femoral joint leading to PFA are: instability with a history of patellar dislocation, posttraumatic osteoarthritis primarily attributable to patellar fractures, and primary osteoarthritis of the patella-femoral joint. The radiological evaluation should include a long leg view film to avoid PFA indication in case of important femoro-tibial frontal deformity and a CT for evaluating tracking of the patella.

Outcomes: The long term outcome studies have pointed out a high rate of conversion to TKA after ten-year follow-ups, showing progression of arthritis in the tibiofemoral joint as most frequent reason for failure.\(^1\)\(^2\) The most recent studies incorporating evolutions in design and surgical technique showed successful clinical and radiological results while reducing the previously reported short-term complications related to patello-femoral maltracking or component malalignment.\(^3\)\(^4\)

Discussion: The clinical evaluation of patients implanted with PFA showed a significant improvement in knee function for patients affected by isolated patellofemoral arthritis, comparable to that of TKA and may be a less invasive option for this selective group of patients.\(^5\)\(^6\) There is a renewed interest in PFA due to recent improvements in implant design and surgical techniques but the long-term outcomes of modern implant should be carefully evaluated.

REFERENCES
While patient selection and sound surgical technique are important drivers of success in PFA, an analysis of results of PFA have shown a disparity in the early and mid-term failures that occur as a result of patellar instability and maltracking, depending on whether an inlay or onlay style trochlear component is used. Although no studies have directly compared inlay- and onlay-style trochlear prostheses, the preponderance of the evidence shows lower revision rates and need for secondary surgery to address patellar maltracking and higher functional success rates and durability with the latter. Inlay style components are often positioned flush with some, but not all, articular surfaces (due to morphologic mismatches between surface anatomy and trochlear implant) and internally rotated due to the native trochlear inclination. Series reviewing the results of inlay style implants have reported an incidence of patellar maltracking ranging between 17% and 36%. Other studies which have reviewed the experience with onlay style trochlear designs in PFA have found a considerably lower incidence of patellar maltracking, typically less than 1%. If patella tracking is satisfactory after PFA, the primary mode of failure will be progressive tibiofemoral arthritis, irrespective of the type of trochlear prosthesis utilized.

Several important technical steps should be followed when using an onlay style PFA system to optimize patellar tracking and therefore outcomes after PFA:

- Resect anterior trochlear surface perpendicular to AP (Whiteside) axis of femur
- Anterior resection should be flush with anterior femoral cortex
- Transitional edges of trochlear component should be flush with or recessed 1 mm relative to adjacent articular cartilage of condyles
  - Avoid keeping implant edges prominent
- Medial-lateral sizing of implant should ensure that the implant does not overhang into the soft tissues to reduce risk of soft tissue irritation
- Patellar preparation similar to TKA
  - Resect parallel to anterior patellar cortex
  - Restore thickness with composite construct (native patella and button)
  - Medialize button
  - Remove uncovered lateral facet
- Balance soft tissues as needed (lateral release/recession; proximal or distal realignment rarely needed)
Introduction: Rupture of the extensor mechanism following total knee arthroplasty is a rare but devastating complication. Due to the significant disability associated with the loss of the extensor mechanism, surgical repair if often required. It is important to recognize patient at risk for development of rupture, in an effort to avoid iatrogenic complications. Over the last several decades, numerous reports have described different methods of reconstruction using a host of materials and tissues and a variety of techniques. Extensor mechanism reconstruction with allograft remains the gold standard although recent advances in reconstruction with synthetic material have appeal and advantages. Results of extensor mechanisms reconstruction with a whole extensor allograft have been variable and speak to the importance of surgical technique.

Technique: In order to achieve success with reconstruction of the extensor mechanism, several important principles must be adhered to. First, prior to surgery, the mechanism of failure must be determined and addressed. If component revision has lead to rupture of the extensor mechanism, then revision of those components must take place at the time of reconstruction. Direct inspection of the allograft prior to surgery is crucial to ensure enough tissue is available for the reconstruction. At the time of surgery, rigid fixation of the distal allograft to host bone is imperative, with preference being for wire rather than screw fixation. Most importantly, the allograft must be sutured proximally with maximum tension to the host tissue with non-absorbable suture and tension must not be tested at time of surgery. Patients should be immobilized in full extension in a cast for 6-8 weeks and then gently begin active flexion and extension exercises.

Results: The results in the literature have been quite variable over time and speak to the importance of a strict surgical technique that has evolved over time. Table 1 lists the available outcomes of extensor mechanism reconstruction with whole extensor allograft.
REFERENCES


Extensor mechanism disruption associated with TKR is an uncommon but potentially disastrous complication. Simple suture fixation has been reported to be insufficient while autograph and allograft tendon reconstruction techniques have had variable results especially with long-term followup. A simple, straightforward technique using synthetic mesh has been utilized since 1995, for both quadriceps and patellar tendon disruptions associated with TKR appears reliable and is very cost effective.

The surgical technique includes the use of a knitted monofilament high-density polypropylene graft to reconstruct the extensor mechanism and facilitate fixation of adjacent host tissue into the graft. The graft is placed within an intramedullary position in the tibia located behind the tibial tubercle and in front of the tibial prosthesis. Graft fixation is accomplished with the use of bone cement and a transfixion cancellous bone screw into the tibial plateau. One of the most important aspects of this reconstruction is to adequately immobilize the two halves of the extensor mechanism on the ventral and dorsal surfaces so that the extensor mechanism can be drawn distally and allow the vastus medialis (VM) to also overlap the underlying mesh and vastus lateralis (VL).

Once the quadriceps is mobilized, the mesh graft is passed from inside-out through a portal in the lateral retinacular tissues. The graft is then secured to the ventral surface of the VL lateralis with a Krackow #5 nonabsorbable suture which creates the base for attachment of the VM in a distally and laterally tensioned position. The final construct is then a “pants-over-vest” advancement so that the mesh is sandwiched between the VM and VL.

Postoperative rehabilitation starts with the use of a long leg cast for 10-12 weeks followed by progressive ROM with a brace over the next 3 months. This session will demonstrate the steps of the surgical technique with tips and pitfalls associated using this reconstructive method.

REFERENCES

Symposium IX: When Problems Arise: Infection

3:24 pm – 3:29 pm

Preventing Periprosthetic Joint Infection: Strategies that Work
Javad Parvizi, MD, FRCS

Periprosthetic joint infection (PJI) is becoming the leading cause of failure following total joint arthroplasty (TJA) and several studies have identified independent risk factors for the development of PJI. Despite the debates revolving around some of the identified risk factors, several preventative perioperative strategies are currently commonly in use.

Detailed evaluation of our institutional data and published reports have been performed to identify perioperative strategies that can be used to minimize the risk of developing a PJI.

Strong evidence was found to support preoperative health and nutritional status optimization, the use of prophylactic antibiotics and antibiotic impregnated cement, preoperative skin preparation and the use of disposable draping, shorter operative time, cautious use of anticoagulants and the avoidance of allogeneic blood transfusion. Little or no evidence was found to support the use of laminar flow operating rooms or use of personalized protection suit, double gloving, hair removal, changing blades after skin incision, or addition of antibiotic to the irrigation solution.

Many of the commonly used practices to lower PJI lack strong data to support their use highlighting the need for larger randomized controlled studies. There is, on the other hand, strong support for implementation of simple strategies that could minimize risk of PJI.
A comprehensive synovial fluid biomarker program has recently identified alpha-defensin, an antimicrobial peptide, as a highly accurate biomarker for periprosthetic joint infection (PJI). The purpose of this study is to evaluate the clinical performance of alpha-defensin, and compare it to the performance of the recently described leukocyte esterase (LE) colorimetric test strip.

Synovial fluid was prospectively collected from patients during evaluation for revision hip or knee arthroplasty. The MSIS criteria, including cultures, CRP, ESR, fluid WBC, PMN %, and histology, was used to classify 23 PJI and 23 cases of aseptic failure. Synovial fluid samples were tested with both a novel synovial-fluid-optimized immunoassay for alpha-defensin and the LE colorimetric test strip.

The synovial fluid alpha-defensin immunoassay correctly predicted the MSIS classification of all patients in the study, demonstrating a sensitivity and specificity of >98% for the diagnosis of PJI. The average alpha-defensin concentration among infected samples was 59,604ng/ml, which was 60-fold higher than the average level among aseptic samples (986ng/ml). The alpha-defensin assay could be run on all samples, including those with blood contamination. The leukocyte esterase test strip could not be interpreted in 8 of 46 samples (17%) due to blood interference. Analysis of the LE strips that could be interpreted yielded a sensitivity of 67% and a specificity of >98%.

The synovial fluid alpha-defensin immunoassay greatly exceeds the diagnostic performance of previously described serum or synovial fluid tests for PJI. Alpha-defensin outperformed the LE colorimetric tests strip in this study, and provided reliable results even when the LE test strip failed due to blood interference.

The simple analytic results provided by the alpha-defensin immunoassay, when compared to the more complex and interpretive nature of both the MSIS criteria and LE colorimetric test strip, make it a highly attractive diagnostic tool.
Debate IV: Debridement and Liner Exchange For Acute Infection: A Reasonable Option

Affirm
Carlos J. Lavermia, MD

Background: Irrigation and debridement (I&D) with liner exchange and implant retention have been recently associated with very poor outcomes. We studied a case-series of acute periprosthetic joint infections treated with aggressive I&D with polyethylene liner exchange and component retention and evaluated: infection control rate; preoperative characteristics; pain and function of patients in whom treatment was successful and outcomes of failed cases.

Materials and Methods: 28 patients who underwent I&D by a single surgeon were retrospectively studied. Mean age was 67 years (range, 32–87). Patient perceived outcomes and clinical knee scores were assessed postoperatively. We defined a successful case as one with decreased symptoms (i.e. pain relief) and improved function regardless of the need for additional I&D or the use of oral suppressive antibiotics. A failed case was defined as one that needed prosthesis resection or a symptomatic one with low functional levels. The mean follow-up after a successful I&D was 4 years (range, 20–104 months). Two patients were lost to follow-up.

Results: 18 patients (64%) were successfully treated with aggressive I&D. Additional I&Ds (mean, 1.4; range, 1–2) were required in 5 of them. Among patients successfully treated, all outcomes improved postoperatively at the latest follow-up. Six additional patients underwent prosthesis resection and reimplantation due to persistent pain and/or functional impairment; among them, four (67%) had a successful outcome after the two-stage procedure. The remaining four patients had a poor outcome.

Conclusion: Aggressive I&D with liner exchange and implant retention is a reasonable treatment option for acute periprosthetic total knee infections particularly in the face of shared decision making. It can yield significant pain relief and acceptable functional outcomes. Treatment should take into account patient preferences. In the short term, resection arthroplasty is a very disabling procedure, impairs function for at least 3 months and it has been associated with significant mortality.

REFERENCES

Periprosthetic infection is a devastating complication for patient and surgeon alike. Irrigation and debridement is a time-honored procedure for orthopedic surgical site infections. All joint surgeons want this operation to succeed and all have anecdotal reports of success. While attempts to save the implant are well intentioned, the results of irrigation and debridement in the literature are inconsistent. In a literature review of over 2000 patients, the failure rate of this procedure ranges between 60-68%. This begs the question of why does a procedure which fails two-thirds of the time continue to be frequently utilized? Such enthusiasm persists given the emotional investment by both the patient and the surgeon. The alternate procedure, removal of the implant, is usually perceived as radical and attempts to save the implant are well intentioned.

To clarify the situation, the Periprosthetic Infection Consortium was established to answer the following questions concerning I&D’s:

1. **Does the offending organism matter?** (i.e.) Is there a difference between strep, and other organisms?
   - Data set 136 patients
   - 71% failure rate for strep (23/31)
   - 67% failure for other organisms (70/105)

2. **Does the timing of the I&D matter?** (i.e.) What is the efficacy of I&D done in the perioperative period?
   - Data set 84 patients I&D within first 3 months
   - 64% failure rate (54/84)

3. **What happens if I&D fails?** (i.e.) What is the fate of a two-stage reimplantation following a failed I&D?
   - Data set 92 patients
   - 30% recurrence of infection (28/92) after two-stage reimplantation

4. **What is the fate of an acute MRSA infection treated by an I&D?**
   - Data set 32 patients
   - 84% failure rate (27/32)

The answers to these questions are as follows:
Conclusion: Irrigation and debridement for periprosthetic infection should be used cautiously. Rare exceptions where this treatment is indicated include an elderly, infirmed patient unable to tolerate a two-stage reimplantation or extremely difficult to remove revision implants where secondary reconstruction may not be possible following such extraction.

REFERENCES


Single Stage Revision in Selected Patients

Professor Fares S. Haddad, BSc, MD (Res), MCh (Orth), FRCS (Orth)

The infected joint arthroplasty continues to be a very challenging problem. Its management remains expensive, and places an increasing burden on health care systems. It also leads to a long and difficult course for the patient, and frequently a sub optimal functional outcome. The choice of a particular treatment program will be influenced by a number of factors. These include the acuteness or chronicity of the infection; the infecting organism(s), its antibiotic sensitivity profile and its ability to manufacture glycocalyx; the health of the patient; the fixation of the prosthesis; the available bone stock; and the particular philosophy and training of the surgeon.

For most patients, antibiotics alone are not an acceptable method of treatment, and surgery is necessary. The standard of care for established infection is two stage revision with antibiotic loaded cement during the interval period and parental antibiotic therapy for six weeks. Single stage revision may have economic and functional advantages however. We have devised a protocol that dictates the type of revision to be undertaken based on host, organism and local factors.

Our protocol has included single stage revision using antibiotic loaded cement in both THA and TKA. This was only undertaken when sensitive organisms were identified preoperatively by aspiration and appropriate antibiotics were available to use in cement. Patients with immunocompromise, multiple infecting organisms or recurrent infection were excluded. Patients with extensive bone loss that required allograft reconstruction or where a cementless femoral component was necessary were also excluded.

Our algorithm was validated first in the knee and extended to infected TKA in 2004. This protocol has now been applied in over 100 TKA revisions for infection between 2004 and 2009. Our single stage revision rate is now over 25%. We continue to see a lower reinfection rate in these carefully selected patients, with high rates of infection control and satisfaction and better functional and quality of life scores than our two stage revision cases.

Whilst our indications are arbitrary and not based on specific biomarkers, we present excellent results for selective single stage exchange. A minimum three year follow-up suggests that these patients have shorter hospital stays, higher satisfaction rates and better knee scores. An ongoing evaluation is in place. One stage revision arthroplasty for infection offers potential clinical and economic advantages in selected patients.

REFERENCES


Bioresorbable Antibiotic Eluting Beads as an Adjunct to Treatment
Edward J. McPherson, MD, FACS

This study reviews the clinical results using commercially pure, synthetic antibiotic-loaded Calcium Sulfate dissolvable beads (Stimulan®) in 258 cases of aseptic and septic revision total knee arthroplasty. A set protocol of Vancomycin and Tobramycin antibiotic was used in all cases. The rate of wound drainage in this series was 3.5%. Wound drainage was generally seen in cases using higher bead volumes. The incidence of heterotopic bone formation was 0.4%. There were two cases of hypercalcemia. Both cases were treated with normal saline hydration and resolved without further treatment. There were fourteen failures in this study, ten of which were due to infection. At this stage of investigation, we do not see the toxic reactive synovial reactions and wound leaks that have been a concern with gypsum-derived Calcium Sulfate products. We feel that commercially pure, synthetic antibiotic-loaded dissolvable beads are an acceptable delivery tool for local antibiotic delivery in aseptic and septic revision joint arthroplasty of the knee.

Further studies are needed to examine the potential of improving outcomes of periprosthetic joint infection (PJI) with this particular local antibiotic delivery system. Randomized controlled studies planned for the near future include the following:

1) Short Course vs. Standard Course IV antibiotic therapy in combination with commercially pure CaSO4 intra-articular beads in 2-stage prosthetic joint infection. Proof of equivalent results.

2) Post-operative PJI DECRA (Debridement, modular Exchange, Component Retention, and IV Antibiotics) with and without intra-articular commercially pure CaSO4 beads. Proof of improved survival.


4) Aseptic revision TKA with and without intra-articular commercially pure CaSO4 beads. Proof of improved survival.
Two Stage Exchange: Dynamic vs. Static Spacers
Arlen D. Hanssen, MD

The use of articulating mobile spacers or use of a block spacer with high dose antibiotic bone cement has been reported on extensively over the past decade. Although almost all reports suggest a superior outcome with the use of an articulated spacer, it is important to recognize that there have been no studies of these two techniques in a non-historical comparison or as a Level-I study. These reports are thus unable to discriminate the poor results of many patients with a block spacer who were not candidates for the use of an articulating spacer. The vast majority of patients with an infected TKR are candidates for use of an articulating spacer except for those patients with severe bone loss and severe compromise of the soft tissue envelope around the knee. In these situations, use of a block spacer is recommended to effectively immobilize the knee. The results of these worst case patients should not be expected to function as well as patients with good bone or soft-tissues.

It is important when using either technique to understand how to do a technically excellent spacer, whether mobile or static. When using a mobile spacer it is preferable to use a polyethylene-metal interface to avoid cement fragmentation debris from the articulating surfaces. Fabrication of static spacers should be done so that the knee is essentially arthrodesed with the cement block and when combined with cast immobilization, the soft tissues are then effectively immobilized.

This talk will demonstrate how to perform effective block spacers and well-functioning articulating spacers with high dose antibiotic cement. Indications and criteria for use of either technique will be discussed. Although the literature on this topic will be reviewed, the case will be made for why a Level-I study should be conducted to solve this controversy.

REFERENCES


Evaluation of the Stiff Knee

Kelly G. Vince, MD, FRCS(c)

My personal bias on this topic includes: 1. “Stiffness” and “arthrofibrosis” are not synonymous. 2. TKA’s with established stiffness should either be revised completely and aggressively, (changing all components and all variables for a construct that favors motion) or should not have surgery at all.

This presentation pertains to the TKA with established stiffness, not the early form that may be amenable to manipulation under anesthesia. The stiff TKA can be characterized by: 1. Degrees of flexion 2. Degrees of extension lacking (flexion contracture or deformity FFD) and 3. Pain. Most stiff knees amenable to revision will have an element of all three. Flexion can often be improved, even if modestly, extension should be completely correctible, but has a high probability of recurring if the patient has contractures of the other knee, hips and kyphosis.

The amount of flexion prior to arthroplasty should be established. It is unlikely that revision will increase flexion beyond what was present prior to the TKA as this reflects limits imposed by the inelasticity of the quadriceps. As with all revision knee arthroplasty, a systematic and comprehensive evaluation of the patient is mandatory.\(^1\) Infection must be considered and ruled out.\(^2\)

The purpose of the evaluation is to answer two questions: 1. Is it reasonable to expect improvements of use to the patient (to flexion, extension and pain) as the result of revision based on identification of factors that can be modified in favor of motion, beyond simply releasing scar and 2. What are the factors that can be changed with revision?

Revision can be planned from single leg weight bearing AP, lateral and Merchant patellofemoral radiographs plus an image of the hip and a computerized tomography (CT) scan of the knee arthroplasty that can quantify rotational position of the components.\(^3,4\)

Flexion contracture can be improved with revision that removes distal femoral bone and flexion, in general, with manoeuvres that increase laxity in flexion. A coordinated surgical technique will ensure balanced gaps.\(^5\) Internal rotation of tibial and femoral components must be corrected, and patellar tracking improved. Patellar thickness can be reduced.

REFERENCES

The Effect of Timing of Manipulation under Anesthesia to Improve Range-of-Motion and Functional Outcomes Following Total Knee Arthroplasty

Michael A. Mont, MD; Kimona Issa, MD; Samik Banerjee, MD and Bhaveen Kapadia, MD

Introduction: Manipulation under anesthesia (MUA) has been reported to improve range-of-motion (ROM) when other rehabilitative efforts fail to obtain adequate motion after total knee arthroplasty (TKA). The purpose of this study was to evaluate the effects of timing of the manipulation on knee ROM and clinical outcomes.

Methods: All 2,128 TKAs performed at our institution from 2005 to 2011 were reviewed to determine the number of patients who had undergone MUA. A total of 144 manipulations in eighty-eight women and forty-five men were reviewed. MUAs that were performed within the first twelve weeks post-TKA were considered early-and after that period were considered late. Patients were further sub-stratified according to the timing of MUA: Group-I: within six-weeks, Group-II: seven to twelve-weeks, Group-III: thirteen to twenty-six weeks, and Group-IV: after twenty-six weeks. Outcomes evaluated included gains in flexion and final ROM, and Knee Society objective and functional scores between early and late manipulation using various adjusted multivariable regression models and at a mean follow-up of fifty-one months (range, twelve to eighty-one months). Mediation analysis was used to investigate whether gains in ROM from the MUAs alone had mediated the effect between timing of the manipulation and clinical outcomes.

Results: Patients who underwent early-manipulations had significantly higher mean gains in flexion (36.5 vs.17 degrees), higher final ROM (119 vs. 95 degrees), and higher Knee Society objective (89 vs. 84 points) and functional scores (88 vs. 83 points) compared to late MUAs. There were no significant differences in the outcomes of group I and II. Manipulations after twenty-six weeks had resulted in unsatisfactory clinical outcomes. Multivariable regression analyses confirmed significantly better clinical outcomes with early manipulations. Mediation analysis showed timing of manipulation independently had significantly contributed to the outcomes.

Conclusion: The authors believe that orthopaedic surgeons should have low thresholds for performing early MUAs (within twelve weeks from arthroplasty procedure) to achieve higher ROM and clinical outcomes. Patients may benefit from counseling in order to not delay early MUAs and when indicated.
Surgical Exposure of the Stiff Knee in Revision Surgery
Michael D. Ries, MD

Most revision TKA’s can be exposed through a medial parapatellar arthrotomy. However, exposure is often limited by shortening of the extensor mechanism and intra-articular scar tissue. Mobilization of the extensor mechanism can be facilitated by synovectomy and excision of scar from the medial and lateral gutters. Patellar subluxation rather than eversion can also reduce tension in the extensor mechanism. However, if exposure is not adequate then extension of the exposure distally with tibial tubercle osteotomy or proximally with a rectus snip will permit wider exposure without risk of patellar ligament avulsion. The tibial tubercle osteotomy is performed generally with a bone fragment 6 to 10 cm in length and 1.5 to 2 cm thick at the level of the tibial tubercle and in a medial to lateral direction. The anterior compartment muscle attachment to the osteotomized bone fragment is preserved which provides both a distal soft tissue tether and vascularity to the bone fragment. Fixation can be achieved with anteromedial wires and screws. If tibial bone stock is poor and fracture of the osteotomy is a considerable risk, then extension of the arthrotomy proximally with a rectus snip is a safer method to extend the exposure. The rectus snip is an oblique transection of the rectus tendon in a distal medial to proximal lateral direction. The continuity of the vastus lateralis to the patella is preserved. With either the tibial tubercle osteotomy or rectus snip postoperative rehabilitation is generally not restricted provided adequate fixation of the repair has been achieved.

REFERENCES


Stiffness after Total Knee Arthroplasty: Soft Tissue Release versus Revision
Robert T. Trousdale, MD

I. Etiology – often multifactorial

A. Patient factors: preop ROM, obesity, previous surgery scarring, motivation, pain control, psychiatric issues

B. Technical errors limiting extension

1. Tight extension space: inadequate distal femoral resection, large posterior osteophytes, avoid flexion of femoral component or too much posterior slope in tibial component, tight posterior capsule

C. Technical errors limiting flexion

1. Tight flexion space: too large of femoral component, reverse slope of tibial component, malrotation of components, poor soft tissue release or balance, too large of distal femoral resection, ↑ femoral component flexion, tight PCL, too thick of patella.

D. Implant design: CR versus PS, posterior offset

E. Perioperative issues: hematoma, infection, RSD, HO

II. Management: (after infection, RSD, hip pathology has been ruled out)

A. Non-surgical management: pain control, therapy

B. Soft tissue surgery: mild stiffness, components in good position, can consider scar excision (open or arthroscopic) ± poly exchange if tight in flexion and extension

C. Revision surgery: severe stiffness, malposition, loosening, improper component sizing, incorrect joint line, marked instability

REFERENCES

**Patellofemoral Instability: Evaluation and Surgical Management**  
*James P. McAuley, MD, FRCSC*

**Introduction:** Patellar component revision is a rare event after primary TKA. However the frequency of anterior knee pain with or without resurfacing, and the unexplained frequency of patient dissatisfaction after TKA remains enigmatic. Patients complain of pain and symptoms very different from their preoperative state. The high clinical threshold for revision of TKA results in some of these patients going untreated.

Historically, various single surgical options have been advocated regardless of anatomic variations, with expected suboptimal results. Increasing understanding of PF instability in the non-arthroplasty population provides principles helpful in diagnosing and treating PF instability in TKA.

**Avoidance and recognition:** Naturally soft tissue balancing of both the tibiofemoral and patellofemoral compartments is a prerequisite. Identifying and addressing all factors contributing to PF instability is key to improving clinical outcomes.

Axial alignment and more importantly individual component rotation are critical as is combined rotational malposition. CT rotational profiles give objective evidence of rotational problems. In addition CT gives objective measurement of the extensor mechanism and can provide indications for distal or proximal realignment procedures.

Preoperative films and exam findings if available can reveal many preoperative risk factors, which if not identified can be problematic (dysplasia, chronic dislocation, patella baja or alta, concave thin patella etc).

**Treatment:** Objectively, the historical results of patellar instability using quads advancement, retinacular release/imbrication, distal realignment have been disappointing. This is very likely due to the lack of recognition of all contributing factors and the use of a single procedure for all comers.

We currently have the ability to identify and address all contributing factors for patellar instability. This has the potential to lessen the incidence of this problem and increase clinical outcomes, but long-term data confirming this is lacking.

**REFERENCES**


Tibial Femoral Instability: Evaluation and Surgical Management
Stuart B. Goodman, MD, PhD; Robert Detch MD; James I. Huddleston, MD and William J. Maloney, MD

Currently, tibial-femoral instability (TFI) is the second most common complication leading to revision surgery after TKR. In some series, TFI is the most common reason for early revision in the first 2 years after primary TKR. In the Stanford University series of 353 revision TKRs performed over a 7-year period, TFI constituted 21.3% of all revisions performed; early revisions constituted 46% of all revisions, with TFI being the leading cause.

The patient’s complaints of instability usually include comments such as “I don’t trust the knee”, “the knee feels weak”, “the knee gives way”, “I have pain and the knee swells”, “something is not right”, or even “the knee seems too loose”. Patients notice these events especially when changing positions of the knee, such as with ascending/descending stairs, getting up from a chair etc., when weight may be placed on one knee at a time. The history usually makes the diagnosis; the physical examination and ancillary tests confirm TFI. Physical examination for anterior-posterior and medial-lateral instability should be performed with the knee in full extension, mid-flexion, and at 90° of flexion. The distraction–compression “clunk” test at 0° and 90° should be noted. Routine knee radiographs are helpful to rule out component loosening and suboptimal alignment. Distraction views with the leg bent at 90° with a weight, or a notch view will often show a gap between the polyethylene and femoral component. Primary TKR pre-operative and post-operative radiographs, and a lateral radiograph of the contralateral normal knee will give the surgeon data on the degree of pre-operative arthritis, anatomical landmarks, and important data relevant to alignment, the position of the joint line, femoral condylar offset and tibial slope.

Once low-grade infection is ruled out, and (perhaps in mild cases of TFI) a trial of physical therapy has failed, revision surgery is warranted. The revision is targeted to the reason for the instability. We have found the following classification of TFI useful in identifying the reason for instability, in order to guide the revision procedure.

Six categories of tibial-femoral instability identified:
- Flexion/extension gap mismatch
- Global instability
- Isolated ligament insufficiency
- Extensor mechanism insufficiency
- Implant loosening
- Implant malposition

The goal of surgery is to provide the patient with an infection-free, stable, functional TKR with little or no pain. This usually requires revision of at least one, and more commonly both components, and increasing the prosthesis constraint. Important aspects to this are correction and reconstitution of the joint line, femoral condylar offset and tibial slope. A closely supervised rehabilitation program is also very important. If these principles are followed, satisfactory outcomes can be expected in the majority of patients.

REFERENCES

Le DH, Huddleston JI, Goodman SB, Maloney WJ: Current modes of failure in total knee arthroplasty. Accepted for publication. Clin Orthop Rel Res


Revision TKA for Instability
Mark W. Pagnano, MD

I. Instability
   A. Extension instability (varus-valgus instability)
   B. Flexion instability (anterior-posterior instability)
   C. Hyperextension (genu-recurvatum)
   D. Global knee instability
   E. Mid-flexion instability: a poorly defined entity with some surgeons using this term for varus-valgus laxity at 30-60 degrees and others using the term in reference to anterior-posterior laxity at 30-60 degrees or the mid-range of flexion. No consensus in 2014.
   F. Extensor mechanism incompetence can mimic ligamentous instability

II. Laxity versus Instability
   A. Laxity is a simple physical finding; many TKA with higher than typical laxity in the varus-valgus or a-p direction still function well
   B. Instability is a clinical diagnosis derived from a combination of patient history and physical exam findings that implicate laxity in one or more planes as the cause of pain and functional limitations

III. Result of Revision TKA for Instability
   A. All revisions for instability must focus on restoring balance medially and laterally in both flexion and extension
   B. It is relatively uncommon that a simple tibial insert exchange will be effective in restoring balance
   C. In some revision cases adequate balance can be restored with standard unconstrained implants (CR or PS)
   D. In many revisions mild asymmetry in balance is best addressed with a constrained condylar/varus-valgus constrained implant
   E. Hinged implants are most often required in 2 circumstances: 1) when there is gross laxity in the flexion gap relative to the extension gap (>10-15mm difference) and 2) in knees with marked genu-recurvatum
   F. Results of revision TKA for instability can be largely predicted based on the attainment of surgical goals: how well balanced?
   G. Results of revision TKA for instability are modified by patient specific characteristics including bone-loss; bone-quality; and co-morbidities
   H. There is a poorly understood subset of patients who seem to progressively stretch-out an otherwise well balanced knee

REFERENCES
2. Vince KG. Diagnosis and management of patients with instability of the knee. Instructional Course Lectures 2012;61:515-524.
Upon completion of this activity, participants will be able to:

- Update clinical skills and basic knowledge through research findings and biomechanical studies.
- Discuss the various surgical and non-surgical treatments and management of conditions related to the knee joint.
- Determine indications and complications in total knee arthroplasty.
- Critique presentations of surgical techniques and demonstrations of treatment options.
- Evaluate the efficacy of new treatment options through evidence-based data.

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Some pharmaceuticals and/or medical devices at the Specialty Day Meeting have not been cleared by the U.S. Food and Drug Administration (FDA) or have been cleared by the FDA for specific purposes only. The FDA has stated that it is the responsibility of the physician to determine the FDA status of each pharmaceuticals and/or medical devices he or she wishes to use in clinical practice.

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Each participant in The Knee Society Specialty Day Meeting has been asked to disclose if he or she has received something of value from a commercial company, which relates directly or indirectly to the subject of their presentation. The Knee Society has identified the options to disclose as follows:

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