FINAL
SCIENTIFIC PROGRAM

Saturday—March 10, 2018
Ernest Morial Convention Center
La Nouvelle Ballroom B
New Orleans, Louisiana
General Program Information

The Mission of The Hip Society

The Mission of The Hip Society is to advance the knowledge and treatment of hip disorders to improve the lives of our patients.

Meeting Objectives

The objectives of the Open (Winter) Meeting of The Hip Society and AAHKS are to provide up-to-date information on the treatment of hip conditions, including non-arthroplasty options, and the latest surgical techniques, as well as the current thinking on bearing surfaces. Other objectives address the difficult primary THA and complication management and include an update on revision THA.

CME Accreditation

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the American Academy of Orthopaedic Surgeons and The Hip Society. The American Academy of Orthopaedic Surgeons is accredited by the ACCME to provide continuing medical education for physicians. The American Academy of Orthopaedic Surgeons designates this live activity for a maximum of 7.5 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Evaluation

Your opinion matters! Please complete your evaluation online at: https://www.surveymonkey.com/r/HSWM2018 or use the QR code to access with your handheld smart device:

![QR Code]

Photography

Please refrain from unauthorized photography and video recording of presentations. Your registration for, and attendance of, this session gives The Hip Society permission to capture images of session attendees and to use these images for internal and marketing purposes.
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Save the Date and Join Us In Las Vegas!

The AAOS 2019 Annual Meeting and Specialty Day

March 12-16, 2019
Acknowledgements

Past Presidents of The Hip Society

<table>
<thead>
<tr>
<th>Year</th>
<th>President</th>
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<tbody>
<tr>
<td>1968-1969</td>
<td>William H. Harris, MD, DSc.</td>
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<td>1969-1970</td>
<td>Frank E. Stinchfield, MD</td>
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<td>1970-1971</td>
<td>Walter P. Blount, MD</td>
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<td>1971-1972</td>
<td>Albert B. Ferguson, Jr., MD</td>
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<td>1972-1973</td>
<td>J. Vernon Luck, Sr., MD</td>
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<td>1973-1974</td>
<td>Mark B. Coventry, MD</td>
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<td>1974-1975</td>
<td>Emmett M. Lunceford, Jr., MD</td>
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<td>1976-1978</td>
<td>Augusto Sarmiento, MD</td>
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<td>1978-1979</td>
<td>Marshall R. Urist, MD</td>
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<td>1979-1980</td>
<td>Harlan C. Amstutz, MD</td>
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<td>1980-1981</td>
<td>Philip D. Wilson, Jr., MD</td>
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<td>1981-1982</td>
<td>Richard C. Johnston, MD, MS</td>
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<td>1982-1983</td>
<td>Clement B. Sledge, MD</td>
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<td>1983-1984</td>
<td>Floyd H. Jergesen, MD</td>
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<td>1984-1985</td>
<td>C. McCollister Evarts, MD</td>
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<td>1985-1986</td>
<td>Jorge O. Galante, MD, DMSc.</td>
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<td>1986-1987</td>
<td>Lee H. Riley, Jr., MD</td>
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<td>1987-1988</td>
<td>William R. Murray, MD</td>
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<td>1988-1989</td>
<td>Joseph E. Miller, MD</td>
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<td>1989-1990</td>
<td>Donald E. McCollum, MD</td>
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<td>1990-1991</td>
<td>J. Phillip Nelson, MD</td>
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<td>1991-1992</td>
<td>Nas S. Eftekhar, MD</td>
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<td>1992-1993</td>
<td>William N. Capello, MD</td>
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<td>1993-1994</td>
<td>Robert H. Fitzgerald, Jr., MD</td>
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<td>1994-1995</td>
<td>Mark G. Lazansky, MD</td>
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<td>1995-1996</td>
<td>Richard B. Welch, MD</td>
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<td>1996-1997</td>
<td>Dennis K. Collis, MD</td>
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<td>1997-1998</td>
<td>Eduardo A. Salvati, MD</td>
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<td>1998-1999</td>
<td>Robert B. Bourne, MD, FRCSC</td>
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<td>1999-2000</td>
<td>Richard D. Coutts, MD</td>
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<td>2000-2001</td>
<td>Leo A. Whiteside, MD</td>
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<td>2001-2002</td>
<td>Benjamin E. Bierbaum, MD</td>
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<td>Miguel E. Cabanela, MD</td>
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<td>2003-2004</td>
<td>Charles A. Engh, Sr., MD</td>
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<td>2004-2005</td>
<td>Richard E. White, MD</td>
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<td>2005-2006</td>
<td>James A. D’Antonio, MD</td>
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<td>2006-2007</td>
<td>John J. Callaghan, MD</td>
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<td>2007-2008</td>
<td>Lawrence D. Dorr, MD</td>
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<td>2008-2009</td>
<td>Wayne G. Paprosky, MD</td>
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<td>2009-2010</td>
<td>William J. Maloney, III, MD</td>
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<td>2010-2011</td>
<td>Chitransjan S. Ranawat, MD</td>
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<td>2011-2012</td>
<td>Adolph V. Lombardi, Jr., MD</td>
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<td>2012-2013</td>
<td>David G. Lewallen, MD</td>
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<td>2013-2014</td>
<td>Vincent D. Pellegrini, Jr., MD</td>
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<td>2014-2015</td>
<td>Paul F. Lachiewicz, MD</td>
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<td>2015-2016</td>
<td>Daniel J. Berry, MD</td>
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<td>2016-2017</td>
<td>Harry E. Rubash, MD</td>
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Past Presidents of AAHKS

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<th>Year</th>
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<td>Hugh S. Tullos, MD</td>
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<td>Merrill A. Ritter, MD</td>
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<td>Richard H. Rothman, MD, PhD</td>
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<td>James A. Rand, MD</td>
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<td>Douglas A. Dennis, MD</td>
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<td>Clifford W. Colwell, Jr., MD</td>
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<td>Richard F. Santore, MD</td>
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<td>Joseph C. McCarter, MD</td>
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<td>William J. Hozack, MD</td>
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<td>2008</td>
<td>David G. Lewallen, MD</td>
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<td>2009</td>
<td>William J. Robb, III, MD</td>
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<td>2010</td>
<td>Mary I. O’Connor, MD</td>
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<td>2011</td>
<td>Carlos J. Lavernia, MD</td>
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<td>2012</td>
<td>Thomas P. Vail, MD</td>
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<td>Thomas K. Fehring, MD</td>
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<td>2014</td>
<td>Brian S. Parsley, MD</td>
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<td>2015</td>
<td>Jay R. Lieberman, MD</td>
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<td>2016</td>
<td>William A. Jiranek, MD, FACS</td>
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As The Hip Society celebrates its 50th Anniversary, we would like to acknowledge the wisdom and the foresight of our founding members, the contributions of many who served and continue to serve as leaders, educators, and mentors to the future of our profession, and thank all for your dedication to excellence in patient care and research.
A Tribute to The Hip Society: 50 Years!
Session V (11:15 am – 12:05 pm)

Lawrence D. Dorr, MD
President of The Hip Society (2007-2008)

William H. Harris, MD, D.Sc.
Founding Member, President of The Hip Society (1968-1969)

David G. Lewallen, MD
President of The Hip Society (2012-2013)

Vincent D. Pellegrini, Jr., MD
President of The Hip Society (2013-2014)

Session moderated by:

Daniel J. Berry, MD
President of The Hip Society (2015-2016)
THIS COURSE IS ABOUT ME!

Contemporary Approaches to Adult Hip and Knee Reconstruction

Scott M. Sporer, MD and
R. Michael Meneghini, MD - Program Co-Chairs

Presented by The Hip Society and The Knee Society

FRIDAY, MAY 18, 2018
9:30 am - 5:45 pm (times are approximate)

In partnership with:
Indiana University Health Saxony Hospital
13000 E 136th St, Fishers, IN 46037

Visit www.hipsoc.org learn more and to REGISTER
Call (847) 698-1638 | Email hip@aaos.org
Congratulations: The 2018 Hip Society Lifetime Achievement Award Recipient
Session V (11:15 am – 12:05 pm)

Reinhold Ganz, MD, Professor Emeritus
Zurich, Switzerland

Reinhold Ganz graduated from medical school in Freiburg, Germany. His early postgraduate training was focusing on bone physiology and biomechanics at the University of Basel and the AO Research Institute in Davos, Switzerland. He pursued the orthopaedic training under the guidance of Maurice Muller in Berne, who engaged his interest in hip surgery. Succeeding Muller as chief of the department, he decided to give more attention to preservation of the native hip.

All research projects were based on detailed cadaver studies of the vascular supply of the involved area.

The goal of a first undertaking was to optimize reorientation surgery of the dysplastic acetabulum and make the procedure more versatile. While the available techniques approached the acetabulum from the pelvic outside and as such were interfering with the main blood suppliers, a technique was developed to execute the osteotomy entirely from inside to spare not only the abductors but also the blood vessels to the acetabular bone. The technique allows large correction and provides sufficient fragment perfusion even after extensive capsulotomy for additional intra-articular surgery. Meanwhile, the Bernese Periacetabular Osteotomy (PAO) has gained worldwide acceptance.

Surgical dislocation of the hip joint was tainted for a long time with the risk of avascular head necrosis. Detailed injection studies of the supplying vessels showed the way to perform a safe and reproducible dislocation without such risks. Rather unexpected, routine surgical hip dislocation allowed to observe impingement and to formulate the concept explaining one important initiation of osteoarthritis of the hip. Furthermore, the extension of surgical hip dislocation with a retinacular flap opened the door for a new class of intraarticular joint preserving procedures, notably, relative neck lengthening, subcapital realignment, true femoral neck osteotomy and head osteotomy to reduce its size.

Such work was only possible with a dedicated team: Katharina Leunig and Morteza Kalhor have provided substantial and specific knowledge of the vascular supply of the hip area. Kaj Klaue and Jeffrey W. Mast have contributed basic facts to concept and technical execution of the PAO technique. Michael Leunig, Klaus A. Siebenrock and Martin Beck have given essential input to the impingement concept and to further specify indication and technical execution of the new procedures.
JOINT ARTHROPLASTY MOUNTAIN MEETING (JAMM)
Park City, Utah

PRESENTED IN PARTNERSHIP BY:

THE HIP SOCIETY
THE KNEE SOCIETY
AAOS

Coming to a mountain near you in January 2019
Email foley@aaos.org to receive updates on JAMM2019
Fundamentals of Hip and Knee Arthroplasty for Orthopaedic Residents

Presented by AAOS, AAHKS, The Knee Society and The Hip Society

THREE DATES THREE LOCATIONS

April 13 – 15
Baltimore, MD
Ronald Delanois, MD
Gregory Golladay, MD
Course Directors

April 27 – 29
Rosemont, IL
R. Michael Meneghini, MD
Brett R. Levine, MD
Course Directors

May 18 – 20
Long Beach, CA
Erik N. Hansen, MD
Mark J. Spangehl, MD
Course Directors

Residents – Expand your surgical skills for hip and knee arthroplasty!

Build your surgical skills leading to proficiency at hip and knee arthroplasty in this interactive skills course designed exclusively for orthopaedic residents! Spend the majority of your time practicing bone cuts, correct ligament balancing for TKA, determining correct implant sizing and restoring biomechanics in THA, and more!

Work on anatomical specimens under the guidance of expert faculty. Panel discussions and faculty-led small group interactions round out your skills lab experience.

AAOS/AAHKS/KS/HS Resident Member/Resident/Post-Residency Fellow $250

To register, call AAOS Customer Service at 1-800-626-6726
Congratulations: The 2018 Hip Society Scientific Award Winners
Session V (11:15 am to 12:05 pm)

The 2018 John Charnley Award

*Analysis of US Hip Replacement Bundled Payments: Physician-initiated Episodes Outperform Hospital-initiated Episodes*

Presenter: **William S. Murphy, AB**

Co-Authors: Ahmed Siddiqui, DO; Tony Cheng, MBA; Ben Lin, BA; David Terry, MBA; Carl T. Talmo, MD; Stephen B. Murphy, MD

The 2018 Otto Aufranc Award

*The Genetics of Osteolysis After Total Hip Arthroplasty*

Presenter: **J. Mark Wilkinson, PhD, FRCS**

Co-Authors: Scott J. Macinnes, PhD; Konstantinos Hatzikotoulas, PhD; Anne Marie Fenstad, MSc; Karan Shan, PhD; Lorraine Southam, PhD; Ioanna Tachmazidou, PhD; Geir Hallan, PhD; Harvard Dale, PhD; Kalliope Panoutsopoulou, PhD; Ove Furnes, PhD; Eleftheria Zeggini, PhD

The 2018 Frank Stinchfield Award

*Spino-pelvic Hypermobility is Associated with Inferior Outcome Post-THA: Examining the Effect of Spinal Arthrodesis*

Presenter: **George Grammatopoulous, BSc, MBBS, D.Phil (Oxon)**

Co-Authors: Wade Gofton, MD, FRCSC, Med; Zaid Jibri, MBChb, MRCSEd, FRCR; Matthew Coyle, MD; Johanna Dobransky, MHK, BSc; Cheryl Kreviazuk, BA; Paul R. Kim, MD, FRCSC; Paul E. Beaulé, MD, FRCSC
The Hip Society’s Traveling Fellowships

The Hip Society’s Rothman-Ranawat Traveling Fellowship

At the core of the mission of The Hip Society is the promotion of the science of disease of the hip. Fundamental to science are the basic tenets of education and research. The ultimate beneficiaries of our knowledge are the patients. The Hip Society Rothman-Ranawat Traveling Fellowship is open to four (4) young orthopaedic surgeons, from North America, and throughout the world. The traveling Fellows will visit up to twelve (12) sites in North America as identified by The Hip Society. The ultimate goal of the fellowship is to offer the young surgeons an inspirational tour of state-of-the-art facilities providing exemplary surgical care of the hip joint throughout North America.

Congratulations, 2018 Rothman-Ranawat Traveling Fellows!

Elie S. Ghanem, MD
Birmingham, AL, USA

Chris R. Gooding, MBBS BSc (Hons), MD, MRCS, FRCS, Tr and Orth
Cambridge, United Kingdom

S.M. Javad Mortazavi, MD
Tehran, Iran

Benjamin M. Stronach, MD
Jackson, MS, USA

Those interested in applying for the 2019 Rothman-Ranawat Traveling Fellowship, please visit The Hip Society’s website www.hipsoc.org, click on the Education tab.

The deadline to apply for the 2019 Fellowship is August 15, 2018.

The Hip Society-British Hip Society Traveling Fellowship

The Hip Society is proud to partner with the British Hip Society to provide an exceptional exchange opportunity to two (2) outstanding North American candidates. Successful candidates will travel throughout the United Kingdom for a period of three-four weeks and will be hosted by world-renowned experts in adult hip reconstruction. The program will include opportunities for scientific exchange, OR observations, close interaction with faculty, as well as social and cultural events.

The 2018 Hip Society-British Hip Society Traveling Fellowship

Those interested in applying for the 2018 Fellowship, please visit The Hip Society’s website www.hipsoc.org, and click on the Education tab.

The extended deadline to apply is April 1, 2018.

To read about the 2016 Fellows’ adventures, learnings, and experiences, go here: https://2016bhsfellowship.wordpress.com/
AAHKS
Clinical Affiliate Membership
STRENGTHEN YOUR PRACTICE

GAIN KNOWLEDGE. MAKE CONNECTIONS. ADVANCE PATIENT CARE.

Your orthopaedic team members will find membership in the American Association of Hip and Knee Surgeons as valuable as you do. Please encourage them to explore membership today!

AAHKS
AMERICAN ASSOCIATION OF HIP AND KNEE SURGEONS
WWW.AAHKS.ORG/JOIN-AAHKS
“Best meeting I have ever attended in terms of content and organization.”
- 2017 evaluation survey

Small group breakouts using a case-based ICL format facilitates one-on-one interaction with leaders in the field of hip and knee arthroplasty. New! AAHKS Past President, Carlos J. Lavernia, MD, will host a Spanish-language academic session and social event for international attendees.

Visit the AAHKS website for CME info, program, faculty and to register.

www.AAHKS.org
<table>
<thead>
<tr>
<th>Time</th>
<th>Session I: Primary Surgical Approach/Technique and Implant Selection: Tips and Tricks to Maximize Outcomes (Video-Based)</th>
<th>Moderator</th>
<th>Time</th>
<th>Session II: Intraoperative and Early Postoperative Complications: Surgical Exposure and How to Manage (Video-Based)</th>
<th>Moderator</th>
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<tbody>
<tr>
<td>7:55 am – 8:00 am</td>
<td>WELCOME</td>
<td>Kevin L. Garvin, MD (Omaha, NE) – President, The Hip Society</td>
<td>8:00 am – 8:06 am</td>
<td>ABMS Approach in the Lateral Decubitus Position</td>
<td>Christopher L. Peters (Salt Lake City, UT)</td>
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<tr>
<td>8:00 am – 8:06 am</td>
<td>ABMS Approach in the Lateral Decubitus Position</td>
<td>Christopher L. Peters (Salt Lake City, UT)</td>
<td>8:06 am – 8:12 am</td>
<td>Direct Anterior Approach Including Tips to Improve Exposure</td>
<td>Paul E. Beaulé (Ottawa, ON, Canada)</td>
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<td>8:06 am – 8:12 am</td>
<td>Direct Anterior Approach Including Tips to Improve Exposure</td>
<td>Paul E. Beaulé (Ottawa, ON, Canada)</td>
<td>8:12 am – 8:18 am</td>
<td>Dysplastic Hip</td>
<td>John C. Clohisy, MD (St. Louis, MO)</td>
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<tr>
<td>8:12 am – 8:18 am</td>
<td>Dysplastic Hip</td>
<td>John C. Clohisy, MD (St. Louis, MO)</td>
<td>8:18 am – 8:24 am</td>
<td>Previous Surgery/Retained Hardware</td>
<td>Michael J. Archibeck, MD (Albuquerque, NM)</td>
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<td>8:18 am – 8:24 am</td>
<td>Previous Surgery/Retained Hardware</td>
<td>Michael J. Archibeck, MD (Albuquerque, NM)</td>
<td>8:24 am – 8:30 am</td>
<td>Previous Lumbar Fusion</td>
<td>Gwo-Chin Lee, MD (Philadelphia, PA)</td>
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<td>8:24 am – 8:30 am</td>
<td>Previous Lumbar Fusion</td>
<td>Gwo-Chin Lee, MD (Philadelphia, PA)</td>
<td>8:30 am – 8:45 am</td>
<td>DISCUSSION</td>
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<td>8:30 am – 8:45 am</td>
<td>DISCUSSION</td>
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<td>8:45 am – 8:51 am</td>
<td>Intraoperative Acetabular Fracture: How to Gain Exposure and Manage Through an Posterior Approach</td>
<td>James I. Huddleston, III, MD (Redwood City, CA)</td>
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<td>8:45 am – 8:51 am</td>
<td>Intraoperative Acetabular Fracture: How to Gain Exposure and Manage Through an Posterior Approach</td>
<td>James I. Huddleston, III, MD (Redwood City, CA)</td>
<td>8:51 am – 8:57 am</td>
<td>Failed Acetabular Fixation: How to Gain Exposure and Manage Through an Anterior Approach</td>
<td>Joseph T. Moskal, MD (Roanoke, VA)</td>
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<td>8:51 am – 8:57 am</td>
<td>Failed Acetabular Fixation: How to Gain Exposure and Manage Through an Anterior Approach</td>
<td>Joseph T. Moskal, MD (Roanoke, VA)</td>
<td>8:57 am – 9:03 am</td>
<td>Management of Early Step Subsidence/Calcar Fracture (Using Either Anterior or Posterior Approach)</td>
<td>Paul J. Duwelius, MD (Portland, OR)</td>
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<td>8:57 am – 9:03 am</td>
<td>Management of Early Step Subsidence/Calcar Fracture (Using Either Anterior or Posterior Approach)</td>
<td>Paul J. Duwelius, MD (Portland, OR)</td>
<td>9:03 am – 9:09 am</td>
<td>Management of Trochanter Fracture (Intra-Op and Early Post-Op)</td>
<td>Rafael J. Sierra, MD (Rochester, MN)</td>
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<td>9:03 am – 9:09 am</td>
<td>Management of Trochanter Fracture (Intra-Op and Early Post-Op)</td>
<td>Rafael J. Sierra, MD (Rochester, MN)</td>
<td>9:09 am – 9:15 am</td>
<td>Component Malposition and Leg Length Inequality: When Should I Go Back and What Should I Do?</td>
<td>Robert L. Barrack, MD (St. Louis, MO)</td>
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<td>9:09 am – 9:15 am</td>
<td>Component Malposition and Leg Length Inequality: When Should I Go Back and What Should I Do?</td>
<td>Robert L. Barrack, MD (St. Louis, MO)</td>
<td>9:15 am – 9:30 am</td>
<td>DISCUSSION</td>
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<td>7:55 am – 8:00 am</td>
<td>WELCOME</td>
<td>Adolph V. Lombardi, Jr., MD, FACS (New Albany, OH) – President, The Knee Society</td>
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<td>8:00 am – 8:45 am</td>
<td>Session I: The Difficult Primary TKA (Video-Based)</td>
<td>Mathias P.G. Bostrom, MD, FACS (New York, NY)</td>
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<td>8:00 am – 8:06 am</td>
<td>Fixed Valgus Knee</td>
<td>Douglas A. Dennis, MD (Denver, CO)</td>
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<td>8:06 am – 8:12 am</td>
<td>The Terrible Varus Knee</td>
<td>Arun B. Mullaji, MD (Mumbai, India)</td>
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<td>8:12 am – 8:18 am</td>
<td>The Obese Patient</td>
<td>David G. Lewallen, MD (Rochester, MN)</td>
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<td>8:18 am – 8:24 am</td>
<td>The Stiff Knee</td>
<td>Wael K. Barsoum, MD (Weston, FL)</td>
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<td>8:24 am – 8:30 am</td>
<td>Previous Incisions/Compromised Soft-Tissue</td>
<td>Henry D. Clarke, MD (Phoenix, AZ)</td>
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<td>8:30 am – 8:45 am</td>
<td>DISCUSSION</td>
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<td>8:45 am – 9:30 am</td>
<td>Session II: Current Trends in Knee Arthroplasty</td>
<td>Thomas S. Thornhill (Boston, MA)</td>
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<tr>
<td>8:45 am – 8:51 am</td>
<td>Can a Bicruciate Retaining TKA Be Successful?</td>
<td>Alfred J. Tria, MD (Princeton, NJ)</td>
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<td>8:51 am – 8:57 am</td>
<td>When Is It Safe to Perform TKA after Steroid/HA Injection?</td>
<td>Thomas P. Sculco, MD (New York, NY)</td>
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<td>8:57 am – 9:03 am</td>
<td>Patient Specific Implants and Instruments</td>
<td>Tom Minas, MD, MS (Chestnut Hill, MA)</td>
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<td>9:03 am – 9:09 am</td>
<td>Alternative Bearing Surfaces</td>
<td>Steven B. Haas, MD (New York, NY)</td>
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<td>9:09 am – 9:15 am</td>
<td>The Pocket Rocket: Handheld Navigation</td>
<td>David J. Mayman, MD (New York, NY)</td>
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<tr>
<td>9:13 am – 9:30 am</td>
<td>DISCUSSION</td>
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</table>
### Session III: Lumbopelvic/Instability: Patient Identification and Methods to Minimize
**Moderator:** Wayne G. Paprosky, MD, FACS (Winfield, IL)

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<tr>
<td>9:30 am – 9:36 am</td>
<td>Who is at Risk of Instability?</td>
<td>Arthur L. Malkani, MD (Louisville, KY)</td>
</tr>
<tr>
<td>9:36 am – 9:42 am</td>
<td>What is the “Safe Zone” for an Individual Patient?</td>
<td>Lawrence D. Dorr, MD (Los Angeles, CA)</td>
</tr>
<tr>
<td>9:42 am – 9:48 am</td>
<td>What Implants and Approach Should We Use to Optimize Outcomes: Is It Patient-Specific?</td>
<td>James D. Slover, MD, MS (New York, NY)</td>
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<tr>
<td>9:48 am – 9:54 am</td>
<td>Is There a Role for Computer Navigation?</td>
<td>Douglas E. Padgett, MD (New York, NY)</td>
</tr>
<tr>
<td>9:54 am – 10:00 am</td>
<td>When Should I Revise the Hip for Postop Instability and What Should I Do?</td>
<td>R. Michael Meneghini, MD (Fishers, IN)</td>
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**DISCUSSION**

### Session IV: Bearing Surface and Taper Corrosion
**Moderator:** Thomas P. Schmalzried, MD (Los Angeles, CA)

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<tr>
<td>10:30 am – 10:36 am</td>
<td>Who is at Risk? Should Everybody Be Screened?</td>
<td>Henrik Malchau, MD, PhD (Boston, MA)</td>
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<td>10:36 am – 10:42 am</td>
<td>What is the Current Understanding of the Problem?</td>
<td>Joshua J. Jacobs, MD (Chicago, IL)</td>
</tr>
<tr>
<td>10:42 am – 10:48 am</td>
<td>What is the Clinical Presentation and How Do I Work Up a Painful Hip?</td>
<td>Don S. Garbuz, MD, MHSc, FRCSC (Vancouver, BC, Canada)</td>
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<tr>
<td>10:48 am – 10:54 am</td>
<td>How Should I Treat This Problem and What are the Outcomes?</td>
<td>William L. Griffin, MD (Charlotte, NC)</td>
</tr>
<tr>
<td>10:54 am – 11:00 am</td>
<td>Should We All Be Going to Ceramic?</td>
<td>Jay R. Lieberman, MD (Los Angeles, CA)</td>
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**DISCUSSION**
### Session III: Special Highlights

#### The Knee Society’s Scientific Awards

**Moderator:** Harry E. Rubash, MD (Boston, MA)

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<th>Time</th>
<th>Award</th>
<th>Speaker/Institution</th>
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<tbody>
<tr>
<td>9:30 am – 9:35 am</td>
<td><strong>The John N. Insall Award</strong></td>
<td>&quot;Unsupervised Home Exercise Equivalent to Traditional Outpatient Therapy After Primary TKA: A Randomized Controlled Trial&quot;&lt;br&gt;Antonia F. Chen, MD, MBA (Philadelphia, PA)</td>
</tr>
<tr>
<td>9:35 am – 9:40 am</td>
<td><strong>The Chitranjan S. Ranawat Award</strong></td>
<td>&quot;Developing and Implementing a Novel Guideline Strategy Reduced Postoperative Opioid Prescribing Following TKA and THA&quot;&lt;br&gt;Cody C. Wyles, MD (Rochester, MN)</td>
</tr>
<tr>
<td>9:40 am – 9:45 am</td>
<td><strong>The Mark Coventry Award</strong></td>
<td>&quot;Does Ceramic Bearing Articulation Improve the Clinical Outcomes of Total Knee Arthroplasty in Younger Patients?&quot;&lt;br&gt;Young-Hoo Kim, MD (Seoul, Republic of Korea)</td>
</tr>
<tr>
<td>9:45 am – 9:50 am</td>
<td><strong>The Insall Travelling Fellowship Update</strong></td>
<td>W. Norman Scott, MD, FACS (New York, NY)</td>
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#### What's Keeping Knee Surgeon's Up at Night: A Global Perspective

**Moderator:** Adolph V. Lombardi, Jr., MD, FACS (New Albany, OH)

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<tr>
<td>10:10 am – 10:11 am</td>
<td><strong>About the Award</strong></td>
<td>Adolph V. Lombardi, Jr., MD, FACS (New Albany, OH)</td>
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<tr>
<td>10:11 am – 10:12 am</td>
<td><strong>Introduction</strong></td>
<td>A Seth Greenwald, D.Phil (Oxon) (Cleveland, OH)</td>
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<tr>
<td>10:12 am – 10:14 am</td>
<td><strong>2018 Lifetime Achievement Award Recipient:</strong> Peter S. Walker, PhD &lt;br&gt;(New York, NY)</td>
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<tr>
<td>10:14 am – 10:15 am</td>
<td><strong>on behalf of the 2018 Lifetime Achievement Award Recipient Richard S. Laskin, MD (Posthumously), Steven B. Haas, MD (New York, NY)</strong></td>
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#### Session IV: Lessons Learned from Difficult Cases

**Moderator:** Aaron A. Hofmann, MD (Salt Lake City, UT)

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<tr>
<th>Time</th>
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<tr>
<td>10:30 am – 11:00 am</td>
<td><strong>Panel Discussion</strong></td>
<td>William B. Macaulay, MD (New York, NY); Geoffrey H. Westrich, MD (New York, NY); Peter F. Sharkey, MD (Media, PA); Nicholas J. Giori, MD (Palo Alto, CA)</td>
</tr>
<tr>
<td>11:00 am – 11:15 am</td>
<td><strong>DISCUSSION</strong></td>
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</table>
**HiP La Nouvelle Ballroom B**

**11:15 am – 12:00 pm**  
**Session V: Special Highlights**  
*Moderator: Kevin L. Garvin, MD (Omaha, NE)*

- **11:15 am – 11:20 am**  
  The Hip Society’s Scientific Awards  
  The John Charnley Award  
  “Analysis of US Hip Replacement Bundled Payments: Physician-initiated Episodes Out Perform Hospital-initiated Episodes”  
  William S. Murphy, AB (Boston, MA)

- **11:20 am – 11:25 am**  
  The Otto Aufranc Award  
  “The Genetics of Osteolysis After Total Hip Arthroplasty”  
  J. Mark Wilkinson, PhD, FRCS (Sheffield, UK)

- **11:25 am – 11:30 am**  
  The Frank Stinchfield Award  
  “Spino-pelvic Hypermobility is Associated with Inferior Outcome Post-THA: Examining the Effect of Spinal Arthrodesis”  
  George Grammatopoulos, MD, FRCS, PhD (Ottawa, ON, Canada)

- **11:30 am – 11:35 am**  
  The Hip Society’s Rothman-Ranawat Traveling Fellowship  
  Recap of the 2017 Rothman-Ranawat Traveling Fellowship  
  Carlos A. Higuera-Rueda, MD (Cleveland, OH); Christopher E. Pelt, MD (Salt Lake City, UT)

- **11:35 am – 11:38 am**  
  Introduction of the 2018 Rothman-Ranawat Traveling Fellows  
  *Moderator: Adolph V. Lombardi, Jr., MD, FACS (New Albany, OH)*

- **11:38 am – 12:00 pm**  
  The 50th Anniversary of The Hip Society: A Tribute  
  *Moderator: Daniel J. Berry, MD (Rochester, MN)*  
  Lawrence D. Dorr, MD (Los Angeles, CA); William H. Harris, MD, MS (Lexington, MA); David G. Lewallen, MD (Rochester, MN); Vincent D. Pellegrini, Jr., MD (Charleston, SC)

- **12:00 pm – 12:05 pm**  
  The Hip Society’s 2018 Lifetime Achievement Award  
  *Presented by: Kevin L. Garvin, MD (Omaha, NE)*

**12:05 pm – 1:00 pm**  
**LUNCH** – Box lunches provided to all participants

**1:00 pm – 1:45 pm**  
**Session VI: Lessons Learned from Difficult Cases**  
*Moderator: Robert T. Trousdale, MD (Rochester, MN)*

- **1:00 pm – 1:30 pm**  
  Panel Discussion  
  Clive P. Duncan, MD (Vancouver, BC, Canada); Richard W. McCalden, MD (London, ON, Canada); Aaron G. Rosenberg, MD (Deerfield, IL); Ran Schwarzkopf, MD, MSc (New York, NY); Thomas P. Vail, MD (San Francisco, CA)

- **1:30 pm – 1:45 pm**  
  DISCUSSION
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<th>Time</th>
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<th>Chairperson/Presenter</th>
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<tbody>
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<td>11:15 am – 12:00 pm</td>
<td>Session V: New Research We Should Know About</td>
<td>Mary I. O'Connor, MD (New Haven, CT)</td>
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<tr>
<td>11:15 am – 11:21 am</td>
<td>What Activity Should I Recommend for My Patients?</td>
<td>Philip C. Noble, PhD (Houston, TX)</td>
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<tr>
<td>11:27 am – 11:33 am</td>
<td>Kinematic Alignment</td>
<td>David W. Murray, MD, FRCS (Oxford, UK)</td>
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<tr>
<td>11:33 am – 11:39 am</td>
<td>RSA Data: What Does It Mean to Me?</td>
<td>Michael J. Dunbar, MD, PhD, FRCSC (Halifax, NS, Canada)</td>
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<tr>
<td>11:39 am – 11:45 am</td>
<td>The Role of Tranexamic Acid</td>
<td>Fred D. Cushner, MD (New York, NY)</td>
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<tr>
<td>11:45 am – 12:00 pm</td>
<td>DISCUSSION</td>
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<tr>
<td>12:00 pm – 1:00 pm</td>
<td>LUNCH – Box lunches provided to all participants</td>
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<tr>
<td>1:00 pm – 1:45 pm</td>
<td>Session VI: Partial Knee Arthroplasty</td>
<td>Andrew A. Freiberg, MD (Boston, MA)</td>
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<tr>
<td>1:00 pm – 1:06 pm</td>
<td>Medial Compartment UKA: Indications/Contraindications</td>
<td>David F. Dalury, MD (Towson, MD)</td>
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<tr>
<td>1:06 pm – 1:12 pm</td>
<td>Lateral Compartment UKA</td>
<td>William A. Jiranek, MD (Durham, NC)</td>
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<tr>
<td>1:12 pm – 1:18 pm</td>
<td>Make It Right the First Time: Robot Wars</td>
<td>Jess H. Lonner, MD (Bryn Mawr, PA)</td>
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<tr>
<td>1:18 pm – 1:24 pm</td>
<td>Without the Grout: Cementless UKA</td>
<td>Christopher A.F. Dodd, MB, ChB, FRCS (Oxford, UK)</td>
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<td>1:24 pm – 1:30 pm</td>
<td>Do Them Both: Bicompartmental TKA</td>
<td>Jean-Noël Argenson, MD (Marseille, France)</td>
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<tr>
<td>1:30 pm – 1:45 pm</td>
<td>DISCUSSION</td>
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</table>
### Session VII: Revision THA: Surgical Options for Success (Case-Based)

**Moderator:** Allan E. Gross, MD, FRCSC, O.Ont (Toronto, ON, Canada)

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<tr>
<td>1:45 pm – 1:49 pm</td>
<td>Safe Removal of Femoral and Acetabular Components</td>
<td>John Antoniou, MD, FRCSC, PhD (Montreal, QC, Canada)</td>
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<td>1:49 pm – 1:53 pm</td>
<td>Acetabular Reconstruction: When Do I Need to Use Augments?</td>
<td>Wayne G. Paprosky, MD, FACS (Winfield, IL)</td>
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<td>1:53 pm – 1:57 pm</td>
<td>Femoral Revision: What is the Best Stem to Use?</td>
<td>Matthew S. Austin, MD (Philadelphia, PA)</td>
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<td>1:57 pm – 2:01 pm</td>
<td>Management of Periprosthetic Femur Fractures</td>
<td>George J. Haidukewych, MD (Orlando, FL)</td>
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<td>2:01 pm – 2:05 pm</td>
<td>What Do I Do if the Abductors are Deficient?</td>
<td>Michael D. Ries, MD (Reno, NV)</td>
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<td>2:05 pm – 2:30 pm</td>
<td>DISCUSSION and Additional Cases</td>
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### Session VIII: Infection

**Moderator:** Arlen D. Hanssen, MD (Rochester, MN)

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<td>2:30 pm – 2:36 pm</td>
<td>Making the Diagnosis: What is the Gold Standard?</td>
<td>Stephen J. Incavo, MD (Houston, TX)</td>
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<td>2:36 pm – 2:42 pm</td>
<td>Indication for I&amp;D: Is There Ever a Role?</td>
<td>Ryan M. Nunley, MD (St. Louis, MO)</td>
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<td>2:42 pm – 2:48 pm</td>
<td>One-Stage vs. Two-Stage vs. Partial Resection</td>
<td>Craig J. Della Valle, MD (Chicago, IL)</td>
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<td>2:48 pm – 2:54 pm</td>
<td>When Do I Replant and What Do I Need to Worry About?</td>
<td>Bassam A. Masri, MD, FRCSC (Vancouver, BC, Canada)</td>
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<td>2:54 pm – 3:00 pm</td>
<td>Postoperative Antibiotics: How Long Are They Needed?</td>
<td>Michael A. Mont, MD (Cleveland, OH)</td>
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<td>3:00 pm – 3:15 pm</td>
<td>DISCUSSION</td>
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| Time              |               |                                               |                |
|-------------------|---------------|-----------------------------------------------|                |
| 3:15 am – 3:30 am | COFFEE / REFRESHMENT BREAK |                                   |                |
|-----------------|--------------------------------------------------------------------------------------|---------------------------------------------------|
| 1:45 pm – 1:51 pm | Step One: Is this Infected?                                                          | Javad Parvizi, MD, FRCS (Philadelphia, PA)        |
| 1:51 pm – 1:57 pm | Should I Just Wash It Out?                                                           | Bryan D. Springer, MD (Charlotte, NC)             |
| 1:57 pm – 2:03 pm | Articulating Spacers: What Works?                                                    | Michael P. Bolognesi, MD, MS (Durham, NC)         |
| 2:03 pm – 2:09 pm | One-Stage vs. Two-Stage Treatment of PJI                                              | Thomas K. Fehring, MD (Charlotte, NC)             |
| 2:09 pm – 2:15 pm | The Burden of Infection                                                             | Kelly G. Vince, MD, FRCSC (Kamo, New Zealand)     |
| 2:15 pm – 2:30 pm | DISCUSSION                                                                           |                                                   |

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<th>Time</th>
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<th>Moderator: John J. Callaghan, MD (Iowa City, IA)</th>
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<td>2:30 pm – 2:36 pm</td>
<td>First Things First: Exposure in Total Knee Revision</td>
<td>Daniel J. Berry, MD (Rochester, MN)</td>
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<td>2:36 pm – 2:42 pm</td>
<td>Fixation Strategies: Stems/Cones/Sleeves</td>
<td>Paul F. Lachiewicz, MD (Chapel Hill, NC)</td>
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<td>2:42 pm – 2:48 pm</td>
<td>Supracondylar Periprosthetic Femur Fracture</td>
<td>David Backstein, MD, MEd, FRCSC (Toronto, ON, Canada)</td>
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<td>2:48 pm – 2:54 pm</td>
<td>Constraint in Total Knee Revision</td>
<td>William J. Maloney, III, MD (Redwood City, CA)</td>
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<td>2:54 pm – 3:00 pm</td>
<td>Extensor Mechanism Reconstruction: Cadavers and Mesh</td>
<td>James A. Browne, MD (Charlottesville, VA)</td>
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<td>3:00 pm – 3:15 pm</td>
<td>DISCUSSION</td>
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3:15 pm – 3:30 pm COFFEE/REFRESHMENT BREAK

Sessions IX and X are combined with The Hip Society and will be held in La Nouvelle Ballroom B
# COMBINED SESSIONS

## La Nouvelle Ballroom B

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<td>3:30 pm – 4:15 pm</td>
<td>COMBINED SESSION IX: Outpatient TJA</td>
<td>Moderator: Adolph V. Lombardi, Jr., MD, FACS (New Albany, OH), President of The Knee Society</td>
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<tr>
<td>3:30 pm – 3:36 pm</td>
<td>Outpatient Arthroplasty: The Time is Now</td>
<td>Richard Iorio, MD (New York, NY)</td>
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<td>Identifying the Optimal Patient</td>
<td>Michael E. Berend, MD (Indianapolis, IN)</td>
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<td>Management of Blood Loss</td>
<td>William G. Hamilton, MD (Alexandria, VA)</td>
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<td>Perioperative Pain Management</td>
<td>Mark W. Pagnano, MD (Rochester, MN)</td>
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<td>3:54 pm – 4:00 pm</td>
<td>The International Perspective</td>
<td>Fares S. Haddadd, BSc, MCh (Orth), FRCS (Orth), FRCS (Ed) Dip, Sports Med FFSEM (London, UK)</td>
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<td>4:15 pm – 4:20 pm</td>
<td>Update from the AAHKS 2017 Annual Meeting</td>
<td>Mark I. Froimson, MD, MBA (Hunting Valley, OH), President of AAHKS</td>
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<tr>
<td>4:20 pm – 5:00 pm</td>
<td>COMBINED SESSION X: Value and Economics in TJA</td>
<td>Moderator: Kevin L. Garvin, MD (Omaha, NE), President of The Hip Society</td>
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<td>4:20 pm – 4:26 pm</td>
<td>Bundled Payments in Total Joint Arthroplasty: How Does Risk and Readmission Impact Cost of Care</td>
<td>Giles R. Scuderi, MD (New York, NY)</td>
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<td>Where Do We Stand with Value-Based Payments? A Washington Update</td>
<td>Kevin J. Bozic, MD, MBA (Austin, TX)</td>
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<td>Patient-Reported Outcomes Measures Made Easy</td>
<td>David C. Ayers, MD (Worcester, MA)</td>
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<td>Hospital-Physician Alignment</td>
<td>C. Lowry Barnes, MD (Little Rock, AR)</td>
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<td>4:44 pm – 4:50 pm</td>
<td>Surgical Centers, Consulting and Implant Recall: What You Should Do to Protect Yourself</td>
<td>Mark I. Froimson, MD, MBA (Hunting Valley, OH)</td>
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<td>4:50 pm – 5:00 pm</td>
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<tr>
<td>5:00 pm – 5:05 pm</td>
<td>Closing Remarks / Meeting Adjourned</td>
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Session I: Primary Surgical Approach/Technique and Implant Selection: Tips and Tricks to Maximize Outcomes (Video-Based)

8:00 am – 8:06 am

**ABMS Approach in the Lateral Decubitus Position**

*Christopher L. Peters, MD*

**Introduction:** Traditional posterior approach (PA) for total hip arthroplasty (THA) is considered the gold standard. Recently, there has been increasing enthusiasm for anterior based approaches, including the anterior based muscle sparing (ABMS) approach. There has also been concern for surgeons when considering changing their practice due to the potential for increased complications during the learning curve period. The purpose of this study was to evaluate the learning curve of a single surgeon when switching from a posterior approach to an ABMS approach.

**Methods:** We retrospectively reviewed secondary data on 169 patients that underwent primary THA by a single surgeon from July 2015 to April 2017. In August of 2016, the surgeon began using an ABMS approach. All ABMS THA patients (n=80) were compared to PA THA patients in the previous year (n=89). Perioperative variables and complications were collected. Multivariable linear regression was used to evaluate the relationship between surgical approach and the continuous variables while controlling for age, sex, body mass index (BMI), and ASA score. Mediation analysis was used to evaluate the estimated blood loss between the groups while accounting for surgical duration. Finally, Exact Poisson Regression was used to compare complications between the groups.

**Results:** There was no difference in age, sex, BMI, ASA score, or preoperative PROs (all, p>0.05). The adjusted mean surgical time in ABMS THA was 99 minutes (95% CI, 93 – 105) compared to 90 minutes (95% CI, 85 – 94) in the PA THA (p=0.025). Length of stay was slightly shorter in ABMS THA with an adjusted mean LOS of 1.53 days (95% CI, 1.3 – 1.7) compared to 1.87 days (95% CI, 1.7 – 2.1) in PA THA (p=0.012). There was no difference in EBL between the groups (p=0.355). The adjusted mean abduction angle was 42° (95% CI, 40° – 44°) in ABMS THA and 43° (95% CI, 41° – 45°, p=0.800) in PA THA. There was no difference in anteversion angle between the groups (p=0.512) with an adjusted mean anteversion angle of 29° (95% CI, 24° – 35°) in ABMS THA and 32° (95% CI, 27° – 37°) in PA THA. There was no difference in intraoperative (p=0.829) or postoperative complications (p>0.99).

**Conclusion:** Our study demonstrates that during the learning curve for this single surgeon there was no difference in the outcome measures or perioperative complications. This is early evidence indicating that there is no learning curve effect for transitioning from a mini-posterior approach to using the ABMS approach in patients with primary osteoarthritis.

The most common reasons for revision after total hip arthroplasty (THA) historically have been aseptic loosening, bearing wear, hip instability, and infection.

As the methods of implant fixation, bearing surfaces, femoral head diameter, operative approaches and the most commonly used implant technologies have changed, the frequency of specific types of revision after THA are also changing.

Overall the rate of revision after primary THA has fallen over the last decade, mainly as a consequence of improved implant fixation and common use of cross-linked polyethylene (PE) bearings.
Wide use of uncemented implant fixation is leading to fewer late revisions for implant loosening. However, the widespread use of uncemented fixation has led to more early revisions for femoral periprosthetic fracture.

Crosslinked PE use is notably reducing revisions for PE wear, especially in younger patients. There are still some patients with metal-metal bearings requiring revision surgery, but this is mainly a “tail” from more frequent use in the mid 2000's.

Dislocation remains the second most common reason for revision after mechanical failure, but larger diameter heads have reduced the absolute rate of revision for this indication. Dual-mobility implant use in selected patients may also reduce the overall rate as time goes on.

Use of the direct anterior approach by some surgeons has been associated with lower rates of early revision for dislocation, but a higher risk of early revision for femoral component loosening.

Infection has not declined and remains a major unsolved problem.
Direct Anterior Approach Including Tips to Improve Exposure
Paul E. Beaulé, MD, FRCSC

Introduction:
Between 2006 and 2016 (5562 hips), of which 1087 hips (937 patients) were primary elective THA were done using the anterior approach in the supine position at our Institution. There were a variety of ‘standard’ length stems 566 (52.1%) and a number of ‘short’ stems 521 (47.9%) that are frequently utilized in the anterior approach. The positioning table was used in 889 hips (81.8%) and 198 hips (18.22%) were operated on the regular table. Since 2006 our center’s use of the anterior approach has increased from 1.5% to 53.2% of all annual THA.

Intra-operative events were reported in 49 hips (4.5%), included calcar crack in 29 hips (2.7%), chip fracture in the greater trochanter in 9 hips (0.82%). Canal perforations or shaft fractures in 5 hips (0.45%), 4 hips (0.36%) had displaced greater trochanter fractures, had acetabular insufficiency fractures in 2 hips (0.18%).

- Higher incidence of intra-operative events with using the regular table and the regular stems 5.1% and 5.7%, respectively versus 4.4% with the positioning table and 3.3% with the short stems, not statistically significant (p-value = 0.68 and 0.058, respectively).

Rate of intra-operative complications was higher in surgeons with less than 100-cases experience: (5.8% versus 3.9%), not statistically significant (p-value 0.175).

Wound complications were reported in 25 hips (2.3%). The rate of infection and wound complications was significantly higher for surgeons who had performed less than 100-cases, 3.7% versus 1.7% (p-value 0.048).

Dislocation was reported in 8 hips (0.73%).

Post-operative periprosthetic fractures were reported in 7 hips (0.64%). Implant failure in 3 hips (0.27%), fractured ceramic linear, fracture of modular neck and polyethylene liner disengagement.

Thirty hips (2.7%) showed HO: only 2 hips required resection. Incidence of HO was significantly higher with the regular table than positioning table 6.1% vs. 2.2% respectively (p-value= 0.004). Other risk factors of HO including male gender: 4.7% vs 1.8% in female (p-value 0.007).

Re-operation was required in 60 hips (5.5%), slightly higher for surgeons who had performed less than 100-cases (6.7% versus 5.1%), not statistically significant (p-value 0.294).

Key Steps for the Anterior Approach in Supine Position

Positioning – Supine position:
- Patient is placed on positioning table with slight counter-traction to non-surgical leg to keep pelvis level.
- Patients with a large pannus, tape can be used to retract it from the surgical site.
**Incision:**

- Can be classic in line with the Tensor muscle or Bikini(1) but regardless will be centered over the greater trochanter.

- With the classic incision, it is lateral to the ASIS which can vary based on body habitus but around 2-4cm.

- Branches of the Lateral Femoral Cutaneous Nerve are at risk(2) with 3 types of distributions(3):
  - Medial to the ASIS.
  - Posterior direction at level of ASIS.
  - Fan-type with multiple branches.
  - Use a sponge to mobilize the fat over the tensor fascia further helping to avoid some of its branches.

**Fascial layers:**

- Tensor: tensor muscle is peeled off the medial aspect which is then retracted laterally.

- Rectus: incising it will then permit retraction of the rectus muscle medially.

- Innominate-Lettourel: Branches of lateral femoral circumflex are located here just proximal to the vastus lateralis. Careful attention is needed to properly cauterize.

**Capsular Exposure:**

- Iliocapsularis is often adherent to the capsule requiring sharp dissection.

- Reflected head of rectus can be released to provide exposure of the antero-lateral acetabular rim.

- A blunt Hohlman retractor is placed around the infero-medial neck-extra-capsular.

- The antero-lateral third of the capsule is resected.

**Femoral Neck cut:** (The neck cut is performed in-situ.)

- Level of the calcar cut is performed according to the preoperative planning, the stem design.

- A sharp Hohman is placed in the lateral shoulder between lateral based of neck and greater trochanter dictating level of cut proximal to distal. A blunt Hohman is placed intracapsularly and medially protecting the soft-tissues.

- In regards to level of cut from the lesser trochanter, this will be dictated by the degree of obliquity of saw. Prior to proceeding with the saw, the cut is marked with cautery.

- The cut is done with slight traction applied to the leg and head is excised with a cork screw with the femur externally rotated while one levers the engaged cork screw proximally and releasing the inferomedical capsule off the femoral head using cautery.
- With the traction released, the level of calcar cut is checked palpating the LT with external rotation of the femur. To facilitate femoral exposure, the pubo-femoral ligament and the medial capsule are released from the calcar.

Pitfalls:

- High cut might lead to increased risk of calcar crack, version alteration and difficult acetabular exposure.
- Low calcar cut might lead to stem varus alignment.
- Never complete neck cut with an osteotome as this can lead to calcar propagation.

**Acetabular Exposure/Preparation:**

- Anterior wall retractor is placed at the 4 O’clock for a right hip and at the 8 O’clock position for the left hip.
- Tensor and posterior capsule are retracted using a small COBRA on the posterior wall.
- Labrum is excised as well as the inferomedial osteophyte.
- Reaming is then began in the standard fashion lifting hand slightly anteriorly to avoid reaming the anterior wall.
- Acetabular component is then implanted in 15-20 degrees of anteversion and 40 degrees of abduction.
- As the patients is not lying on their side, secondary impaction can be important in patients with good quality bone as there is no counter force on the pelvis during reaming and impacting.

**Proximal femur exposure:** (Aiming anterior displacement of the proximal femur till at least the middle of the acetabulum.)

- With the leg in extension, a hooked in placed to elevate the femur after which the leg is locked into external rotation of 80 to 90 degrees. This ensures that the greater trochanter remains anterior to the ischium.
- The leg is then brought in extension of about 30-40 degrees ensuring no traction is applied to the leg.
- External rotation of the femur is adjusted so that posterior femoral cortex is parallel to the wall.

In patients with femoral retro-torsion or large muscle mass this may not be achievable.

- The leg is adduction to facilitate clearing of the broach passing the ilac wing.

- We have two different positing tables: Delacroix-Judet (Maquet, France) using a posterior bump or HANA® table (Mizuho OSI) with femoral bone hook to stabilize femur during broaching.

**Access to femoral canal:**

The box cut is performed using a rongeur or offset box osteotome, then the femoral canal is accessed using a canal finder (curved canal finder) by applying axial pressure starting hugging the calcar simultaneously with anterior to posterior movement.
Femoral Broaching:

The femur is broached sequentially to a final size that yielded excellent axial and rotational stability. A trial reduction was performed to ensure restoration of leg lengths and good stability before implanting the definitive stem.

Tips:

- It is helpful to decide using either the single or double offset broach handle to clear the iliac crest (double offset used with excessively retro-verted femur).
- Posterior pressure should be applied during broaching to push the stem into valgus.
- Always try one size above before deciding the final size due to tendency of under-sizing with the anterior approach.
- Stability and range of motion (impingement) checked by disengaging the boots from the positioning table, carried out by the help of the circulating nurse.
- In most cases, an intra-operative radiograph was obtained to ensure adequate leg length and offset and identify any under-sizing, mal-alignment, bony perforation or fracture.

Check the calcar:

- The calcar should be checked all around for any hairline cracks or fractures before reduction. Calcar cracks are treated using a bicortical 3.5mm screw.

Greater trochanter (tip/chip)

- Because of the intact sling with the vastus and abductors, those are most commonly treated with restricted weight bearing.

Hip is then reduced with the leg in extension. Range of motion check is done in every case by disengaging the booth to ensure proper implant positioning and stability. This is followed by an AP pelvis to verify leg lengths and implant positioning.


Developmental dysplasia of the hip (DDH) is a common etiology of hip pain, dysfunction and progressive joint degeneration. Patients with endstage OA secondary to DDH commonly require total hip arthroplasty, and can be challenging to treat surgically. These patients tend to be young at the time of presentation, can have previous failed procedures, and can have substantial deformities on both the femoral and acetabular sides. THA clinical outcomes can be excellent, but an increased risk of complications has been documented especially in more severe deformities. The Crowe and Hartofilakidis classification schemes are most commonly used for DDH and focus primarily on acetabular deformity and proximal displacement of the femoral head. Various disease characteristics of DDH can make THA more challenging and should be considered when contemplating THA.

**General DDH disease characteristics (variable)**
- Disuse osteoporosis
- Compromised musculature (previous surgery)
- Soft tissue laxity
- Previous surgery- scar, retained hardware, iatrogenic deformity (acetabulum and femur)

**DDH structural disease characteristics (variable)**
- Femur- coxa valga, torsional deformities, canal stenosis, dislocation
- Acetabulum- anterolateral insufficiency, increased acetabular inclination, lateralized hip center, version abnormalities, small true acetabulum

**Technical considerations**
- Acetabulum
  - medialize, optimize host coverage, posterior bone stock, minimize rim overhang (anteriorly), avoid excessive anteversion and abduction
  - severe deformity (dislocation)- identify true acetabulum for placement at true hip center, augment/graft to supplement host coverage if needed.
- Femur
  - assess and know version, avoid excessive anteversion, recreate offset, length, different stem options
  - severe deformity (dislocation/osteofomy deformity)- consider subtrochanteric shortening osteotomy or angular correction if needed

**Summary**
The DDH hip can present substantial challenges to the reconstructive hip surgeon. Careful preoperative planning, understanding of the hip pathomorphologies, awareness of potential technical pitfalls and availability of appropriate equipment/implants can optimize total hip arthroplasty in this patient population.
References


Total hip arthroplasty following prior hip surgery can dramatically complicate the procedure and increase the rate of complications. Studies have shown a higher dislocation rate, infection rate, fracture rate, a longer surgical duration, and higher blood loss. The surgeon should be aware of these issues and educate the patient about them as well.

The task of this presentation is to provide a systematic method for preoperative evaluation of such patients, discuss surgical techniques to assist in minimizing the risk of complications, and review implant selection in cases of deformity or defects from hardware removal.

At initial presentation, the history and physical examination can provide valuable information regarding potential concerns that may need to be addressed. Beyond the typical history of hip pain and OA, the surgeon should ask about the prior procedure and any postoperative complications (infection, DVT, nerve injury, HO, prolonged drainage or antibiotic use). Examination should include an assessment of the neurovascular status of the limb, a measurement of LLD, examination of prior scars, abductor function and ROM of the hip.

Studies should include preoperative radiographs. In cases of prior trauma, the presence of heterotopic ossification should be identified and perioperative prophylactic radiation should be considered. In the case of prior injury and retained hardware, infection needs to be ruled out. CRP and ESR should routinely be obtained in such cases. If elevated, or any clinical history that would raise suspicion is present, aspiration and additional studies (leukocyte scan, PET scan) may be needed to rule out infection. In cases of acetabular hardware or fracture, a CT scan can be helpful to confirm bony union of the fracture and identify areas of defect and potential hardware encroachment on reaming or implant. Vascular studies should be obtained if pulses are diminished. Nutrition panel may be needed in cases of potential malnutrition.

Preoperative planning should include obtaining old operative notes if possible – especially in cases of failed ORIF of hip fracture. This will aid in extraction with minimal trauma. Metal cutting burrs and hardware removal sets should be available especially if retained acetabular plates/screws are present. Proximal femoral deformity or overgrown hardware may require an extended trochanteric osteotomy. Implant selection should generally include a primary plan and at least one back up plan. On the acetabular side, the need for enhanced ingrowth surfaces and augments should be considered. Supplemental screws should generally be used. Anticipate the potential need for augmentation, cages, bone grafting, dual mobility, etc. On the femoral side, depending on several factors, cemented fixation or cementless fixation should be planned. In either case, the femoral component should bypass any stress risers (screw holes) if possible. If it is not possible, prophylactic fixation should be considered (plate or struts). If concerned about the presence of possible infection, consider having spacers available. In complex cases, consider the use of blood salvage procedures such as intraoperative cell saver.

Intraoperative considerations include the approach. Generally, old scars can be ignored about the hip. If it is within the surgeon’s armamentarium, consideration should be given to an approach that mitigates against the elevated risk of dislocation (eg. modified Hardinge, etc). Approach the hip joint and dislocate the hip with any retained femoral hardware in situ. Resist the temptation to remove the hardware first. Once a nontraumatic dislocation is easily obtained, re-reduce the hip and remove the hardware. This will minimize the risk of iatrogenic fracture through screw hole with a forced dislocation. On the acetabular side, ream until screws are encountered and remove with a burr from within. In cases of disuse osteopenia, such as following a failed hip
fracture ORIF, ream cautiously as the bone deep to the thin subchondral layer can be very soft and lead to overpenetration. Use supplemental screws. Consider the use of a dual mobility in high risk patients. On the femoral side consider prophylactic cerclage cables in cementless cases if significant stress risers are present. Consider sending cultures if infection is a concern. Consider intraoperative radiographs or C-arm if needed.

Postoperatively, consider radiation therapy if at risk for heterotopic ossification. Consider more aggressive anticoagulation for DVT prophylaxis if relatively restricted mobility is present. Consider restricted weight bearing if fixation tenuous.

References:

25. Mehlongh T, Landon GC, Tullos HS. Total hip arthroplasty following failed internal fixation of hip fractures. Clinical orthopaedics and related research (269); 32, 1991
Instability following primary total hip arthroplasty remains a leading cause of revision surgery [1]. While avoiding extremes in acetabular and femoral component positioning can reduce the risk for dislocation, the safe zones for each individual remains unknown [2]. In recent years, the contributions of the spine and spino-pelvic motions to hip implant stability has been recognized [3]. Additionally, there has been increased awareness that prior lumbar surgery places the hip patient at higher risk for postoperative instability [4]. Therefore, we explore potential strategies to minimize complications in this patient population.

Impingement is the root cause for most dislocations. In patients with spinal pathology, the acetabular opening angle and the functional arc of motion is decreased leading to greater risk for impingement [5]. In the stiff spine (i.e. prior fusion), there is a relative decrease in acetabular anteversion because there is a relative lack of pelvic extension leading to relative acetabular retroversion in a seated position. In cases where the spine is rigid and unbalanced in the sagittal plane, the risk of impingement is further magnified. In a flat back deformity, the pelvis is fixed in extension thus leading to risk for posterior impingement and anterior dislocation [6].

Careful preoperative planning and implant selection can reduce the risk for postoperative instability in this patient population. The use of additional imaging such as sitting to standing radiographs or dynamic imaging such as EOS imaging can preoperatively define the relation between the hip and the spine and prompt adjustments in the target for hip implants. Careful templating and restoration of offset will help restore appropriate soft tissue tensions. Increasing the acetabular component anteversion and abduction can reduce the risk for impingement in some patients [7]. Finally, the use of larger heads and selective use of dual mobility articulation can further effectively enlarge the safe zone for these patients.

In summary, patients with prior lumbar fusion undergoing THA are at increased risk for postoperatively hip instability. Preoperative planning, intraoperative adjustments for acetabular positioning, and maximizing head size and offset can help reduce the risk for dislocation.

References

Intraoperative Acetabular Fracture: How to Gain Exposure and Manage Through a Posterior Approach
James I. Huddleston, III, MD

Intraoperative fracture of the acetabulum is a rare complication associated most commonly with insertion of a cementless acetabular component. In a series of 7,121 primary total hip arthroplasties (THA) from 1990-2000, the rate of intraoperative acetabulum fracture was 0.4% (21 of 5,359 cementless THAs). There weren’t any fractures in the 1,762 cemented sockets. Seventeen of the 21 fractures were deemed stable and four were treated successfully with supplemental screw fixation.1 In a case series of 13 hips, only nine were diagnosed intraoperatively. Four of these cases required reoperation.2 Another case series of 32 hips reported a 66% failure of cases with posterior column instability.3 The most recent case series reports 16 fractures in 21,519 THAs (0.0007%) performed from 1997-2015.4 Intraoperative fractures associated with cemented sockets (1 of 5,400)5 and cup removal are even less common.

Several classification systems have been developed to assist with diagnosis and management of intraoperative acetabulum fractures. The initial classification was based on in vitro fracture patterns: anterior wall, transverse, posterior wall, and inferior lip.6,7 Another system distinguishes between stable and unstable fracture patterns.8 A third classification scheme differentiates between a non-displaced fracture with a stable shell (type I), a non-displaced fracture that threatens the stability of the shell (type II), and a displaced fracture (type III). Lastly, the Unified Classification System (UCS) is the most recent and has been endorsed by the AO and Orthopaedic Trauma Association.9

Successful management of these fractures requires prompt intraoperative detection (cup seats deeper than final reamer), achievement of adequate exposure (superior gluteal neurovascular bundle and sciatic nerve), stable fracture fixation, maintenance of satisfactory alignment and stability of the prosthetic socket, and achievement of fracture union and osseointegration. Risk factors for this complication include excessive press-fit, poor bone quality, small sockets, and over-reaming. Stable fractures should be treated with screws through the cup. Unstable fractures should be treated with posterior column plating and screws through the cup. Cup-cage constructs and anterior column screws may be needed, in addition to posterior column plating, in the most unstable fracture patterns. Weight-bearing should be limited postoperatively for at least 6-12 weeks.

Failed Acetabular Fixation: How to Gain Exposure and Manage Through an Anterior Approach
Joseph T. Moskal, MD

In this technique, the patient is positioned in supine position on either a regular operating room table or a specialized table depending on surgeon preference, and a spinal or general anaesthesia is administered. A modified Smith-Petersen approach to the hip is used for exposure (1,2). The incision is started along the iliac crest, over the ASIS and directed distally over the tensor fascia lata (TFL) (Figure 1). Subcutaneous flaps are raised medially and laterally, care is taken to try and avoid injuring the lateral femoral cutaneous nerve. The TFL fascia is incised and peeled off the TFL fibers. The interval between the TFL and the rectus femoris is identified and the lateral circumflex vessels are coagulated. Proximally, the aponeurosis of the external oblique muscle is sub-periosteally peeled of the iliac crest and reflected medially along with the oblique abdominal muscles. The aponeurosis of the sartorius and the inguinal ligament is then peeled off the anterior superior iliac spine (ASIS). The hip is slightly flexed and the medial muscle envelope is lifted off the inner iliac table with a Hohmann retractor that sub-periosteally rests on the pelvic brim, and in cases of an extensive medial defect on the inner surface of the sciatic spine. The iliopsoas muscle is thus retracted medially. The anterior inferior iliac spine (AIIS) and the rectus femoris are identified (Figure 1). The interval between the iliopsoas medially and the insertion of the rectus femoris and iliocapsularis laterally is identified and opened. A Langenbeck retractor is used to lift the iliopsoas off the ileopectineal eminence and a sharp tipped Hohmann retractor is put medially to the eminence. The tip of this retractor is fixed into to the pubic bone in order to safely retract the psoas medially (Figure 2). If the view on the anterior column is insufficient, the rectus femoris tendon can be tenotomized as originally described by Ganz et al.(1,2). In some cases the rectus femoris tendon can be tenotomized to improve exposure and allow the desired reconstruction, in these cases the tendon was sutured back at the end of the procedure. The hip capsule is then incised. The superior part of the capsule can be removed if hindering visualization. The pubo-femoral ligament (i.e. the inferior capsule) is tagged and retracted inferiorly by a postero-inferior retractor. The superior capsular release is done with the hip located. The femur is then dislocated followed by dislodging of the femoral head component in isolated acetabular revisions, extraction of the femoral component in reconstructions requiring revising both the femoral and acetabular components or performing the femoral neck cut at the desired level in a primary arthroplasty. The femur is then lifted to the level of the TFL. A superior retractor is placed at the level of the superior release just in front of the gluteus minimus. Attention is then placed towards socket removal and debridment of the bony defects.

Overall reconstruction constructs can consist of highly porous hemispherical acetabular components, along with particulate graft and/or titanium augments if needed. If a cage is required, a slot is created into the ischium for anchorage of the distal flange of the cage and the anterior insertion of the gluteus minimus was sub-periosteally peeled off the outer table of the ilium to allow fixation of the proximal flange of the cage to the ilium (Figure 3). The polyethylene liner is cemented in either the revision shell or the cage, which is put over the revision shell. (Figure 4).

Testing for stability or impingement is performed in deep flexion with 30° internal/external rotation as well as hyperextension with external rotation. In cases were the rectus femoris tendon had a suture repair performed at the end of the procedure this is followed by trans-osseous suturing of the muscle insertions at the level of the AIIS. The oblique abdominal muscle is sutured onto the conjoined fascia of the TFL and the maximus at the level of the iliac crest. The TFL fascia is then closed. A drain is placed and subsequently removed within 24 to 48 hours. Patients are immediately mobilized, partial weight bearing (50 to 75%) for 6 weeks. Open chain exercises were prohibited to allow the rectus femoris tendon to heal.
Figure 1. The Modified extensile Smith-Petersen approach to the anterior column of a right hip is shown on a cadaver specimen. (a) The iliac crest and anterior superior iliac spine (ASIS) (¶) are identified. The incision runs over the lateral side of the crest towards the ASIS and then distally over the muscle belly of the tensor fascia lata (*). (b) The ASIS is identified after the abdominal muscles have been peeled off sub-periosteally. Similarly, the insertion of the inguinal ligament is sub-periosteally peeled off. (c) With the hip flexed, a Hohmann retractor is put at the inner table of the ileum underneath the iliacus muscle (★). (d) The retractor is put at the pelvic brim and the interval between the iliacus-iliopsoas medially and the rectus femoris direct head laterally is opened (blue arrow).

Figure 2. (a) The ASIS (¶) and the anterior inferior iliac spine (AIIS) (^) is identified. The iliopsoas (blue arrow) is retracted medially. The hip remains flexed. (b) The pubic eminence (★) is identified and marks the medial extension of the acetabulum. (c) A sharp retractor is fixed in the pubic bone, just medial to the eminence. The psoas and the neurovascular structures are retracted medially.
Figure 3. (a) A 83-year old female patient presented with a severe acetabular defect and a peri-Vancouver type B3 peri-prosthetic femoral fracture 20 years following a cemented hip replacement. (b) A retractor was put at the ischial spine and one at the pubis. The posterior column was intact but the anterior column and medial wall were completely disrupted. (c) A lateral augment was applied to provide support to the trabecular revision shell was inserted. (d) A cage was applied to provide support and (e) a liner was cemented in. (f) The incision was extended distally, cerclage wires were applied around the femur and a modular revision stem was inserted (g).
Figure 4. (a) A 45-year old female presented with a Paprosky type 2 lateral defect of the left hip (b). (c) The intra-operative view of the cup-augment trials was excellent. (d) The lateral augment was inserted and loosely fixed. (e) The revision shell was inserted and the augment was fixed. (f) A trial reduction was done and allowed for extensive stability testing. (g) Radiograph 4 years post-operatively.

References


Management of Early Stem Subsidence/Calcar Fracture
(Using Either Anterior or Posterior Approach)
Paul J. Duwelius, MD

I. Introduction

- Epidemiology: 0.5-1% incidence in primary THA
- However, one study found a 5.4% incidence in primary THA with cementless stem versus 0.3% incidence when cemented stem used.
- Another study revealed 1.2% incidence with a cemented stem versus 3% with a cementless stem
- Problems with these studies include variability due to sample size or use of different femoral stems or insertion techniques
- Risk factors for periprosthetic fracture:
  - Cementless stems versus cemented stems
  - Recent reports of present day dual tapered stems decrease incidence
  - Small incision surgery
  - Female gender
  - Previous surgery on the affected hip
  - Increased age
  - Osteoporosis
  - Altered bone morphology or deformity such as Paget’s disease
  - Surgical approach (Anterior approach higher risk)

Diagnosis and Treatment

- Surgeon must have high index of suspicion intraoperatively
- Broach technique very important in uncemented technique
  - Listen for pitch change
  - Sudden change in resistance highly suggestive of fracture
  - Stop and let bone expand due to viscoelastic properties of bone during broaching
  - Intraoperative radiograph if fracture suspected
  - Insure stem stability prior to closure
  - Revise stem versus cable and continue if fracture discovered

II. Identification of the Problem

- High risk patient with poor bone quality:
  - Cemented stem
  - Cementless stem with cable
  - Care with rapid mobilization: 50% of patients with postoperative periprosthetic fracture report no mechanism of injury
  - High-risk patients should be advised not to come off assisted weight bearing too soon.

III. Fracture Occurs: Now What?

- Classifications exist but reliability and validity not tested
- Don’t miss the fracture
- Intraoperative fracture easily treated with cerclage wiring
- Fractures occur in classical pattern intraoperatively: calcar crack or triangular fragment of proximal medial femur
- Trochanteric fracture usually requires cable with tension band technique; plating associated with high rate of trochanteric escape
  - Careful attention to protection of trochanter with anterior retractor
  - Maybe indication to prepare femur first and leave broach in femoral canal so retractor pressure is on broach and not the GT
- Postoperative fracture with stem subsidence
  - Usually fracture unstable due to shortening and retroversion
  - Stem revision rather than ORIF with plate or cable preferable
  - Revision to standard or mid length stem with some diaphyseal fixation (Taper fluted modular or non-modular stem or extensively coated stem).
  - Fracture can be treated with cerclage wire and standard stem if excellent stability and good bone quality
  - Realize risk of complications with early revision especially infection

IV. Conclusions

- Anterior versus posterior: Where are we with calcar fractures?
  - All approaches have problems
  - Ease of making approach extensile?
  - Consider the learning curve
  - What’s the “bail out”
  - Consider the next operation if revision required?
  - What’s the problem? (32 or 36 femoral heads)
  - Do what works best in your hands
  - Long term results good if periprosthetic fracture recognized and treated properly
Periprosthetic Femur Fracture References

Management of Trochanter Fracture (Intra-Op and Early Post-Op)

Rafael J. Sierra, MD

- Intraoperative GT fractures:
  - Incidence: 132 of 32644 Primary THA (0.4%) Mayo Data
  - Classification:
    - Intraoperative: Vancouver A2 or A3: crack vs displaced fractures.
  - Occurrence most likely during femoral component placement or preparation (Table: From Abdel et al BJJ 2017) See below.
  - 70% nondisplaced/ 30% displaced
  - 50% treated with ORIF

<table>
<thead>
<tr>
<th>Fractures of the greater trochanter (n = 132)</th>
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<tr>
<td>When (n; %)</td>
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<tr>
<td>Femoral component placement (61; 46.2)</td>
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<tr>
<td>Femoral canal preparation (50; 37.9)</td>
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<td>Necrosis (5; 3.9)</td>
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<td>Exposure/dislocation (7; 5.3)</td>
</tr>
<tr>
<td>Hardware removal (3; 2.2)</td>
</tr>
<tr>
<td>Unrecognised (2; 1.5)</td>
</tr>
</tbody>
</table>

- Postoperative:
  - Incidence: 135 of 32644 Primary THA (0.4%) Mayo Data
  - Classification:
    - Vancouver A₄: Postoperative Fractures
  - Occurrence: No known trauma 47%, 83% tip avulsions that are treated nonoperatively (90%) (Table from Abdel et al BJJ 2017)

Table IV: Details of post-operative fractures (ORIF, open reduction and internal fixation)

<table>
<thead>
<tr>
<th>Vancouver A₄ fractures (n = 135)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cement status</td>
</tr>
<tr>
<td>Uncemented</td>
</tr>
<tr>
<td>Cemented</td>
</tr>
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<td></td>
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</table>

- Results of Treatment of Trochanteric Fractures
  - Intraoperative: most treated with suture or cable fixation if minimally displaced.
  - Postoperative: Most are treated nonoperatively.
    - Fixation may be an option if displacement greater than 2 cm, significant pain, trendelenburg and/ or associated with dislocation. See options below.
  - Pritchett (CORR 2001): 30 GT fractures, 6 intraop, 5 seen on initial radiograph. Average time to fracture was 8 months. 90% had less than 2.5 cm of displacement.
    - 6 Intraop fractures treated with Dall Miles cables, or suturing No. 5 ethibond.
    - No other fracture was treated surgically during first year
    - NO bracing, activity restriction or restricted weightbearing was used as treatment.
  - Results:
    - No dislocations occurred
    - 6 of 30 had trendelenburg sign at 1 year
    - 8 patients had displacement of > 2 cm
> 1/3 of patients had pain or limp and in half of persisted into final follow-up.

Hendel et al. (Acta Orthop Scand 2002):
- 21 intraop fx.
- 15 treated with wire fixation at the time of surgery
  - All healed, 1 with minimal displacement
- 6 treated nonoperatively
  - 1 did not unite > 2 cm displacement
- All together 8 patients slightly limped postoperatively and had pain.

Fixation options:
- Sutures and Wires: good option intraop fractures with minimal displacement.
- Dall Miles Claw and Cables: has been used in the past for fixation of trochanter after trochanter osteotomy. Breakage ranges from 3% (Dall and Miles JBJS Br 1983) to 32% (Ritter JBJS Br 1991) Not the preferred method for postoperative fractures. Maybe option in intraop fractures if additional fixation other than wires or sutures is needed.

Special circumstances:
- Comminuted fractures: Best to treat nonop initially then fix if displaced.
- Fractures associated with osteolysis. Best allow some healing, then revise hip and bone graft lytic trochanteric lesions.
- Fractures associated with Dislocation: operative fixation with cable plate or locked plates if displaced and revision of implants if needed.
- Marked displacement of the trochanter that cannot be reduced. Allograft interposition has been used with poor results. Subperiosteal Elevation of gluteus medius and minimus on vascular pedicle off the iliac crest has been reported with decent reports. (Chin et al JBJS Am 2000) I have not done this procedure.
Component Malposition and Leg Length Inequality: When Should I Go Back and What Should I Do?

Robert L. Barrack, MD

Instability and limb lengthening are two of the most common complications leading to patient morbidity, dissatisfaction, and lawsuits. The indications for early return to the operating room are not clear in part because some degree of component malposition and limb length discrepancy is relatively common while acutely returning to the operating room is extremely rare. To get some sense of the incidence of this occurrence, the registry of cases of a small group of arthroplasty surgeons at the single university center of primary hip arthroplasty cases. In only 11 of almost 8,000 cases (0.14%) was a patient returned to the operating on the same day as surgery or during the index hospitalization. Seven cases involved component malposition, three fractures and one mismatch pair of components. There were no cases of return to the O.R. for limb length inequality.

The indications for return to the O.R. for limb length inequality are not established. Lengthening associated with nerve deficit is one possible indication. One such case successfully treated with modular neck shortening has been reported. [1] Lengthening of >1cm which is noticeable and bothersome to the patient is another possible indication. The clinical significance of such a discrepancy is controversial. The incidence has been reported to be over 20% in some series. [2] Some studies have reported worse outcomes associated with lengthening of this degree, [3] while others have not found such a correlation. [2] The indications for return to the O.R. for malposition are also not clear. The most common indication is malposition associated with instability (subluxation or dislocation). Other cases of malposition are most often treated with watchful waiting since most malposition components do not go on to dislocate and the risk of acute reoperation can be daunting with a risk of over 30% reported. [4]

Given the enormous risk of missing over lengthening and component malposition, avoiding these occurrences at all reasonable costs is warranted. One successful approach is the use of modern intraoperative imaging. Outliers for length and cup position have been avoided in virtually all cases in studies from a number of centers reported recently. [5-7]

References:

Who is at Risk of Instability?
Arthur L. Malkani, MD

Dislocation continues to be one of the most common etiologies of failure leading to revision surgery following primary total hip arthroplasty. Over the past several years, dislocation rates have plateaued to approximately 2% and all the gains from use of large femoral head sizes have now been realized. (1) To make any further gains, attention needs to focus on patients at high risk for dislocation. There are several patient related factors that have been implicated leading to increased risk of dislocation following primary THA such as increased age, extent of co-morbid conditions, prior hip surgery, and patients with neuromuscular and cognitive disorders. (2) More recently the presence of lumbosacral disease in patients undergoing THA has also been implicated as a risk factor for dislocation. In a medicare database study following THA patients over a decade, the number of patients with prior lumbar spine fusion undergoing primary THA had increased by 293%. The incidence of hip dislocation in patients undergoing primary THA with prior lumbar spine fusion was 7.4% compared to 4.8% without fusion, p<.001. There was an 80% increased incidence of dislocation in the fusion group at 6 months, 71% at 1 year. (3) In another medicare database study using PearlDiver Technologies, the incidence of dislocation at 2 years following primary THA was 2.36% in the group without lumbar fusion, whereas the dislocation incidence increased to 4.26% in a short lumbar fusion segment group and 7.5% in a group with more than 3 lumbar segments fused. (4)

In a recent study, evaluating EOS images in the standing and sitting position in 1000 primary THA’s, patients with fixed spino-pelvic alignment (lumbar spine DJD and lumbar fusion) were at increased risk of dislocation. (5) The group that dislocated had decreased compensatory spine/pelvic flexion and functional acetabular inclination / anteversion compared to the non-dislocators. Lumbar spine fusion alters the dynamic relationship between the pelvis and the lumbosacral spine which leads to less flexible spino-pelvic junction during standing and sitting. (6) In another study the timing of THA and lumbar fusion was addressed. There was a 72% increased risk of dislocation in the prior lumbar spine group compared to those with hip arthroplasty first followed by a lumbar spine fusion within 2 years and 130% increased risk of dislocation in the lumbar spine fusion group compared to those with THA first and lumbar spine fusion within 5 years. (7) Patients with a history of lumbosacral pathology are at increased risk of hip dislocation leading to revision surgery following primary THA. Identifying patients at increased risk of dislocation due to fixed spino-pelvic alignment along with a treatment strategy to include a thorough evaluation of intra-operative functional cup position and possible use of dual mobility cups may help minimize the incidence of post-operative hip dislocation following primary THA. Additional studies are required to determine the ideal or best functional acetabular cup position for the specific fixed spino-pelvic alignment or pathology being addressed in patients undergoing primary THA.
References:


5) Jerabek S, Esposito C, Carroll K, Sculco P, Padgett D, Mayman D. THA patients with fixed spinopelvic alignment from standing to sitting are at higher risk of hip dislocation. Presented at AAHKS 2017, Dallas.


What is the “Safe Zone” for an Individual Patient?
Lawrence D. Dorr, MD

Background: The Lewinnek safe zone has not proven to be a reliable guide for surgeons in cup placement in total hip replacement. Recent knowledge about acetabular position change in the Sagittal plane as the pelvis rotates may be one clue for this unreliability. A second reason can be the failure of Lewinnek et al to include the femoral side of the joint in establishing the ideal acetabular component position. We considered these anatomical factors in researching whether the spatial motion of the acetabulum provided a key to determine a “safe zone” for the cup placement.

Questions/purpose: We asked three questions: 1) Can a sagittal functional hip mobility be defined and is it a sagittal “safe zone”? 2) Can the sagittal functional hip mobility be translated into a coronal “safe zone”? 3) Are there hips which have no “safe zone”?

Methods: 220 hips (213 patients) were prospectively studied with AP pelvis and stand and sit lateral spine-pelvis-hip radiographs, as well as the computer numbers for cup inclination and anteversion, and the stem anteversion achieved intraoperatively. Measurements of the biomechanical reconstruction of the hip, and the cup angles of anteversion and inclination, were done on the AP pelvis X-ray. The measurements from the spinopelvic X-rays focused on the dynamic motion of the posterior lumbosacral hinge (sacral slope) and the anterior hip hinge (ante-inclination and pelvic femoral angle). Stiffness of the lumbosacral hinge translated into a stiff pelvic gear so that it could not rotate during standing and sitting. The compensation is increased motion of the anterior hinge (the hip) which increases risk for impingement. This imbalance cannot be factored into the Lewinnek angles. So we identified a sagittal measurement of the hip joint which is a combination of the acetabular and femoral angles both standing and sitting (the Combined Sagittal Index, CSI) which could be predicted by the mobility of the lumbosacral hinge (sacral slope, dSS) and the maximum hip flexion sitting or standing (pelvic femoral angle, PFA). The sacral slope mobility affects the pelvic mobility which affects the acetabular angle/mobility because it is part of the pelvis.

Results: 207 of 220 hips (94%) were within Combined Anteversion of 25°-45°; 193/220 hips had inclination of 35°-50°. All 13 of the hips outside the normal Combined Anteversion range could have been within that range with different intraoperative decisions because they were in retroverted hips. 203/207 hips (99%) with normal combined anteversion also had 90% coverage of their femoral head sitting. Therefore we considered Combined Anteversion of 25°-45°, and inclination of 35°-50° as a coronal safe zone. To be truly classified as a safe zone meant that hips within these ranges must also keep the sagittal mobility in its normal range. 203 of 220 hips had normal range for CSI sitting, and 206 were within the normal range standing, and 94% of these hips also were in the coronal safe zone. There were 17 hips which could never be classified within a safe zone because their spinopelvic stiffness did not allow normal sagittal mobility even with correct coronal safe zone values.
Conclusions: The Lewinnek safe zone failed in its intent because it considered only one side of the hip joint. Combined anteversion of $25^\circ$-$45^\circ$ can be used as an anteversion safe zone with inclination of $35^\circ$-$50^\circ$ with confidence that it keeps the sagittal functional hip mobility inside its normal Combined Sagittal Index range for 94% of hips. There were 17 hips which were not able to be classified within a safe zone because their spinopelvic stiffness increased their risk for impingement even with normal coronal safe zone numbers. This combination safe zone for functional cup position will need to be subjected to the same clinical tests performed with the Lewinnek safe zones, but we conclude that the clinical correlation in this study of the coronal hip position of both sides of the joint to the sagittal functional position of both sides of the joint warrants further study and clinical validation by other researchers. If it performs well in these additional studies it provides a guideline for surgeons that is not difficult to accomplish in the operating room.
What Implants and Approach Should We Use to Optimize Outcomes: Is It Patient-Specific?

James D. Slover, MD, MS

The goal of any hip surgery is to improve function and relieve pain by implanting or revising an implant with a construct that will achieve these goals, while surviving over the long term and simultaneously minimizing complications. When considering the implant and surgical approach to the hip you will employ to achieve these goals for a specific patient several important considerations are needed. First, a firm understanding of the goals of the surgery is needed. This includes needed anatomic access and obstacles that need to be overcome or addressed to achieve the required reconstruction. In certain situations, an approach that provides more direct ability to deal with these challenges can be employed. For example, if a reconstruction requires removal of hardware in the posterior hip, a posterior approach may be chosen over an anterior approach, where this would be more difficult to accomplish. In contrast, a hip with significant anteversion or anterior pathology may be more easily dealt with using an anteriorly based approach. Previous incisions, though not mandatory for re-use, may be used to guide the approach as long as the other aforementioned goals can be achieved.

Secondary goals of hip reconstruction surgery include ease and speed of recovery. This typically involves rapid early mobilization. The ultimate goal is full functional recovery of muscles and other soft tissues surrounding the hip joint. These goals can be achieved using almost all approaches to the hip in the vast majority of cases, and this has been demonstrated for numerous approaches and implants in the literature. In addition, provided surgeons are experienced with the approach, this should not limit implant selection. Most implants will work well with the majority of primary hip reconstruction cases.

Patient characteristics may also be an important factor when selecting the surgical approach for a hip reconstruction. In select situations, patient anatomy and any deformity or pathology present may dictate a certain implant for reconstruction. For example, excessive anteversion or retroversion of the femur may require a modular implant, or an elderly osteoporotic patient with a stovepipe femur may require a cemented femoral stem. In most cases these can be anticipated during pre-operative templating for the case, but surgeons should ensure appropriate training and understanding of the implant before using it in a patient reconstruction.

Another important factor to consider is surgeon experience and comfort with the approach. As almost all cases can ultimately be reconstructed safely and effectively using any of the common approaches to the hip, surgeons need to ensure they are confident in their ability to perform the surgical approach chosen. Numerous studies have documented the impact of the learning curve for various surgical approaches, and surgeons should take appropriate steps to minimize these effects through education and collaboration during the learning phase. In addition surgeons should select cases carefully, particularly during the early phases of adoption of a new surgical approach or implant, or when choosing an approach or implant not used frequently, in order to optimize outcomes and minimize complications.

In conclusion, the vast majority of hip reconstructive cases can be completed safely and effectively through any of the common surgical approaches to the hip using most implant systems. However, select cases, pathology and patient characteristics may make one approach or implant system preferred for a particular situation and surgeons can anticipate this through careful planning. Attention to training and preparation can allow experienced surgeons to use these alternate approaches when necessary and to achieve optimal patient outcomes.
Is There a Role for Computer Navigation?
Douglas E. Padgett, MD

The 2 most concerning issues following THR remain:
- short term: instability
- long term: bearing wear

Both of these concerns are impacted by component position. Historically, we have used static 2-D metrics to guage the accuracy of implant position: “The safe zone of Lewinnek”. This classic paper focusing on roughly 100 THR’s of which 9 dislocated, has been the standard by which we have measured “ideal implant position”.

The limitations of the Lewinnek zone have been borne out recently by work at both our institution and that of the Mayo clinic. It appears that there is no safe zone! Why? It appears that:

1. Pelvic position and by default, functional acetabular position may change dramatically from standing, sitting to squatting positions.
2. The vast majority of studies ignore the femoral side of the equation: the other “half” of the hip story which certainly can impact combined orientation of the articulation.

Based upon computational analysis, clinical studies assessing change from standing to sitting as well as the impact of deeper flexion, I believe we are getting closer to understanding the optimal position of implants to achieve the desired short term and long-term effects.

Assuming we can identify optimal 3-D placement of implants on an individualized basis, it seems logical that we use enabling technology to aid in executing this plan. The limitations and wide variability of implant position using manual guides enabling technologies include:

- navigation
- smart tools
- robotic assistance

These technologies can be either image based (CT, MRI or ultrasound) or imageless using anatomic landmarks. Many of the criticisms of the outcomes of studies using these technologies are that the typical metrics such as reduction in dislocation, increase in patient satisfaction, or a reduction in bearing wear have not justified their use. However, given that optimal implant position was frankly “guessed at”, these criticisms do not appear justified.

In summary, I believe we are entering a new phase of total hip arthroplasty: not one based upon improvement in design or bearing but an era of “customized / individualized” implant delivery. Based upon the patients unique anatomy and spino-pelvic alignment, hip arthroplasty will be placed utilizing these enhancing technologies to optimize function and longevity.
References:

Pelvic Tilt in Patients Undergoing Total Hip Arthroplasty: When Does it Matter?
Joseph D. Maratt, Christina I. Esposito, Alexander S. McLawhorn, Seth A. Jerabek, Douglas E. Padgett, David J. Mayman

Cup Position Alone Does Not Predict Risk of Dislocation after Hip Arthroplasty
Christina I. Esposito, Brian P. Gladnick, Yuyu Lee, Stephen Lyman, Timothy M. Wright, David J. Mayman, Douglas E. Padgett

Does CT-Based Navigation Improve the Long-Term Survival in Ceramic-on-Ceramic THA?
Nobuhiko Sugano, Masaki Takao, Takashi Sakai, Takashi Nishii, Hidenobu Miki

Hip–spine relations and sagittal balance clinical consequences
Jean-Yves Lazennec, Adrien Brusson, Marc-Antoine Rousseau

What Safe Zone? The Vast Majority of Dislocated THAs Are Within the Lewinnek Safe Zone for Acetabular Component Position
Matthew P. Abdel, Philipp von Roth, Matthew T. Jennings, Arlen D. Hanssen, Mark W. Pagnano
When Should I Revise the Hip for Postop Instability and What Should I Do?

R. Michael Meneghini, MD

There are multiple causes of recurrent dislocation after total hip arthroplasty (THA) and include component malposition, extra-prosthetic impingement, polyethylene wear, abductor muscle incompetence, altered neurologic function about the hip from neurologic or spinal disease and less commonly adverse local tissue reaction from metal hypersensitivity or infection. Successful treatment of recurrent instability after THA requires an assessment of potential causal factors, identification of the etiology and treatment targeting the specific etiology of instability.

When To Revise?

The decision of when to revise a patient with instability after THA is based on the clinical scenario and whether the instability can be predicted to be recurrent. If the hip dislocation is an isolated occurrence either in the early postoperative period or from a traumatic event with well-positioned implants, then continued observation is warranted. In this scenario, the surgeon and patient can expect a reasonable chance of closed reduction rendering the hip stable without surgical intervention. Studies show a success rate of 67-81% for closed reduction of an early dislocation after a THA.1,2 Conversely, if more than one dislocation has occurred remote from the original surgery, the chance of closed reduction rendering the hip stable without further surgery is less likely. Further, if an isolated dislocation in the immediate postoperative period or in a previously well-functioning THA is the result of an identifiable and correctable etiology that is known to render the hip unstable surgical correction should be considered.

What Should I Do? – Surgically Correct the Underlying Etiology of Instability

The Rush University group published a system of classifying recurrent instability into 6 etiology groups, which guides the surgical treatment strategy.3 Type 1 instability is characterized by an acetabular component outside the “safe zone”. This instability type is treated with revision of the acetabular component. It should be noted, however, that the “safe zone” as reported by Lewinnek has recently been refuted and it is acknowledged that the ideal position is likely patient specific.4-7 Type 2 instability is characterized by femoral component malposition and the recommended treatment is revision of the femoral component. Type 3 instability is compromise or complete absence of the abductor-trochanteric complex. The recommended treatment is optimization of implant position and insertion of a constrained liner, while some would propose avoiding a constrained liner in favor of a dual-mobility bearing.8,9 Type 4 instability is intra-prosthetic impingement or impingement caused by extra-prosthetic bone or soft-tissues. The recommended treatment is removal of the offending impingement and optimization of femoral head diameter. This may include use of a dual-mobility bearing in some cases, particularly in smaller cup sizes. Type 5 instability is eccentric polyethylene wear in well-functioning THA with appropriately positioned components and treatment is a head and liner exchange with optimization of femoral head diameter. Type 6 is a diagnosis of exclusion, where no identifiable etiology is found and the treatment is with a constrained liner3, or more recently a consideration would be given to a dual-mobility articulation.8,9

While this classification system is useful to provide guidance for treatment, other factors may contribute to instability. There is emerging evidence that alterations in the lumbopelvic alignment can adversely affect THA stability by creating a “dynamic” acetabular component malposition. This is most commonly seen in patients with lumbar spine disease or instrumented lumbar spinal fusion surgery.10-21 Further research is warranted to provide more specific guidance on the exact implant position that is optimal in these particular patients.
References


Introduction: Many metal-on-metal (MoM) implants fail due to adverse local tissue reactions (ALTRs) secondary to implant wear. There is little consensus regarding the relationship between symptomaticity and ALTR presence, as several studies have shown similar pseudotumor incidence between symptomatic and asymptomatic patient cohorts.

The primary objective of this study was to determine if ALTR prevalence differs between asymptomatic and symptomatic patients treated with MoM HRA and MoM THA implants. The secondary objective of this study was to evaluate the association between ATLR severity and symptomaticity among patients diagnosed with ALTR.

Methods: The study cohort consisted of 327 patients treated with a unilateral hip replacement (145 MoM THA and 182 MoM HRA). The study patients were selected from a prospective, multicenter, follow-up study of a recalled hip system from sites performing annual metal artifact reduction sequence magnetic resonance imaging (MARS-MRI) irrespective of patient symptoms. Follow-up also consisted of three patient-reported outcome measures (PROMs), the Harris Hip Score (HHS), VAS Satisfaction score, and VAS Pain score, and whole blood cobalt and chromium ion levels. The presence of ALTR of MARS-MRI was graded using the Anderson classification system. The maximal diameter and synovial thickness of the ALTR were determined for hips in which ALTR was found. MoM THA and MoM HRA patients were considered separately for all analyses. We used univariate tests and a multivariable binary logistic regression to determine predictors of ALTR.

Results: Overall, 33.8% of our MoM THA patients developed a moderate or severe ALTR by the time of their follow-up. Symptoms were observed in 38.6% of patients, and 46.2% had elevated metal ion levels (Table 1). During our univariate analyses of the MoM THA patient cohort, we found that ALTR presence was associated with symptomaticity (p = 0.015) but not with elevated blood metal ion levels (p = 0.870) (Figure 1). More than half (51.2%) of the symptomatic patients had ALTRs, while only 28.2% of the asymptomatic patients had ALTRs. This association was highlighted in our multivariable model, as symptomaticity was the only variable that proved significant when assessing moderate or severe ALTR presence (OR = 2.6; p = 0.019) (Table 2). For patients with an ALTR, the ALTR diameter did not vary between symptomatic and asymptomatic patients (p = 0.330), but synovial thickness did (p = 0.037) (Figure 2).

In the MoM HRA patients, we found a 15.9% prevalence of moderate or severe ALTR. Elevated metal ion levels were seen in 21.4% of patients, and 22.5% were symptomatic (Table 1). We found a univariate association between ALTR and metal ion levels (p < 0.001), but none between ALTR and symptomaticity (p = 0.796) (Figure 1). These findings were reinforced in the multivariable model, as only elevated metal ion levels were found to be predictive of ALTR (OR = 9.2; p < 0.001) (Table 2). When considering patients with an ALTR only, we found that neither ALTR diameter (p = 0.330) nor synovial thickness (p = 0.535) (Figure 2) were associated with the presence of symptoms.
**Conclusion:** We found that symptomaticity was associated with an increased risk of having ALTR in patients who had MoM THA, but not for those with MoM HRA. Furthermore, ALTR severity (quantified by synovial thickness) in MoM THA patients is associated with increased risk of having symptoms. For patients treated with the MoM HRA, we found that although elevated blood metal ion levels may be used to screen for ALTR, there was no association between symptoms and ALTR.

**Figure 1.** Prevalence of ALTR separated by metal ion level and symptomaticity.
Figure 2. Boxplots showing the differences in synovial thickness between symptomatic and asymptomatic patients diagnosed with ALTR. Error bar represent 95% confidence intervals.

<table>
<thead>
<tr>
<th>Table 1. Patient demographics and clinical follow-up data</th>
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<tbody>
<tr>
<td><strong>MoM THA</strong></td>
</tr>
<tr>
<td>Number of patients</td>
</tr>
<tr>
<td>Female sex*</td>
</tr>
<tr>
<td>Time to follow-up (years)†</td>
</tr>
<tr>
<td>Co or Cr &gt; 5.0 ppb*</td>
</tr>
<tr>
<td>Symptomatic*</td>
</tr>
<tr>
<td>Moderate (C2) or severe (C3) ALTR*</td>
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* Values given as N (%). † Values given as mean (range).

Table 2. Results of binary logistic regression analyses considering the outcome of ALTR presence

<table>
<thead>
<tr>
<th><strong>MoM THA</strong></th>
<th><strong>MoM HRA</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Odds Ratio (95% Confidence Interval)</strong></td>
<td><strong>P Value</strong></td>
</tr>
<tr>
<td>Age</td>
<td>1.7 (0.7, 4.2)</td>
</tr>
<tr>
<td>Female sex</td>
<td>0.5 (0.5, 1.0)</td>
</tr>
<tr>
<td>Head size</td>
<td>0.8 (0.3, 1.7)</td>
</tr>
<tr>
<td>Metal ion levels</td>
<td>1.1 (0.5, 2.4)</td>
</tr>
<tr>
<td>Follow-up time</td>
<td>1.1 (0.8, 1.3)</td>
</tr>
<tr>
<td>Symptomatic</td>
<td>2.6 (1.2, 5.6)</td>
</tr>
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</table>

* Denotes statistical significance at p ≤ 0.05.
What is the Current Understanding of the Problem?

Joshua J. Jacobs, MD

The science of tribocorrosion addresses the synergistic effects of mechanical and electrochemical degradation processes of metal interfaces including bearing surfaces and modular junctions. Mechanically assisted crevice corrosion (MACC) is a well-described tribocorrosion phenomenon that was first reported in the early 1990s after the introduction of modular heads in total hip arthroplasty. While many retrieval studies conducted during that era documented the presence of corrosion in cobalt alloy/cobalt alloy, cobalt alloy/titanium alloy and alumina ceramic/cobalt alloy combinations, there were a very limited number of reports indicating that there were clinical sequelae associated with MACC. Gilbert et al. described the mechanistic basis of MACC whereby the inciting event was fretting at the head-neck coupling leading to disruption of the passivating oxide layer, re-passivation, depletion of oxygen, change in the local solution chemistry (decrease in pH and increase in chloride ion concentration) resulting in instability of the oxide and subsequent attack of the underlying metal. This sequence of events can lead to the release of large quantities of metal degradation products.

In retrospect, as we consider cases of osteolysis from that era, some of the local tissue reactions that were attributed to polyethylene were likely a reaction to corrosion debris which has subsequently been shown to be capable of causing osteolysis in experimental animal models and in humans with corroded modular stainless steel intramedullary femoral nails. Furthermore, in some cases histological analysis of periprosthetic tissue associated with failed corroded devices from that area demonstrated a perivascular lymphocytic infiltrate akin to what was later reported as ALVAL (aseptic lymphocyte-dominated vasculitis-associated lesion) in association with failed metal-on-metal devices.

Subsequent to this early experience with head/neck modularity, the concern regarding MACC seemed to have virtually disappeared from our literature, presumably because the orthopaedic implant industry responded by producing head-neck couplings with better performance. However, this issue has re-emerged over the last few years and has taken on a new significance since MACC has been associated with adverse local tissue reactions (ALTR) and clinical failure at a prevalence rate reported to be 3.2% or greater depending on the design and year of manufacture. The central question is: Why is this happening now? In this presentation, five possibilities are considered: i) the implants have changed; ii) the operation has changed; iii) the patients have changed; iv) the surgeon’s awareness has changed; and 5) the patients are being over- or misdiagnosed. While MACC-associated ALTR is incompletely understood at this juncture, important insights are emerging from in vitro tribocorrosion testing and implant retrieval studies pointing to the importance of metallurgical characteristics of Co-based implant alloys.
REFERENCES


What is the Clinical Presentation and How Do I Work Up a Painful Hip?

Don S. Garbuz, MD, MHSc, FRCSC

Taper corrosion (trunionosis) is a clinical problem in both metal on metal (MOM) and metal on poly (MOP) total hip replacements. It is a problem first identified in MOM total hips. In a RCT from our center MOM total hips were found to have significantly elevated serum cobalt and chromium levels compared to resurfacing. Subsequent studies have shown a high rate of adverse local tissue reactions secondary to trunionosis in patients with MOM total hips.

More recently it has been recognized that MOP total hips can also have ALTRs secondary to taper corrosion. This is much less frequent than in MOM THAs. Patients will present with new onset pain, stiffness and instability. Be suspicious in patients with previously well positioned hip implants who present with dislocation between 2-6 years post surgery.

In patients with MOM or MOP THAs who present with pain one must be suspicious of an ALTR. However, first infection must be ruled out. Standard tests are done however diagnosis can be difficult. Often ESR/CRP are elevated. For cell count one must ask for a manual cell count. Once infection is ruled out workup now focuses on ALTR

In MOM THAs metal ions are not very useful as even well-functioning THAs with no ALTR can have elevated cobalt and chromium levels. To R/O ALTR in these patients’ cross-sectional imaging is needed. This can be ultrasound or metal reduction MRI. The choice will depend on your centers expertise in these areas. A study from our center has shown that both tests are excellent, however due to its cheaper cost and high sensitivity we have favoured ultrasound. However, one must have an ultrasonographer who has experience with hip ultrasound.

In patients with MOP THAs workup for infection includes x-rays, metal ions and cross-sectional imaging. On plain x-rays rounding of the calcar will often be the first subtle clue. However, the majority of the time plain x-rays are normal. Serum cobalt above 1 part per billion is an indication of a problem with taper corrosion. In any patient with this number additional cross sectional imaging should be obtained. Again this can be ultrasound or MARS MRI.

In summary taper corrosion is very common in MOM THA and less frequent in MOP THAs. In MOP THAs be suspicious in patients who present with new pain, stiffness or instability. IN MOP THAs certain implants seem to be at higher risk than others. Workup in both groups include plain x-rays and cross sectional imaging. IN MOP THAs cobalt levels are very useful and a value greater than 1 part per billion.
References


How Should I Treat This Problem and What are the Outcomes?

William L. Griffin, MD

Modular heads, necks, and stems allow for intra-operative optimization of offset, anteversion, leg lengths, and soft tissue tension. However, modularity comes with a cost. All modular junctions are subject to interface motion which can lead to mechanically assisted crevice corrosion (MACC). Fretting and the metal debris generated from trunnion corrosion can cause adverse local tissue reactions (ALTR) as seen with metal on metal bearings and corrosion can occasionally lead to implant fracture.

Implant retrievals and FEA studies have identified a number of mechanical factors associated with fretting and corrosion. Taper angle, taper diameter, surface area and finish, neck length, flexural rigidity, and mixed alloys (Ti and CoCr) can all affect the degree of corrosion. Increasing head size, evaluated in several studies, did not correlate with the development of taper corrosion.

Dual modular stems with CoCr necks and Ti stems are subject to loads that can exceed the elastic limits of the Ti stems and have led to fretting and ALTR, high revision rates, and subsequent implant recalls from two manufacturers.

The incidence of taper corrosion at the modular head-neck junction in a metal-on-poly THA is relatively rare (1-2%), making the diagnosis more difficult. It is more commonly seen in dual modular stems at the neck-stem junction and in cases of metallosis with metal-metal bearings at the head-neck trunnion.

Evaluation of these patients requires a high index of suspicion in a painful MOP THA. If MOP patients have even mildly elevated Co and Cr ion levels (>1.0), then a cross sectional study such as a MARS-MRI is indicated to help identify ALTR.

Isolated head-neck taper corrosion with minimal damage to the soft tissues and bone can be successfully treated with exchange of the CoCr metal head to a ceramic head with a Ti sleeve. Recurrence of taper corrosion with a retained stem is rare, but has been reported. For those cases with more severe adverse local tissue reactions, there is an increased postoperative risk of instability, and infection. In these cases large heads, MDMs, or constrained liners may be indicated.

For recalled dual modularity stems with revision rates ranging from 25-48%, stem revision is recommended. There is insufficient data on all of the dual modular stems to make definitive recommendations regarding the need for stem removal.

Further study will help to better delineate who is at risk for taper corrosion and which patients are better treated with stem revision vs head exchange.
References:


Should We All Be Going to Ceramic?
Jay R. Lieberman, MD

Bearing surface utilization has undergone significant change over the past decade. The rise of ceramic heads has increased for a number of different reasons including: low reported revision rates from registry data; decreased frequency in femoral head fractures; and reduced costs. However, the most important reason for the increase in use of ceramic femoral heads are the reports beginning in 2010 of femoral neck taper corrosion associated with cobalt chrome heads.

The question is should we all just be using ceramic heads? At this point it does not appear that the data is strong enough to recommend that ceramic femoral heads should be used in all patients. Taper corrosion has been associated with ceramic heads in the past. We need to determine the etiology of taper corrosion before completely switching to the use of ceramic heads. In younger patients, it seems reasonable to switch to ceramic heads in the hopes of having decreased wear. The data is not clear for elderly patients. If there is no difference in price between metal and ceramic heads at a particular institution then it may seem reasonable to use a ceramic head. However, we really cannot say that this will completely solve the taper corrosion problem.
THE JOHN CHARNLEY AWARD

Analysis of US Hip Replacement Bundled Payments: Physician-initiated Episodes Out Perform Hospital-initiated Episodes
William S. Murphy, AB; Ahmed Siddiqu, DO; Tony Cheng, MBA; Ben Lin, BA; David Terry, MBA; Carl T. Talmo, MD; Stephen B. Murphy, MD

Background: The Center for Medicare and Medicaid Services (CMS) launched the Bundled Payment for Care Improvement (BPCI) Initiative in 2013 to create incentives to improve outcomes and reduce costs in various clinical settings, including total hip arthroplasty (THA). This study seeks to quantify BPCI initiative outcomes for THA and determine the optimal party (e.g. Hospital vs Physician Group Practice [PGP]) to manage the program.

Questions/purposes: (1) Is BPCI associated with lower 90-day costs, readmissions, or mortality for elective THA? (2) Is there a difference in 90-day payments, readmissions, or mortality between episodes initiated by PGP s and hospitals for elective THA? (3) Is BPCI associated with reduced total Elixhauser comorbidity index or age for elective THA?

Methods: We performed a retrospective analysis on the CMS Limited Data Set (LDS) on all Medicare primary elective THAs without major comorbidity (DRG 470) performed in the United States (except Maryland) between January 2013 and March 2016, totaling more than $7.1 billion in payments. Episodes were grouped into hospital-run BPCI (n = 43,922), PGP-run BPCI (n = 44,662), and THA performed outside of BPCI (n = 284,002). All Medicare Part A payments were calculated over a 90-day period after surgery and adjusted for inflation and regional variation. For each episode, age, sex, race, geographic location, background trend, and Elixhauser comorbidities were calculated to control for major confounding variables. Total payments, readmissions, and mortality were compared among the groups with linear regression.

Results: When controlling for age, sex, race, background trend, geographic variation in spending, and total Elixhauser comorbidities, BPCI was associated with a 4.44% (95% CI, -4.58% to -4.30%; p < 0.001) cost decrease for all participants ($1,244 decrease from baseline of $18,802); however, odds ratios (ORs) for 90-day mortality and readmissions were unchanged in elective, DRG 470 THA episodes. PGP-run episodes achieved a 4.81% decrease in cost (95% CI, -5.01% to -4.61%; p < 0.001) after enrolling in BPCI ($1,335 decrease from baseline of $17,841). Hospital-run episodes achieved a 4.04% decrease in cost (95% CI, -4.24% to 3.84%; p < 0.01) after enrolling in BPCI ($1,138 decrease from baseline of $19,799). The decrease in cost of PGP-run episodes was greater than the decrease in cost of hospital-run episodes (p < 0.001). ORs for 90-day mortality and readmission remained unchanged after BPCI for PGP- and hospital-run BPCI programs. The average Elixhauser comorbidity index rose by 0.21 for hospital-run after BPCI (95% CI, 0.03–0.38; p = 0.02) and by 0.19 for BPCI overall (95% CI, 0.02–0.037; p = 0.03), while there was no change in PGP-run programs (p = 0.21). Patient age did not change after BPCI for PGP-run (p = 0.97), hospital-run (p = 0.62), or overall BPCI episodes (p = 0.73).
**Conclusion:** This study demonstrates that at risk physician leadership in BPCI is more effective than hospital leadership in reducing cost while maintaining patient outcomes; physicians may be a more logical group in which to entrust further healthcare reform. Even when controlling for decreasing costs in traditional fee-for-service care, BPCI is associated with a further cost reduction without increased adverse events, and this is not due to the selection of younger patients or those with fewer comorbidities.
THE GENETICS OF OSTEOLYSIS AFTER TOTAL HIP ARTHROPLASTY

Scott J. Macinnes, PhD; Konstantinos Hatzikotoulas, PhD; Anne Marie Fenstad, MSc; Karan Shah, PhD; Lorraine Southam, PhD; Ioanna Tachmazidou, PhD; Geir Hallan, PhD; Harvard Dale, PhD; Kalliope Panoutsopoulou, PhD; Ove Furnes, PhD; Eleftheria Zeggini, PhD; J. Mark Wilkinson, PhD, FRCS

Background: Periprosthetic osteolysis resulting in aseptic loosening is a leading cause for total hip arthroplasty (THA) failure. Individuals vary in their susceptibility to osteolysis. Heritable factors are thought to contribute to this variation. We conducted two genome-wide association studies to identify genetic risk loci associated with osteolysis susceptibility and with time to prosthesis failure due to osteolysis.

Methods: The Norway cohort comprised 2,624 subjects after THA recruited from the Norwegian Arthroplasty Registry, 779 with revision surgery for osteolysis. The UK cohort comprised 890 subjects recruited from hospitals in the north of England, 317 with radiographic evidence or revision surgery for osteolysis. Osteolysis susceptibility case-control analyses and quantitative trait analyses for time to prosthesis failure were undertaken after genome-wide genotyping. Finally, a meta-analysis of the discovery datasets was undertaken.

Results: Genome-wide association analysis identified 4 and 11 independent suggestive genetic signals for osteolysis susceptibility at P≤5x10^-6 in the Norwegian and UK cohorts, respectively. Following meta-analysis, 5 independent genetic signals showed suggestive association with osteolysis at P≤5x10^-6, with the strongest comprising 18 correlated variants on chromosome 7 (lead signal rs850092, P=1.13x10^-6). Genome-wide quantitative trait analysis in cases only showed a total of 5 and 9 independent genetic signals for time to prosthesis failure at P≤5x10^-6, respectively. Following meta-analysis, 11 independent genetic signals showed suggestive evidence of association with time to failure at P≤5x10^-6, with the largest association block comprising 174 correlated variants in chromosome 15 (lead signal rs10507055, P=1.40x10^-7).

Conclusions: These studies provide the first genome-wide insights into the heritable biology of osteolysis. Although there were no signals of genome-wide significance, we find replicating evidence for several independent genetic loci both for osteolysis susceptibility and time to prosthesis failure at P≤5x10^-6, consistent with the complex aetiology of the disease.
THE FRANK STINCHFIELD AWARD

Spino-pelvic Hypermobility is Associated with Inferior Outcome Post-THA: Examining the Effect of Spinal Arthrodesis

George Grammatopoulos, BSc, MBBS, D.Phil (Oxon); Wade Gofton, MD, FRCSC, Med; Zaid Jibri, MBCHB, MRCSEd, FRCR; Matthew Coyle, MD; Johanna Dobransky, MHK, BSc; Cheryl Kreviazuk, BA; Paul R. Kim, MD, FRCSC; Paul E. Beaulé, MD, FRCSC

Background: The mechanisms of how spinal arthrodesis (SA) affects patient function after total hip replacement remain unclear.

Purposes: a) Determine how outcome post-THA compares between patients with- and without-SA, b) Characterize sagittal pelvic changes that occur when moving between different functional positions, and test for differences between patients with- and without-SA, and c) Assess whether differences in sagittal pelvic dynamics are associated with outcome post-THA.

Methods: Forty-two patients with THA-SA (60 hips) were case-control matched for age, gender, BMI with 42 THA-only patients (60 hips). All presented for review where outcome, PROMs [including Oxford-Hip-Score (OHS)] and 4 radiographs of the pelvis and spino-pelvic complex in 3 positions (supine, standing, deep-seated) were obtained. Cup orientation and various spino-pelvic parameters [including pelvic tilt (PT) and Pelvic-Femoral-Angle (PFA)] were measured. The difference in PT between standing and seated allowed for patient classification based on spino-pelvic mobility into normal (±10–30°), stiff (<±10°) or hypermobile (>±30°).

Results: The THA-SA group had inferior PROMs (OHS: 33vs.43; p<0.001) and more complications (12vs.3; p=0.01), especially dislocation (5vs.0) than the THA-only group. No difference in change of PT between supine and standing positions was detected between groups. When standing THA-SA patients had greater PT (24°vs.17°; p=0.01) and the hip was more extended (194°vs.185°; p<0.001). THA-SA patients were 4x more likely to have spino-pelvic hypermobility with anteriorly tilting of their pelvis. Of all biomechanical parameters, only spino-pelvic hypermobility was associated with significant inferior PROMs (OHS:35; p=0.04) and was also present in dislocating hips that required revision despite optimum cup orientation.

Conclusion: In patients with SA who have undergone a THA, the presence of spino-pelvic hypermobility is associated with an inferior outcome and leads to hip instability secondary to anterior impingement when deep seated (anterior tilt functionally retroverting cup). For those patients, current implant positioning may not be sufficient to avoid dislocation.
Component removal, both on the femoral and acetabular sides, during revision total hip arthroplasty (THA) requires careful planning in order to minimize bone loss. If successfully performed, reconstruction options are maintained and a successful revision operation is more easily achieved.

Surgeon experience and familiarity with different techniques is of the utmost importance in order to remove the components safely and expeditiously while preserving as much bone as possible. Access to specialized tools is often essential. Different surgeons have a variety of preferences for tools and techniques. In this talk, we will present you with an overview of various tips and techniques that are described in the literature. A logical and stepwise method for dealing with implant removal that works best in our hands will be demonstrated.

As witnessed by the attached reference list, the many different techniques described indicate that a single safe, reproducible ideal method doesn’t exist. We will highlight a few of the systems that we have found to be useful and versatile in our hands over the years: the extended trochanteric osteotomy for femoral revisions, the Explant system on the acetabular side and the OSCAR on both the femoral and acetabular sides. Although some may prefer other techniques, we recommend that surgeons use an approach with which they are familiar and that works well in their hands. Generally, use of careful preoperative planning, use of an extensile approach, patience and a stepwise logical progression are always recommended.

Bibliography

Acetabular reconstruction in revision total hip arthroplasty can be complicated by the presence of acetabular bone loss. In severe cases of acetabular bone deficiency with segmental bone defects or pelvic discontinuity, obtaining a stable, well-fixed acetabular component can be very challenging. The anatomic location and degree of bone loss is important in determining the treatment algorithm for acetabular revision. Porous coated uncemented hemispherical cups have been successful and are indicated in the majority of patients. As the severity of acetabular deficiencies increases, more complex alternatives are needed for revision. Antiprotrusio cages traditionally have been used but higher failure rates necessitated the development of alternatives. Porous coated acetabular augments have become an attractive alternative to structural allograft and oblong components in the setting of severe bone loss.

Radiographic Parameters for Paprosky Acetabular Bone Loss Classification

a. Superior Migration of the hip center
   i. Referenced off of the superior obturator line
   ii. > 3 cm signifies severe bone loss
   iii. Assessment of acetabular dome bone stock
b. Teardrop osteolysis
   i. Assessment of inferomedial and medial wall bone loss
c. Ischial osteolysis
   i. Assessment of posterior column bone stock
d. Violation of Kohler’s line
   i. Represents the ilioischial line
   ii. Medial migration of the acetabular component
   iii. Assessment of anterosuperior and medial wall bone loss
e. Type III
   i. Severe bone loss
   ii. Distorted oblong shaped acetabulum
   iii. Columns NOT supportive
      1. IIIA
         a. UP and OUT defect
         b. Superior migration > 3 cm
         c. 30-60% acetabular bone loss
      2. IIIB
         a. UP and IN defect
         b. Superior migration > 3 cm
         c. 60%+ acetabular bone loss
         d. Violation of Kohler’s line
         e. Possible pelvic discontinuity present
f. Type of Augment Secondary Support
   i. Intra cavitary
   ii. Extra cavitary
g. Type of Augment Primary Support
   i. Intra cavitary
   ii. Anterior or posterior column or both
   iii. Intra cavitary footing severe anterior support medial defect
   iv. Primary supportive extra cavitary

Summary for use of porous metal AUGMENTS for reconstruction
a. Augments are NOT only bone void fillers
b. What is the purpose of the augment
   i. Primary stability
   ii. Supplemental fixation
c. ALL augments MUST BE unitized to the cup with cement
Femoral Revision: What is the Best Stem to Use?
Matthew S. Austin, MD

What is the best stem to use in femoral revision arthroplasty? The answer to this question depends primarily upon the degree of femoral bone loss encountered after removal of the prior component. Proper preoperative planning is an essential component to success in revision femoral arthroplasty. A dependable classification method to define bone loss can aid in surgical decision making. The Paprosky classification also helps to determine treatment:

Type I: Minimal loss of metaphyseal cancellous bone and an intact diaphysis

Revisions with type I bone loss can be treated like a primary total hip arthroplasty with either cemented or uncemented fixation.

Type II: Extensive loss of metaphyseal cancellous bone and an intact diaphysis

Revisions with type II bone loss in the femur require extensively porous coated diaphyseal fitting implants as much of the cancellous bone in the metaphysis in lost or unreliable.

Type II A: Metaphysis is severely damaged and nonsupportive and there is >4cm of intact diaphyseal bone available for distal fixation

Revisions with type II A bone loss have extensive metaphyseal deficiency and require an extensively coated stem that must obtain greater than 4cm of scratch fit to ensure proper fixation.

Type II B: Metaphysis is severely damaged and nonsupportive and there is <4cm of intact diaphyseal bone available for distal fixation

Revisions with type II B bone loss are challenging due to the diaphyseal compromise. Current recommendations for this type of scenario include cementless, tapered stem with flutes to aid in rotational stability.

Type IV: Extensive metaphyseal and diaphyseal damage in conjunction with a nonsupportive isthmus and widened femoral canal

Revisions with type IV bone loss are a significant challenge during revision hip arthroplasty. The widened femoral canal makes the use of traditional cementless stems difficult. Alternative techniques such as impaction grafting, allograft-prosthetic composites and mega-prostheses are part of the armamentarium when dealing with type IV bone loss.

Utilizing the Paprosky classification system and following the basic principles of revision surgery (gentle and adequate surgical exposure, use of extensile exposures when necessary, careful removal of the prior component, and anatomic reconstruction of the femur) can lead to reproducible and successful reconstruction of the femur in total hip revision surgery.
Management of Periprosthetic Femur Fractures
George J. Haidukewych, MD

Proximal fractures of the greater trochanter (Vancouver A) are typically result from osteolysis. Bearing exchange and grafting of the trochanteric defect is recommended. If fixation is needed typically suture fixation is preferred. Fractures around a well fixed stem (Vancouver B1) are typically treated with ORIF. Balancing the fixation and optimizing proximal fixation with a combination of locked screws and cerclage is recommended. Fractures around loose stems (Vancouver B2-3) are treated with revision. Modular, fluted, tapered titanium stems are very effective for this indication. The technique involves obtaining solid distal fixation, assembling the appropriate proximal body to restore hip stability and leg length, then obtaining proximal fragment fixation with an economy of cerclage. Maintaining vascularity with minimal soft tissue dissection from the proximal bony fragments is recommended. Distal fractures (Vancouver C) are treated with long laterally based locking plates. Obtaining good bypass of the hip stem is preferred. Careful attention to technical details and soft tissue viability will minimize complications.
Abductor deficiency after THA can result from proximal femoral bone loss, trochanteric avulsion, muscle destruction associated with infection, pseudotumor, adverse local tissue reaction (ALTR) to metal debris, abductor paralysis from surgical trauma, or other causes (1,2). Constrained acetabular components are generally indicated to control instability after THA with deficient abductors. However, the added implant constraint also results in greater stresses at the modular liner-locking mechanism of the constrained component and bone-implant fixation interface, which can contribute to mechanical failure of the constrained implant or mechanical loosening (3).

Use of large heads has been effective in reducing the rate of dislocation after primary THA. However, relatively large (36mm heads) were not found to be effective in controlling dislocation in patients with abductor deficiency (4). Dual mobility implants which can provide considerably larger head diameters than 36mm may offer an advantage in improving stability in patients with abductor deficiency (5). However the utility of these devices in controlling instability after THA with deficient abductors has not been established.

Direct repair of abductor avulsion may restore some abductor function, but results are variable (6,7). Augmentation using achilles tendon allograft has also been described (8). However allograft tendon can attenuate over time in vivo (9). Whiteside utilized a transfer of the anterior gluteus maximus and subsequently described combined transfer of the tensor muscle and anterior gluteus maximus to the greater trochanter for treatment of absent abductors after THA (10,11). The transposed tensor muscle also provides muscle coverage over the greater trochanter, which may be beneficial in controlling lateral hip pain. Whiteside reported satisfactory results in five patients treated with the combined muscle transfer. Preoperatively all patients had severe or moderate pain, severe abductor limp, and a positive Trendelenburg sign. At three months after surgery, all patients could actively abduct and at 1 year postoperatively, three patients had no hip pain, two had mild pain that did not limit their activity, three had no limp, and one had mild limp.

Treatment of patients with hip instability and abductor deficiency has generally required use of a constrained acetabular component. Transfer of the tensor muscle and anterior gluteus maximus to the greater trochanter can improve abductor strength and also reduce lateral hip pain. The combination of a large head and tensor muscle transposition may be a viable alternative to use of a fully constrained component in patients with deficient abductors after THA. However the need for implant constraint should also be individualized and based on factors such as the viability of the transposed muscle, patient compliance with post-operative activity restrictions, femoral head/neck ratio, and cup position.
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Making the Diagnosis: What is the Gold Standard?
Stephen J. Incavo, MD

The diagnoses of infection complicating total hip replacement (THR) can be straightforward in many, if not most, cases. However, some cases may be difficult to diagnose, and misdiagnosis can lead to unnecessary surgical procedures, increased pain and morbidity, or bone and soft tissue destruction. The diagnosis of an infected THR can be compromised if antibiotics have been administered, if the infection is caused by a less virulent or a hard to culture organism, or in the case of a culture-negative infection which may be seen in 10-20% of infection cases.

Accurate and timely diagnosis of infection is important for multiple reasons: Avoiding inappropriate or casual antibiotic use, preventing revision of unsuspected infected components, and differentiating infection from trunionosis or metallosis. In addition to the diagnosis of infection, identification of the organism(s) is very important for several reasons. The safest, easiest, and least expensive antibiotic can then be used for the infecting organism. Consideration of one-stage revision may be best suited for certain organisms. Some organisms are considered easier to eradicate and carry a better prognosis.

Goals of the orthopaedic surgeon include properly diagnosing periprosthetic joint infection (PJI) and ruling out infection before further implant surgery is performed. Patient history and physical exam, serum ESR and CRP, and joint aspiration for cell count and culture remaining the mainstay of diagnosis. Because there is no gold standard for the diagnosis of PJI diagnostic criteria have been adopted.

| Major Criteria (one) | • Two positive periprosthetic cultures  
|                      | • A sinus tract communicating with the joint. |
| Minor Criteria (3 of 5 necessary) | • Elevated serum CRP and ESR.  
|                                      | • Elevated synovial fluid WBC count or changes in the leukocyte esterase strip.  
|                                      | • Elevated synovial fluid PMN percentage.  
|                                      | • Positive histological analysis of periprosthetic tissue.  
<p>|                                      | • Single positive culture.  |</p>
<table>
<thead>
<tr>
<th>Criterion</th>
<th>Chronic PJI (&gt;90 DAYS)</th>
</tr>
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<tbody>
<tr>
<td>Erythrocyte Sedimentation Rate</td>
<td>&gt;30</td>
</tr>
<tr>
<td>(mm/hr)</td>
<td></td>
</tr>
<tr>
<td>C-reactive protein (mg/L)</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Synovial Fluid WBC count (cell/µl)</td>
<td>≥3,000</td>
</tr>
<tr>
<td>Synovial Fluid PMN (%)</td>
<td>≥80</td>
</tr>
<tr>
<td>Leukocyte Esterase</td>
<td>+ OR ++</td>
</tr>
<tr>
<td>Histological Analysis of Tissue</td>
<td>Greater than 5 neutrophils/ HPF</td>
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Serum and synovial fluid markers are the focus of recent attention. Alpha-defensin testing is commercially available and is rapidly gaining acceptance. It has been reported to be unaffected by antibiotic use. A partial list of other markers include IL-6, IL-2, TNF, ELA-2, and NGAL. These markers have been reported to have sensitivity and specificity in the 90% - 100% range for the presence of infection but have no ability to identify organisms. These may prove most useful in the diagnosis of difficult to diagnose infections or in the timing of re-implant surgery. These synovial fluid markers require ELISA testing. D-Dimer, a product of fibrin breakdown that accompanies inflammation, has recently been identified as a promising, readily available serum marker.

New techniques are emerging that may significantly impact the diagnosis of PJI, especially in culture negative cases. Next Generation Sequencing involves sequencing pathogen DNA in a given sample. Metagenomic Shotgun Sequencing is a process based on extraction of microbe DNA, gene amplification and sequencing. Both of these techniques may identify polymicrobial infections that were not apparent using conventional culture.

To date, the “best” test for PJI diagnosis and treatment has not been established. Serum and synovial fluid markers and microbial DNA analysis have the potential to enhance our understanding and treatment of PJI.
One-Stage vs. Two-Stage vs. Partial Resection
Craig J. Della Valle, MD

A “two-stage exchange” remains the gold standard for treatment of the infected THA in North America. Although there is interest in “one-stage exchange” this technique is not as familiar to many US surgeons and it is unclear if the reported results of Europe can be translated to North American practice. Specific concerns include the “radicalness” of the debridement required and the use of cemented revision components, which are not used commonly in North America. Thus while the idea of a one stage exchange is attractive to many North American surgeons, careful study will be required to determine if success can be achieved with a more “conservative” debridement and the use of cementless revision components which are preferred by some surgeons. Generally agreed upon indications for a one-stage exchange include a culture positive infection with a sensitive organism, a good soft tissue envelope and simple bony defects.

The basic principles of a two-stage exchange include:
- Thorough debridement of all infected appearing foreign material and all cement
- Placement of an interval antibiotic loaded spacer (note that the addition of antibiotics to bone cement is NOT FDA approved)
  - 4-6g of antibiotics per pkg of cement; typically vancomycin + tobramycin
  - Higher viscosity cement may be associated with higher elution
  - The combination of antibiotics also leads to higher elution

Antibiotic spacers can be “articulating” or “static”. Potential advantages of an articulating spacer include greater patient comfort and an easier approach at the second stage exchange as soft tissue tension and range of motion is maintained. However, these spacers are oftentimes more costly and can break or dislocate.

The first stage is followed by approximately 6 weeks of organism specific IV antibiotics. An interdisciplinary approach with an infectious disease specialist, internal medicine and a nutritionist optimizes outcomes. Our protocol then includes weekly ESR and CRP to monitor their trend. These labs are re-checked two weeks after cessation of antibiotics to ensure the trend has not changed. We have found that while the ESR and CRP are significantly lower than prior to removal of the infected implant, they often times DO NOT normalize and there is no specific cut-off value that predicts persistent infection.

Partial resection has been reported from some specialized centers as a solution for patients where removal of their present femoral or acetabular implant would lead to a situation that as NOT RECONSTRUCTABLE. This technique should be used VERY SPARINGLY.

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When Do I Replant and What Do I Need to Worry About?

Bassam A. Masri, MD, FRCSC

The timing of reimplantation during two-stage exchange arthroplasty for an infected hip replacement remains difficult to predict. There are no standardized or well-agreed upon algorithms for when to reimplant. The purpose of the two-stage exchange arthroplasty is to allow infection eradication in the first stage, where implants removed so that when the implants are re-inserted at the second stage, the surgical field is ideally perfectly sterile, so that the risk of recurrent infection is minimized.

The surgeon, therefore, must balance the patient’s needs for a permanent implant to minimize the morbidity of the procedure, with the risk of recurrent infection. It is widely accepted that parenteral antibiotics are required between stages. Most but not all experts, also, recommend an antibiotic holiday during which patients are monitored off antibiotics to ensure that the hip is not re-infected, and to ensure safety of the reimplantation. During the interval between stages, patients are monitored with serological markers, most often ESR and CRP. Also, prior to reimplantation, it is possible to aspirate the joint for cell count and differential and to culture the fluid to see if bacteria can be grown. More sophisticated tests such as measurement of α-defensin-1 levels may be done on the aspirated synovial fluid. Also it is possible to obtain a frozen section of the synovial tissue to look for the number of PMN’s per high power field, as an indicator of infection.

Shukla et al reported on 87 hips revised for periprosthetic joint infection [1]. They reported 7 hips with persistent infection. The area under the cure (AUC) for receiver operator characteristics (ROC) curves of the markers studied in their study ranged between 0.55 and 0.91. With lowest AUC value attributed to the CRP and highest attributed to aspirated joint fluid WBC counts.

Janz et al studied 69 patients after resection hip arthroplasty prior to reimplantation [2]. They concluded that aspiration WBC counts and CRP had a PPV of 75% and 36%, respectively and NPV of 70% and 90%, respectively. They did not report the AUC of the ROC curves. These values do not provide any diagnostic value.

Bori et al studied 21 patients prior to reimplantation [3]. They studied WBC per HPF microscopy during reimplantation. They concluded that using WBC above 5 per HPF yielded positive and negative predictive values of 100% and 73.6%, respectively. However, their sample size was small. They did not report the AUC of the ROC curves of WBC count and they did not use any statistical means to choose optimal cut-off values.

Some authors considered the use of sonication of antibiotic spacers in order to identify residual infection prior to reimplantation [4,5]. However, sonication of the antibiotic spacers can only be used for cultures during reimplantation and not pre-stage 2 for the diagnosis of residual infection.

Another option gaining popularity is the use of Alpha Defensin-1 to diagnose residual infection [4]. It has been shown that it is a good diagnostic tool for a wide range of bacteria and even in patients already treated with antibiotics [6,7]. The Alpha Defensin -1 has shown promising results with close to 100% sensitivity and specificity for identifying periprosthetic joint infection [8] outperforming all available markers for the diagnosis of periprosthetic joint infection. However, only one study included 6 patients (out of 61) that had Alpha Defensin-1 tested before reimplantation [9]. In that study the authors did not analyze these patients separately.
Based on the available evidence to date, the mainstay of judging when to reimplant remains carefully clinical monitoring of the patient to make sure that the wound is well-healed and that the patients' symptoms are not suggestive of ongoing infection. Serial monitoring of the ESR and the CRP to ensure that they continue to decline and do not suddenly spike is important. There is no validated cut-point for the ESR and CRP above which reimplantation should be delayed. In many patients who do not become reinfected the ESR and the CRP do not necessarily return to normal levels, but plateau at significantly lower levels than they were preoperatively.

In an effort to identify if we can refine the diagnostic criteria that are predictive of a successful reimplantation, prior to reimplantation, we reviewed 182 patients with infected hip and knee replacement who underwent two-stage exchange arthroplasty. Of these 107 (58.8%) were male and 75 (41.2%) were female. Mean age was 66.6 (SD=11.1, range=31-90). Mean body mass index of the patients was 30.25 (SD=6.99, range=18.3-46.6). The study population included 73 (40.1%) knee and 109 (59.9%) hip replacements revised for infection.

There were 144 (79.2%) patients in which two stage revision due to infection resulted in infection free arthroplasty. In 38 (20.8%) patients persistent infection was diagnosed after the second stage operation. (see Table 1) Of these patients 8 (21.1%) patients had additional irrigation and debridement, 10 (26.3%) patients were on antibiotic suppression, 4 (10.5%) had an amputation, 11 (28.9%) had a new two stage revision, 3 (7.9%) had a resection arthroplasty, 1 (2.6%) had an arthrodesis and one (2.6%) patient had multiple plastic surgery procedures for wound closure.

Markers prior to reimplantation included CRP, WBC and Neut% in aspiration. During reimplantation, histologic count of WBC per HPF microscopy (×400) in the final (not frozen) sections was also included. There was no statistically significant difference in markers’ value in the infected and non-infected patients between arthroplasty sites (hip or knee). Of all the markers examined only the CRP had a statistically significant higher values for residual infection prior to reimplantation (p value=0.002). However, for the CRP, the AUC of the ROC curve was 0.677 indicating that this marker has poor accuracy in diagnosing residual infection prior to reimplantation (see Table 2).

Cultures during the second stage were also highly unreliable. Out of 37 patients who were infected after the second stage and had intraoperative culture results, 26 (70.2%) patients had negative cultures. Only 11 patients (29.8%) out of the aforementioned 37 had positive intraoperative cultures at the time of reimplantation (see Table 2). While negative cultures predicted lack of infection with a p-value of 0.001, the AUC was 0.634 indicating poor performance. This is highlighted by the fact that 70.2% of ultimate failures had negative cultures at the time of the second stage procedure.

Using optimal cutoff values as determined by the Youden’s index, the positive predictive values for residual infection ranged between 26.3% and 57.1%, and negative predictive values ranged between 78.3% and 85.2% (see Table 3).

Combining the results of the infection markers yielded positive predictive values between 50% and 80% and negative predictive values between 77% and 90%. The best combination of markers was CRP above 15mg/L and Neut% above 80% in aspiration. This combination yielded positive predictive value of 80% and negative predictive value of 85.4% (see Table 4).

Examinations of monthly CRP values at one to four months after the first stage had AUC of ROC curves of 0.581, 0.647, 0.591 and 0.603, respectively (Figure 1). Although CRP at four months after the first stage was higher in patients with residual infection, its diagnostic value is limited due to the fact that about half of the infected cases had CRP values below the cut-off of 15mg/Liter.

In summary, we are no further ahead at having an ideal test for predicting whether the reimplantation will be
successful. It remains to be seen whether tests such as Alph-Defensin-1 will allow us to better prognosticate and to determine when it is appropriate to reimplant. In the meantime, we generally give 6 weeks of IV antibiotics, and wait another 6 weeks off antibiotics while monitoring the ESR and CPR weekly, in collaboration with the infectious disease consultant. Once the ESR and CRP have dropped to near normal levels, and once the surgeon and the infectious disease consultant agree that the clinical features do not suggest ongoing infection, the hip is reimplanted.

Table 1: Demographic and clinical data

<table>
<thead>
<tr>
<th></th>
<th>Total N=182</th>
<th>No residual infection (N=144, 79.2%)</th>
<th>Residual infection (N=38, 20.8%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>107 (58.8%)</td>
<td>84 (78.5%)</td>
<td>23 (21.5%)</td>
<td>0.807</td>
</tr>
<tr>
<td>Female</td>
<td>75 (41.2%)</td>
<td>60 (80.0%)</td>
<td>15 (20.0%)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>66.6 (±11.1)</td>
<td>67.5 (±10.5)</td>
<td>63.4 (±12.8)</td>
<td>0.106</td>
</tr>
<tr>
<td>Site</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee</td>
<td>73 (40.1%)</td>
<td>52 (71.2%)</td>
<td>21 (28.8%)</td>
<td>0.032</td>
</tr>
<tr>
<td>Hip</td>
<td>109 (59.9%)</td>
<td>92 (84.4%)</td>
<td>17 (15.6%)</td>
<td></td>
</tr>
<tr>
<td>Side</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>90 (49.5%)</td>
<td>69 (76.6%)</td>
<td>21 (23.4%)</td>
<td>0.533</td>
</tr>
<tr>
<td>Right</td>
<td>92 (50.5%)</td>
<td>75 (81.5%)</td>
<td>17 (18.5%)</td>
<td></td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>30.25 (±6.99)</td>
<td>29.62 (±6.09)</td>
<td>32.91 (±9.66)</td>
<td>0.154</td>
</tr>
<tr>
<td>ASA score</td>
<td>2.45 (±0.58)</td>
<td>2.39 (±0.56)</td>
<td>2.66 (±0.58)</td>
<td>0.018</td>
</tr>
</tbody>
</table>

ASA = American society of Anesthesiologists
Table 2: Values of diagnostic parameters

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>No residual infection</th>
<th>Residual infection</th>
<th>AUC of ROC</th>
<th>P val</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CRP prior to reimplantation (mg/L)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>14.07 (±32.0)</td>
<td>10.51 (±22.15)</td>
<td>27.79 (±53.95)</td>
<td>0.677</td>
<td>0.002</td>
</tr>
<tr>
<td><strong>WBC in aspiration (cells/L)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3572.00 (±14,381.5)</td>
<td>2950.5 (±13,768.2)</td>
<td>5303.1 (±16,395.6)</td>
<td>0.506</td>
<td>0.944</td>
</tr>
<tr>
<td><strong>Neutrophils % in aspiration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>48.33% (±31.46%)</td>
<td>45.76% (±31.23%)</td>
<td>56.91% (±32.04%)</td>
<td>0.623</td>
<td>0.200</td>
</tr>
<tr>
<td>Neutrophils in histology HPF at reimplantation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-10</td>
<td>136 (87.7%)</td>
<td>110 (80.9%)</td>
<td>26 (19.1%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11-30</td>
<td>7 (4.5%)</td>
<td>5 (71.4%)</td>
<td>2 (28.6%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;30</td>
<td>11 (7.1%)</td>
<td>8 (72.7% %)</td>
<td>3 (27.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 (0.6%)</td>
<td>1 (100%)</td>
<td>0 (0%)</td>
<td>0.524</td>
<td>0.801</td>
</tr>
<tr>
<td><strong>Cultures at reimplantation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>160 (91.4%)</td>
<td>134 (83.8%)</td>
<td>26 (16.3%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>15 (8.6%)</td>
<td>4 (26.7%)</td>
<td>11 (73.3%)</td>
<td>0.634</td>
<td>0.001</td>
</tr>
</tbody>
</table>

HPF = High power field; AUC= Area under the curve for the Receiver Operator Characteristic (ROC) curve.
Table 3: Diagnostic properties of infection markers

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>LR+</th>
<th>LR-</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP (mg/L) &gt; 15</td>
<td>43.8%</td>
<td>84.6%</td>
<td>42.4%</td>
<td>85.2%</td>
<td>2.83</td>
<td>0.67</td>
</tr>
<tr>
<td>Asp WBC (cells/Liter) &gt; 1100</td>
<td>28.6%</td>
<td>92.3%</td>
<td>57.1%</td>
<td>78.3%</td>
<td>3.71</td>
<td>0.77</td>
</tr>
<tr>
<td>Asp Neut% &gt; 80%</td>
<td>41.7%</td>
<td>85.0%</td>
<td>45.5%</td>
<td>82.9%</td>
<td>2.78</td>
<td>0.69</td>
</tr>
<tr>
<td>WBC per HPF ≥ 5 cells</td>
<td>16.1%</td>
<td>88.7%</td>
<td>26.3%</td>
<td>80.9%</td>
<td>1.43</td>
<td>0.95</td>
</tr>
</tbody>
</table>

CRP = C reactive protein, Asp = Aspiration, WBC = White blood cells, Neut% = Neutrophil percent, HPF = high power field, PPV = positive predictive value, NPV = Negative predictive value, LR+ = positive likelihood ratio, LR- = negative likelihood ratio.

Table 4: Combining infection markers.

<table>
<thead>
<tr>
<th></th>
<th>Sen</th>
<th>Spec</th>
<th>PPV</th>
<th>NPV</th>
<th>LR+</th>
<th>LR-</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRP (mg/L) &gt; 15 and Asp WBC (cells/Liter) &gt; 1100</td>
<td>16.7%</td>
<td>97.1%</td>
<td>66.7%</td>
<td>77.3%</td>
<td>5.83</td>
<td>0.86</td>
</tr>
<tr>
<td>CRP (mg/L) &gt; 15 or Asp WBC (cells/Liter) &gt; 1100</td>
<td>66.7%</td>
<td>82.9%</td>
<td>57.1%</td>
<td>87.9%</td>
<td>3.89</td>
<td>0.40</td>
</tr>
<tr>
<td>CRP (mg/L) &gt; 15 and Asp Neut% &gt; 80%</td>
<td>40.0%</td>
<td>97.2%</td>
<td>80.0%</td>
<td>85.4%</td>
<td>14.40</td>
<td>0.62</td>
</tr>
<tr>
<td>CRP (mg/L) &gt; 15 or Asp Neut% &gt; 80%</td>
<td>70.0%</td>
<td>77.8%</td>
<td>46.7%</td>
<td>90.3%</td>
<td>3.15</td>
<td>0.39</td>
</tr>
<tr>
<td>Asp WBC (cells/Liter) &gt; 1100 and Asp Neut% &gt; 80%</td>
<td>33.3%</td>
<td>92.3%</td>
<td>50.0%</td>
<td>85.7%</td>
<td>4.33</td>
<td>0.72</td>
</tr>
<tr>
<td>Asp WBC (cells/Liter) &gt; 1100 or Asp Neut% &gt; 80%</td>
<td>50.0%</td>
<td>84.6%</td>
<td>50.0%</td>
<td>84.6%</td>
<td>3.25</td>
<td>0.59</td>
</tr>
<tr>
<td>CRP &gt; 15 and Asp WBC &gt; 1100 and Asp Neut% &gt; 80%</td>
<td>20.0%</td>
<td>97.1%</td>
<td>66.7%</td>
<td>81.0%</td>
<td>7.00</td>
<td>0.82</td>
</tr>
</tbody>
</table>

Sen= Sensitivity; Spec=Specificity; CRP=C reactive protein, Asp = Aspiration, WBC=White blood cells, Neut%= Neutrophil percent, HPF = high power field, PPV=positive predictive value, NPV= Negative predictive value, LR+ = positive likelihood ratio, LR- = negative likelihood ratio.
REFERENCES

Postoperative Antibiotics: How Long Are They Needed?

Michael A. Mont, MD

The treatment of infected total hip arthroplasty involves much morbidity including surgical and medical techniques with the use of prolonged intravenous antibiotic administration. The surgical treatment may involve a débridement with polyethylene replacement and implant retention, a one stage, or most commonly a 2-stage re-implantation procedure. Intravenous antibiotics are usually started in the hospital setting and are continued on the out-patient basis. Although treatment is shifting towards out-patient management, some insurance plans disallow out-patient administration of antibiotics and patients are required to stay at the hospital for a prolonged duration of time [1]. The adverse effects of intravenous antibiotics combined with the increased hospital costs incentivize providers to administer these medications for a minimal duration of time which is required to achieve the clearance of infection [1]. However, there is no clear consensus on how long this therapy is needed. Furthermore, some orthopaedists prescribe prophylactic oral antibiotics to be taken for a specific duration of time or indefinitely. Due to the differences in duration and route of antibiotic administration, we have conducted a literature review of this topic in: 1) débridement with polyethylene exchange and implant retention; 2) one-stage; and 3) two-stage re-implantation procedures. We have identified 28 reports on implant retention (See Table 1), 3 reports on one-stage (See Table 2), and 4 reports on two-stage re-implantation (See Table 3). The highest success rate of infection eradication was in two-stage (approximately 93%), followed by one-stage re-implantation (approximately 90%), and implant retention (approximately 75%). A total of 12 of the 28 studies on implant retention administered antibiotics for less than 12 weeks and had a mean success rate of 74%. The remaining studies (n=16) administered antibiotics for at least 12 weeks and had a mean success rate of 82%. The mean success rate in one-stage re-implantation cohort was approximately 90% and there was no association between duration of the antibiotic treatment (range, 2 weeks to 6 months) and infection eradication. The mean success rate of two-stage re-implantation was 93% and there was no difference between antibiotic administration duration (range, 0 to 6 weeks) and infection eradication. Two-stage re-implantation appears to provide the highest success of infection eradication, followed by only slightly lower success rates of one-stage re-implantation. Débridement with polyethylene replacement and implant retention has lower success rate. Two weeks may be a sufficient duration of antibiotic therapy for one-stage and two-stage procedures. Débridement with polyethylene replacement and implant retention may be considered for some patients, however, a longer antibiotic regimen of at least 12 weeks may be needed. Although some studies have used as little as 2 weeks of postoperative antibiotics, the majority do 6 weeks or longer and this duration needs further study.
Table 1. Débridement with polyethylene exchange and implant retention.

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>N</th>
<th>Duration of Antibiotic (months)</th>
<th>Follow-up (months)</th>
<th>Success Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Veltman et al. [2]</td>
<td>2015</td>
<td>8</td>
<td>12 weeks</td>
<td>36</td>
<td>88</td>
</tr>
<tr>
<td>Moojen et al. [3]</td>
<td>2015</td>
<td>35</td>
<td>12 weeks</td>
<td>N/A</td>
<td>71</td>
</tr>
<tr>
<td>Betz et al. [4]</td>
<td>2015</td>
<td>38</td>
<td>12 weeks</td>
<td>42</td>
<td>82</td>
</tr>
<tr>
<td>Moojen et al. [5]</td>
<td>2014</td>
<td>33</td>
<td>12 weeks</td>
<td>48</td>
<td>88</td>
</tr>
<tr>
<td>Konigsberg et al. [6]</td>
<td>2014</td>
<td>20</td>
<td>42 weeks</td>
<td>56</td>
<td>80</td>
</tr>
<tr>
<td>Aboltins et al. [7]</td>
<td>2013</td>
<td>19</td>
<td>52 weeks</td>
<td>24</td>
<td>89</td>
</tr>
<tr>
<td>Geurts et al. [8]</td>
<td>2013</td>
<td>69</td>
<td>13 weeks</td>
<td>27</td>
<td>83</td>
</tr>
<tr>
<td>Kuiper et al. [9]</td>
<td>2013</td>
<td>34</td>
<td>18 weeks</td>
<td>35</td>
<td>74</td>
</tr>
<tr>
<td>Westberg et al. [10]</td>
<td>2012</td>
<td>38</td>
<td>7 weeks</td>
<td>48</td>
<td>71</td>
</tr>
<tr>
<td>Perez-Cardona et al. [11]</td>
<td>2012</td>
<td>5</td>
<td>11 weeks</td>
<td>15</td>
<td>100</td>
</tr>
<tr>
<td>Choi et al. [12]</td>
<td>2012</td>
<td>28</td>
<td>6 weeks</td>
<td>N/A</td>
<td>68</td>
</tr>
<tr>
<td>Sukeik et al. [13]</td>
<td>2012</td>
<td>26</td>
<td>6 weeks</td>
<td>79</td>
<td>77</td>
</tr>
<tr>
<td>Buller et al. [14]</td>
<td>2012</td>
<td>62</td>
<td>6 weeks</td>
<td>34</td>
<td>56</td>
</tr>
<tr>
<td>Puhto et al. [16]</td>
<td>2011</td>
<td>32 THA</td>
<td>4 weeks of IV followed by 4 weeks of PO</td>
<td>26</td>
<td>90</td>
</tr>
<tr>
<td>Cobo et al. [17]</td>
<td>2011</td>
<td>57</td>
<td>12 weeks</td>
<td>26</td>
<td>53</td>
</tr>
<tr>
<td>Aboltins et al. [18]</td>
<td>2011</td>
<td>15</td>
<td>75 weeks</td>
<td>28</td>
<td>87</td>
</tr>
<tr>
<td>Vilchez et al. [19]</td>
<td>2011</td>
<td>53 (18 THA)</td>
<td>IV 11 days, oral 88 days</td>
<td>24</td>
<td>76</td>
</tr>
<tr>
<td>Bernard et al. [20]</td>
<td>2010</td>
<td>144 (62 THA)</td>
<td>1.5 or 3 months</td>
<td>36 (median)</td>
<td>80</td>
</tr>
<tr>
<td>Martinez-Pastor et al. [21]</td>
<td>2009</td>
<td>47 (15 THA)</td>
<td>Median 2.6 months</td>
<td>15.4</td>
<td>75</td>
</tr>
<tr>
<td>Tintle et al. [22]</td>
<td>2009</td>
<td>3</td>
<td>6 weeks</td>
<td>39</td>
<td>100</td>
</tr>
<tr>
<td>Byron et al. [23]</td>
<td>2009</td>
<td>52</td>
<td>52 weeks</td>
<td>28</td>
<td>87</td>
</tr>
<tr>
<td>Aboltins et al. [24]</td>
<td>2007</td>
<td>13</td>
<td>72 weeks</td>
<td>44</td>
<td>92</td>
</tr>
<tr>
<td>Soriano et al. [25]</td>
<td>2006</td>
<td>39 (10 THA)</td>
<td>2.7 months</td>
<td>24</td>
<td>77</td>
</tr>
<tr>
<td>Berdal et al. [26]</td>
<td>2005</td>
<td>29 (12 THA)</td>
<td>3 months</td>
<td>22.5</td>
<td>83</td>
</tr>
<tr>
<td>Giuliani et al. [27]</td>
<td>2004</td>
<td>11</td>
<td>100 weeks</td>
<td>28</td>
<td>64</td>
</tr>
<tr>
<td>Krasin et al. [28]</td>
<td>2001</td>
<td>7</td>
<td>6 weeks</td>
<td>30</td>
<td>29</td>
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<tr>
<td>Tsukayama et al. [29]</td>
<td>1996</td>
<td>41</td>
<td>6 weeks</td>
<td>46</td>
<td>68</td>
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</table>
Table 2. One-stage re-implantation.

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>N</th>
<th>Duration of Antibiotic (months)</th>
<th>Follow-up (months)</th>
<th>Success Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yoo et al. [30]</td>
<td>2009</td>
<td>12</td>
<td>8 weeks</td>
<td>3.6 years</td>
<td>83</td>
</tr>
<tr>
<td>Winkler et al. [31]</td>
<td>2008</td>
<td>37</td>
<td>2 weeks</td>
<td>4 years</td>
<td>92</td>
</tr>
<tr>
<td>Rudelli et al. [32]</td>
<td>2008</td>
<td>32</td>
<td>6 months</td>
<td>103</td>
<td>94</td>
</tr>
</tbody>
</table>

Table 3. Two-stage re-implantation.

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>N</th>
<th>Duration of Antibiotic (months)</th>
<th>Follow-up (months)</th>
<th>Success Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whittaker</td>
<td>2009</td>
<td>44</td>
<td>2 weeks</td>
<td>49</td>
<td>93</td>
</tr>
<tr>
<td>Stockley et al. [33]</td>
<td>2008</td>
<td>114</td>
<td>0</td>
<td>74</td>
<td>88</td>
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<tr>
<td>McKenna et al. [34]</td>
<td>2009</td>
<td>30</td>
<td>5 days IV, ? PO</td>
<td>35</td>
<td>100</td>
</tr>
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<td>Hsieh et al. [35]</td>
<td>2005</td>
<td>99</td>
<td>1 week IV vs. 4 weeks IV + 2 weeks PO</td>
<td>43</td>
<td>89% 1 week IV; 91% other cohort p=0.67</td>
</tr>
</tbody>
</table>
References


Traditionally, the vast majority of hip and knee joint replacement procedures have been performed in an inpatient hospital setting and required a hospital stay of 3 days or longer. Improved anesthesia and surgical techniques, advances in postoperative care management, and growing patient demand for elective outpatient procedures are combining with healthcare economic factors to drive these operations to hospital outpatient departments, orthopaedic surgical specialty facilities and ambulatory surgery centers (ASC) at an accelerated rate. Over the next 10 years, it has been forecast that inpatient joint replacement volumes will remain relatively flat while outpatient primary joint replacement volumes will experience triple-digit growth.

Surgeons, payers, hospitals and independent facilities are fostering an increasingly favorable environment for total joint replacement (TJR) in the outpatient setting. As the transition to the outpatient setting begins to take hold, facilities must shift their strategic focus to maintain market share and margin. Orthopedic service line leaders can prepare their programs with an assessment of expected demand, competitive pressure and the payer landscape to assess market feasibility. Collaboration among providers, point of service facilities, insurers, and patients will facilitate more outpatient arthroplasty in the years ahead.

CMS believes (1) that most outpatient departments are equipped to perform TKA for Medicare beneficiaries; (2) most outpatient departments may perform TKA; and (3) the procedure is already being performed in numerous hospitals on an outpatient basis. CMS is looking for data to support the belief as to whether these criteria have been satisfied. CMS has allowed that TKA (CPT code 27447 will be assigned to C-APC 5115 (Level 5 Musculoskeletal Procedures) with status indicator “J1”. CMS expects providers will “carefully develop evidence-based patient selection criteria to identify patients who are appropriate candidates for an outpatient TKA procedure as well as exclusionary criteria that would disqualify a patient from receiving an outpatient TKA procedure.” Further, while CMS is not adding TKA to the ASC covered surgical procedures list for CY 2018, it appears that CMS is moving toward to allowing TKA at outpatient and ambulatory surgery centers.

While CMS believes that some less medically complex TKA cases could be appropriately and safely performed on an outpatient basis, CMS does not expect to create or endorse specific guidelines or content for the establishment of providers’ patient selection protocols. CMS acknowledges the importance of deferring to patients and providers to decide the appropriate site of service for a particular patient. It is anticipated that total hip arthroplasty will be removed from the in-patient only list in the future.
Identifying the Optimal Patient
Michael E. Berend, MD

Perhaps the most significant developments in joint replacement surgery in the past decade have been in the area of multimodal pain management. This has reduced length of stay in the inpatient hospital environment opening the opportunity for cost savings and paved the way for outpatient joint replacement surgery in appropriately selected patients either in free standing ASC’s or hospital environments. The synergy and implementation of the knowledge gained over the past two decades of arthroplasty care make outpatient joint replacement possible and effective.1,2

Refinement of surgical techniques, anesthesia protocols, and patient selection has facilitated a transformation to same day discharge for arthroplasty care in our practice.13-15 This initially began in September of 2011 with selected Partial Knee Replacement (PKR) cases. The surgical procedures included in the outpatient program have expanded to include primary TKA (Total Knee Arthroplasty), primary THA (Total Hip Arthroplasty), and selected revision cases.

The trend for early discharge has already happened for procedures formerly regarded as "inpatient" procedures such as upper extremity surgery, arthroscopy, ACL reconstruction, foot and ankle procedures, and rotator cuff repair. These cases are now routinely performed in free standing ASC’s. ASC’s afford surgeon flexibility and ownership opportunities. They also allow a “white board” approach to new innovations in outpatient care such as joint replacement surgery of the hip, knee, and shoulder.

The outpatient program centers on the patient needs, family engagement, essentials of home recovery, preoperative education, efficient surgery, and a surgeon controlled environment with highly standardized care. This is a distinct shift in today’s healthcare environment, which has seen the expansion of regulatory demands; focus on Electronic Health Record (EHR), and discussions of potential future value creation.

The hallmark of this program is meticulous protocol execution and surgeon directed care pathways. Preemptive pain control with oral anti-inflammatory agents, gabapentin, regional anesthetic blocks that preserve quad function for TKA (adductor canal block) and pericapsular long acting local anesthetics with the addition of injectable ketorolac and IV acetaminophen are key adjuncts. Over the past two years utilizing this type of program the majority of our partial knee replacement patients are now returning home the day of surgery.13-15

Since 2011 we helped develop and implement an outpatient program as part of 76 participating physician-owned ambulatory facilities in 19 states. 19,415 joint replacements have been performed. The cohort included 6,146 TKA, 5,102 THA, 7,227 partial knee replacements, and 940 revisions and TSA. Patients had a mean age of 58 years and 50% of the patients were female. 97% of patients were discharged same day, the deep infection rate was 0.2%, and the readmission rate was 0.3%.

Interestingly we have had no readmissions for pain control since the programs inception. The majority of readmissions were for manipulation done as an outpatient with the remainder being known complications following inpatient or outpatient arthroplasty care and not unique to their outpatient care. The program centers on the patient, their family, home recovery, preoperative education, efficient surgery, and represents a shift in the paradigm of arthroplasty care. It can be highly beneficial to patients, surgeons, anesthesia, facility costs, and payors as arthroplasty procedures shift to the outpatient space. We believe this brings the best VALUE to the patients, surgeons, and the arthroplasty system.

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The outpatient program centers on the patient needs, family engagement, essentials of home recovery, preoperative education, efficient surgery, and a surgeon controlled environment with highly standardized care. This is a distinct shift in today’s healthcare environment, which has seen the expansion of regulatory demands; focus on Electronic Health Record (EHR), and distractions from real discussions of demonstrated value creation. The future is bright for both ASC and hospital development of successful outpatient joint replacement program for patients and surgeons alike.

Patient Satisfaction scores were outstanding with this program achieving 98% Great/Good for 2014-15. We believe this brings the best VALUE to the patients, surgeons, and the arthroplasty system and represents the future of arthroplasty care with future growth of both partial knee replacements and outpatient arthroplasty.

The future is bright for both ASC and hospital development of successful outpatient joint replacement program for patients and surgeons alike.
Management of Blood Loss
William G. Hamilton, MD

1. Introduction:
   a. Total joint arthroplasties have well known significant average blood loss
      i. Total Hip 4.0 gm/dl
      ii. Total Knee 3.8 gm/dl (1)
   b. Historical transfusion rates are as high as 70% (2)
   c. Despite years of work to optimize blood management, some published data suggests that transfusion rates (especially with allogeneic blood) are rising (3, 4)
   d. There is wide variability between surgeons as well, suggesting that varying protocols can influence transfusion rates
   e. Multiple studies now associate blood transfusions with negative outcomes
      i. Increased surgical site infection (5)
      ii. Increased costs
      iii. Increased length of stay

2. Preoperative
   a. Identify patients that are at increased risk of blood transfusion (6)
      i. Pre-op anemia (Hgb less than 13.0 gm/dl)
      ii. Female patients
         1. Especially smaller stature female patients with lower blood volume
      iii. Revision surgery
      iv. Bilateral surgery
      v. Elderly
   b. Check Hgb prior to surgery (finger monitor in clinic is non-invasive)
   c. For pre-operative anemia, consider tactics to raise hgb
      i. Iron supplement
      ii. Epogen
      iii. IV Iron infusion

3. Intraoperative
   a. Anesthesia
      i. Regional anesthesia- linked to reduced postoperative transfusions (7)
      ii. Hypotension (Mean arterial pressure <60 mm/hg) (8, 9)
   b. Lower operative time
      i. Efficient, organized, quality surgery, leave a dry field
   c. Bipolar sealer
      i. Initial enthusiasm for maintaining a dry surgical field, level 1 studies did not show benefit to using expensive device (10,11)

4. Tranexemic acid
   a. Antifibrinolytic agent
b. Reduces average blood loss by 300 cc

c. Multiple different administration protocols
   i. IV (12-18)
      1. Weight based dosing 10-20 mg/kg
      2. Standardized dosing for all patients
         a. Our current regimen: 1 gm IV pre-op, 1 gm IV in PACU
   ii. Topical (19-22)
      1. Usually 2-3 gm mixed in 50-100 cc of saline, spray in wound and allow to soak for 3-5 minutes
   iii. Oral (23, 24)
      1. 1950 mg PO 2 hrs prior to surgery

d. Clinical practice Guideline: AAHKS/AAOS/ASRA/Hip & Knee Society
   i. All individual formulations are effective at reducing blood loss- strong
   ii. No method of administration is clearly superior at reducing blood loss and the risk of transfusion
   iii. The dose of IV or topical TXA does not significantly affect the drug’s ability to reduce blood loss and risk of transfusion
   iv. Multiple doses of IV or oral TXA compared to a single dose does not significantly alter the risk of blood transfusion
   v. Pre-incision IV TXA administration potentially reduces blood loss and risk of transfusion compared to post-incision administration
   vi. Administration of all TXA formulations in patients without history of VTE does not increase the risk of VTE
   vii. Administration of all TXA formulations in patients with a history of VTE, MI, CVA, TIA, or vascular stent does not appear to increase the risk of VTE
   viii. Administration of all TXA formulations does not appear to increase the risk of arterial thrombotic events

5. Postoperative
   a. Change transfusion triggers
   b. Do not treat a “number”, safe algorithms established (1)

| < 7 gm/dl | • Discuss with patient  
|           | • Transfuse 1 U PRBC |
| 7-8 with symptoms | • Volume crystalloid vs colloid, evaluate meds  
|           | • Reevaluate |
| Persistent orthostasis, dizziness, fatigue | • Transfuse 1 U PRBC (rare) |

6. Summary
   a. A comprehensive blood management program can reduce transfusion rates to less than 3% for THA and 1% for TKA can facilitate outpatient total joint arthroplasty
References:

17. Ralley, FE. Berta, D, Binns, V, Howard, J, Naudie, DD. One intraoperative dose of tranexamic acid for patients having primary hip or knee arthroplasty. CORR, 2010, Jul;468: 1905-11
18. Rajesparan, K, Blant, LC, Ahmad, M, Field, RE. The effect of an intravenous bolus on tranexamic acid on blood loss in total hip replacement. JBJS-Br, 2009, Jun; 776-83
Perioperative Pain Management
Mark W. Pagnano, MD

The entirety of the patient experience after contemporary total knee and total hip replacements in 2017 is markedly different from that encountered by patients just a decade ago. Ten years ago most patients were treated in a traditional *sick-patient model* of care and because they were assumed to require substantial hospital intervention, many cumbersome & costly interventions (e.g. indwelling urinary catheters, patient-controlled-analgesic pumps, autologous blood transfusion, continuous passive motion machines) were a routine part of the early postoperative experience. Today the paradigm has shifted to a *well-patient model* with a working assumption that once a patient has been medically optimized for surgery then the intervention itself, hip or knee replacement, will not typically create a sick-patient. Instead it is expected that most patients can be treated safely & more effectively with less intensive hospital intervention. While as orthopedic surgeons we are enamored with the latest surgical techniques or interesting technologies most busy surgeons recognize that advances in perioperative pain management, blood management, and early-mobilization therapy protocols account for the greatest share of improvements in patient experience over the past decade.

One can think pragmatically to *get ahead and stay ahead* of 3 predictable physiologic disturbances that adversely impact rapid recovery after knee and hip replacement: fluid/blood loss; pain; and nausea. The modern orthopedic surgeon and his/her care team needs a simple strategy to pro-actively, not reflexively, manage each of those 3 predictable impediments to early recovery. Those surgical teams that routinely get ahead and stay ahead in each of those areas will routinely witness faster recovery, lower costs and greater patient satisfaction and that is clearly a win for patient and surgeon alike.

Effective pain management improves patient satisfaction, decreases hospital stay, and facilitates discharge to home. Today’s emphasis is on a multi-modal strategy that minimizes the use of opioids. Most protocols use preop medications including an NSAID, acetaminophen, an oral opioid and some include gabapentin. Regional anesthesia is typically preferred over general. Both peripheral nerve blocks and periarticular local anesthetic cocktail injections have proved as effective adjuncts in decreasing early postoperative pain. Postoperative oral medications delivered on a schedule, not just as needed, often include acetaminophen, an NSAID and some include gabapentin. Oral and parenteral opioids are reserved for breakthrough pain.

Improved pain management techniques, surgical practices and the introduction of novel interventions have enhanced patients’ post-operative experience after total joint arthroplasty (TJA). Enhanced recovery pathways require a multidisciplinary team to manage pre-operative education, multimodal pain control and accelerated rehabilitation. The current economic climate and restricted budgets favour brief hospitalisation while minimising costs. This has put considerable pressure on hospitals to combine excellent results, early functional recovery and shorter admissions.

In this session, others will have covered some common interventions and methods that shorten length of stay and make outpatient TJA possible. These include pre-operative patient education, pre-emptive analgesia, local infiltration analgesia, pre-operative nutrition, peri-operative rehabilitation, wound dressings, different surgical techniques, minimally invasive surgery and fast-track joint replacement units.

The concept of enhanced recovery has been widely implemented by orthopaedic centres worldwide. The adoption of multimodal pathways and accelerated rehabilitation programmes appear to improve patient care and function while reducing length of stay. The introduction of day-case / outpatient TJA at leading centres has been achieved for a selected subgroup of patients with low morbidity and mortality.

There are undoubted advantages to a robust pathway through which patients can learn about their procedure, optimise their nutritional and physical status, learn what to expect from surgery and the peri-operative period, reduce the risks of surgery and speed up recovery and discharge. Although a number of pathways have been described, there has been a paucity of multicentre randomised trials comparing outcomes from these dedicated centres to those of conventional services. So far the evidence is largely circumstantial. Implementation of ERPs in each hospital needs to be tailored to the services and expertise available at each centre.

The shift towards day-case or outpatient arthroplasty has resulted from a number of drivers. The desire to limit the morbidity, mortality and cost of surgery has generated an enhanced recovery programme which has been extremely successful in limiting pain and smoothing the patient pathway around the time of surgery. This in turn has had economic benefits in terms of reducing length of stay. Ultimately, the reduction in length of stay increased risks for some patients, whilst it potentially benefitted others. That threshold remains unclear. Other drivers, however, have intervened and, in particular, the push towards generating hospital and surgeon profits by reducing length of stay and transferring the resulting savings into a hospital or surgical budget/ profit have led to a push to discharge patients on the same day. This has been shown to be possible and indeed safe for a selected subset of patients in the United States and is being applied in certain centres in Europe. There is a cohort of young, medically fit, healthy and highly-motivated patients with a good support network in whom this can be applied. The resource saving in terms of hospital stay has to be balanced against extra resources that have to be put in preoperatively and immediately postoperatively to ensure that this pathway is smooth but, ultimately, it may well be to the benefit of that group of patients to have a shorter time in hospital.
The adoption across the world has been much slower and is much less surgically driven than it is in the United States, and that may well relate to the different economic models outside the United States. Current United Kingdom regulations are that surgeons can only have a maximum 5% stake in any surgical unit or SurgiCentre. The motivation, therefore, to shift patients from an inpatient to an outpatient setting is much smaller. Like many innovations, it can be driven by the need to get market share, and hence competitive advertising, and also by patients who see a shortened length of stay as a surrogate for an earlier return to work and to activity.

The international perspective on outpatient arthroplasty is that it is the natural endpoint of enhanced recovery protocols but that it has not yet found its happy medium/equilibrium. It can be applied to a select group of patients. The resulting preoperative and postoperative care pathways created will benefit all patients. The belief in most large institutions is that the trend towards decreasing length of stay will continue and will be of benefit of patients and to society as a whole in terms of the overall cost of healthcare. We have yet, however, to define the exact population of patients who could be compromised by this and it, therefore, will continue to be introduced slowly and carefully.
**Bundled Payments in Total Joint Arthroplasty: How Does Risk and Readmission Impact Cost of Care?**  
*Giles R. Scuderi, MD*

**Introduction:** This study aims to better understand the impact of patient specific variables on the total cost of care in the total joint arthroplasty population. The impact that these patient specific variables including discharge disposition, comorbidities, and readmissions have on total cost of care will better allow physicians to modify the way care is bundled into episodes, and alleviate excessive financial risk.

**Methods:** All payment data was retrospectively reviewed for 1,092 (617 Total Knee Arthroplasty and 475 Total Hip Arthroplasty) patients who underwent a procedure during the initiation of a bundled payment model at a single academic center in a major city (January 2014 to November 2016). The LACE index was used to stratify patients as low (0-4), moderate (5-9) or high risk (10+). Discharge disposition, and readmissions were analyzed to understand their financial impact on total cost.

**Results:** After classifying patients into low, moderate and high risk groups we found a significant increase in total cost per episode of care between the low and moderate risk group in our TJA population. The significant difference between the two cohorts was $5,507.00 (p-value < 0.001) with the low risk cohort displaying a lower total cost of care. The mean difference in cost between cohorts remained significant when comparing the low risk cohort against the high-risk cohort, seeing patients categorized as high risk paying on average $10,604.00 more than those classified as low risk (p-value < 0.001). Patients discharged to a Skilled Nursing Facility and Acute Rehabilitation Facility had the highest total cost, with similar averages of total cost per episode of care. Patients discharged home had the least total cost across discharge disposition groups. Those discharged to a SNF/ Acute Rehabilitation Facility paid on average $11,623.00 more than those discharged home (p< 0.001). There were 34 hospital readmissions consisting of 19 surgical and 15 medical readmissions. A hospital readmission adds on average $17,629.00 to the total cost per episode of care. It was determined that surgical readmissions cost on average $15,313.00 more than medical readmissions (p= 0.001). A high percentage of the total cost per episode of care was attributed to post-discharge fees and services, which seems to increase considerably per LACE group, and is in agreement with results found in similar literature.

**Conclusion:** It is important for surgeons to modify bundled episodes of care to account for various factors of a patient’s care. Total cost per episode of care for Total Joint Arthroplasty increases linearly alongside patient risk, classified by LACE Score. Hospital readmissions and post discharge destination have a significant impact on total cost. A significant difference in cost was found between medical and surgical readmissions. While medical readmissions may be unavoidable, surgical readmissions are costly, and often preventable.
Where Do We Stand with Value-Based Payments? A Washington Update

Kevin J. Bozic, MD, MBA

There continues to be ongoing discussions revolving around the transition from a fee-for-service (FFS) payment system to one focused on value – defined as health outcomes achieved per dollar spent. Indeed, regardless of political ideology, it is accepted that current healthcare spending is problematic for America’s economy and the future of the country’s health and wellbeing. Over half of the increase in healthcare spending can be attributed to rising service prices and intensity, and currently, healthcare represents 17.9% of the United States’ Gross Domestic Product (GDP). Part of the solution to curtail unsustainable healthcare spending involves the implementation of value-based medicine initiatives.

In Washington, DC, there continues to be support for a shift to value-based payment models, beginning in 2013 with the implementation of the Bundled Payments for Care Improvement (BPCI) program by the CMS Innovation Center. This voluntary program offered or currently offers participants four innovative value-based payment models:

- **Model 1**) An episode of care was defined as the acute hospital stay only – reimbursement included a discounted fee to the hospital based on historical Medicare rates plus FFS reimbursement to physicians [discontinued in December 2016]
- **Model 2**) An episode of care included the acute inpatient care plus post-acute care services rendered related to the arthroplasty procedure – reimbursement is provided in a FFS manner but then reconciled against a target CMS price
- **Model 3**) An episode of care begins immediately following acute in-hospital arthroplasty care with post-acute care services (e.g., skilled nursing facility) – reimbursement is provided in a FFS manner for the post-acute care services but then reconciled against a target CMS price
- **Model 4**) An episode of care includes all inpatient services related to an arthroplasty procedure, as well as any related readmissions – reimbursement is provided by CMS in a single, prospective manner and the hospital reimburses care providers using such funds.

While BPCI Model 1 is no longer offered, the remaining models are currently being utilized. As of October 1, 2017, 514, 675 and 2 participants were active using Models 2, 3 and 4, respectively. Further, the BPCI initiative will continue through Fall 2018 for all participants in the three models extending their involvement for two additional years. Such a program is an important step in transitioning payment incentives from quantity to quality.

In addition to the BPCI program, the Centers for Medicare & Medicaid Services (CMS) have also implemented the Comprehensive Care for Joint Replacement (CJR) model; this bundled payment structure provides a lump sum to cover all related lower extremity joint replacement care within 90 days, including both in-hospital and post-acute care services rendered (similar to BPCI Model 2). The two MS-DRGs covered under this program are: 1) 469 (Major joint replacement or reattachment of lower extremity with major complications or comorbidities); and 2) 470 (Major joint replacement or reattachment of lower extremity without major complications or comorbidities). This program was mandatory for many hospitals not participating in the BPCI initiative, including those that were 1) paid under the Inpatient Prospective Payment System (IPPS), and 2) located in the Metropolitan Statistical Areas (MSAs) – counties with an urban area that has a population of at
least 50,000 citizens – selected by CMS. Currently, hospitals in 67 designated MSAs participate in the program, although 33 MSAs, low volume hospitals and rural hospitals are doing so voluntarily. These volunteer care centers can elect to opt-in to continue participating in January 2018 or withdraw. Similar to the BPCI program, the CJR model represents the changing payment landscape; indeed, the focus with the CJR model is on financially rewarding healthcare value, which provides benefit to both the provider and the patient.

In 2014, over $7 billion in hospitalization costs alone were spent on greater than 400,000 lower extremity arthroplasty cases covered by Medicare across the United States. In addition, there was a variation in the cost of care up to $16,500. These facts, coupled with the unsustainable increase in American healthcare spending, have led to the development of the federal value-based payment programs discussed in detail above. These initiatives attempt to incentivize quality, not quantity, in the healthcare marketplace. As private insurers follow CMS’ lead, more value-based payment options are likely to be introduced, including reimbursement models that incorporate patient-reported outcomes (PROs).

The shift to value-based reimbursement is not without continued challenges, as more initiatives aimed at promoting quality, not quantity, are introduced and heavily debated. Recently, the Medicare Payment Advisory Commission (MedPAC), the committee the advises Congress on appropriate Medicare policy, has recommended the elimination of the Merit-Based Incentive Payment System (MIPS). The main goal of MIPS is to apply a bonus-type scheme to the traditional FFS model by rewarding physicians for improves outcomes and meaningful EHR use. Unfortunately, the burden appears to be quite high on physicians, as MedPAC suggests that MIPS reporting requirements cost clinicians over $1 billion in 2017. Instead of MIPS, MedPAC has suggested that clinicians be offered the opportunity “opt in” to a voluntary rewards program focused on claims data; this would eliminate a significant portion of the reporting burden felt under MIPS. In this proposed program, Medicare would withhold a small portion of reimbursement dollars from all doctors and allow physicians to “recoup” this money by meeting predetermined quality targets; those who opt not to participate would not be able to recover the withheld funds. While a final policy decision has yet to be made, this ongoing discussion further reinforces the challenges, yet potential, seen in the shift towards value-based reimbursement and improved healthcare quality across the United States.

In general, it is recognized at the highest levels of the federal government that the shift to value-based payments is a necessity for the health of our country moving forward. Many challenges remain but problems continue to be solved on a daily basis. Recently, current Administrator of CMS, Seema Verma, gave a speech stressing ongoing projects at CMS aimed to assist this movement to a value-based healthcare system focused on patients. She discussed an initiative entitled “Patients Over Paperwork”, which aims to review all regulations at CMS and improve or only keep those that truly put patients first. Additionally, she introduced “Meaningful Measures”, a collaborative initiative involving a number of healthcare stakeholders aimed to ensure that “measure sets are streamlined, outcomes-based, and meaningful to doctors and patients.” Lastly, she stated that the Center for Medicare and Medicaid Innovation (CMMI) would be collecting ideas via a “Request for Information”, shifting the idea generation from Washington to the communities that serve patients. Administrator Verma’s ultimate goal is to have competition lead to improved patient-centered healthcare focused on quality, not quantity.

Currently, there are a number of exciting initiatives in Washington, DC focused on the ongoing shift from a FFS model to a value-based payment structure. As we continue to learn more through both the successes and failures of current proposals and projects, a more concrete formula for longitudinal success will develop. An exciting future within healthcare is on the horizon.
References

Patient-Reported Outcomes Measures Made Easy
David C. Ayers, MD

- PROs support the IOM vision for 21st Century to use information technology to support patient-centered, evidence based decisions
- As healthcare moves to a value based reimbursement system PROs are used to define outcomes and quality and therefore are the numerator of the value equation
- PROs have moved into clinical Practice In TJR
  - Ayers, Bozic. The Importance of Outcome Measurement in Orthopedics
  - Orthopedic surgeon reimbursement in US increased by PRO reporting in PQRS through FORCE-TJR
  - Pay for Performance Quality Reporting; CJR; Pilot project by BC of MA
  - PROs used for negotiations with insurance companies, ACOs and referring MDs as a measure of quality
- PROs can be collected in a busy practice with >85% follow-up at 1 year
  - Collect joint specific PRO scores; include pain, function, quality of life (12 questions)
  - General Health PRO from which PCS and MCS can be calculated (10-12 questions)
  - Ayers, Franklin. Integrating PRO into Ortho.Practice; Proof of Concept from FORCE-TJR
- PRO must bring value to visit; real time scoring; CAT enabled
- PRO used for Shared Decision Making and part of routine clinical care, not “research”
  - Ayers. Patient-Reported Outcomes Move into Clinical Practice.
    Orthopedics Today. August 2014
- FORCE-TJR has collected >35,000 patients PROs (Pre-op, 6M and 1 Yr Post-op with 86% collection rate).
  1. Franklin, Allison, Ayers. Beyond Implant Registries; a Patient-Centered Approach to TJR.
    JBJS-A. 2014; 96:1567-9
  - National TJR research registry and Comparative effectiveness consortium based at University of Massachusetts Medical School
  - Currently includes >225 sites in >28 states in the US
  - Established by a $12 Million P50 Grant from AHRQ
  - Currently collects and measures Level 1,2,3, and 4 data
  - Establish PRO standards at the surgeon and hospital level
  - FORCE members now using FORCE platform and FORCE infra-structure to manage bundled payment programs with CMS (BPCI and CJR) and private payers
  - FORCE –TJR feedback to surgeons/hospitals for quality improvement and real-time operational data to manage bundle payment programs
    - Patient characteristics/mix/ Charlson co-morbidity index
    - Patient selection (timing of surgery)
    - Medical and ortho co-morbid conditions
- Discharge location/ use of ancillaries
- TJR outcomes including post-TJR pain and function
- TJR outcomes also including adverse events/ readmissions/return to surgery/ revision surgery
  - FORCE-TJR Now open to new member enrollment

- PROs used to evaluate patient mix at the hospital/surgeon level for medical and MSK co-morbidities
  - Used to answer how do my patients compare to FORCE-TJR cohort on key risk-adjustment factors
  - **Ayers, et al. Patient Reported Outcomes After TKR; Need for MSK Co-Morbidity Index**
    - *JBJS-A: 95(20)1833-7, 2013*

- Patient Selection and Timing of Surgery; Appropriateness
  - How do my patients compare to other sites on pre-TJR pain and function?
  - **Ayers, Franklin. Pre-Op Pain and Function Profiles Reflect Consistent TKA Patient Selection**
    - *Among US Surgeons. CORR: Jan 2015, 473(1) p76-81*

- TJR patient reported outcomes;
  - How does my risk adjusted 1 year pain and function scores compare to FORCE-TJR national cohort?
  - Surgeons/hospitals want to improve!

- PROs improve risk adjustment models for readmissions
  - FORCE-TJR and AAHKS showed that adding pre-op function (PCS), BMI as continuous variable, smoking, modified Charlson co-morbidity score, Orthopedic co-morbidities improve readmission model from CMS C=.62 to FORCE-TJR C=.78
  - **Ayers, et al. Using FORCE-TJR Data to Improve Risk Adjusted Readmission Prediction Models**
    - *JBJS-A: 97(88) 668-71, 2015*

- PROs used to evaluate Cemented vs. Cemented TKRs; risk adjustment for PROs based on patient characteristics

- PROs already play an important role in clinical practice in TJR and will play an increasingly vital role in assessing quality and value in the future; look for a turn-key internet based option that provides you with real-time scoring of PROs and access to PRO national norms to benchmark your practice
Hospital-Physician Alignment

C. Lowry Barnes, MD

The current healthcare environment allows numerous opportunities for physicians and hospitals to align incentives. Opportunities such as co-management, gain-sharing, as well as partnering in CJR, BPCI, and BPCI-Advanced will be discussed. Large numbers of surgeons are now being employed by hospitals, and models of employment will be shared. As total joints move to out-patient settings, partnerships in ASC’s may become more viable for joint replacement surgeons. Additionally, lower level alignments such as flip rooms, support of third-parties to help with patient engagement, research relationships, and hospital employment of mid-level providers to assist with in-patient care will be reviewed also.
Today’s rapidly changing medical and health care environment provides both opportunity and risk for surgeons. As surgeons are the prime advocate for the welfare of their patients, they are constantly and justifiably seeking ways to improve care delivery. Among an array of rapidly evolving issues, three stand out as particularly impactful: the site of care delivery, the adoption of new technology, and the business and financial relationships that are often associated with these. Patient care is rapidly moving to outpatient centers, implants have been introduced and recalled at a blistering pace and physician consulting relationships continue to be seen as both essential and concerning. An important legal and regulatory framework has been developed intended to safeguard patients. But, as with any oversight, there are both beneficial elements and unintended consequences. The surgeon who is actively seeking to test the boundaries of existing practice must do so with a thorough understanding of how to navigate these elements. Innovation and progress must be accompanied by an appropriate measure of prudence and circumspection. By understanding a wide array of stakeholder and environmental perspectives, the proper course and cadence can be set.
CME Accreditation Statement
This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the American Academy of Orthopaedic Surgeons and the Hip Society. The American Academy of Orthopaedic Surgeons is accredited by the ACCME to provide continuing medical education for physicians.

Credit Hours
The American Academy of Orthopaedic Surgeons designates this live activity for a maximum of 7.5 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Goals and Objectives
The objectives of the Open Meeting of The Hip Society are to provide up-to-date information on the treatment of hip problems including arthroplasty and non-arthroplasty options and surgical techniques. Interactive symposia will be utilized.

Upon completion of this program, participants should 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 hip joint.
• Determine indications and complications in total hip arthroplasty.
• Critique presentations of surgical techniques and demonstrations of treatment options.
• Evaluate the efficacy of new treatment options through evidence-based data.

FDA Statement
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Scott M Sporer, MD Submitted on: 01/18/2018; American Association of Hip and Knee Surgeons: Board or committee member; American Joint Replacement Registry: Board or committee member; DJO Surgical: IP royalties; Paid consultant; Hip Society: Board or committee member; Myoscience: Paid consultant; Stock or stock Options; Osteoremedies: IP royalties; Paid consultant SLACK Incorporated: Publishing royalties, financial or material support; Stryker: Research support; Zimmer: IP royalties; Research support

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