CURRENT CONCEPTS INSTITUTE

in partnership with

The Hip Society and The Knee Society

present

CURRENT CONCEPTS IN JOINT REPLACEMENT®

Spring 2020

Online Live Meeting

Twenty-First Annual

May 18 - 20, 2020

Course Director:

A. SETH GREENWALD, D.PHIL.(OXON)

A Continuing Medical Education Program

Accredited by the Current Concepts Institute

CURRENT CONCEPTS IN JOINT REPLACEMENT® - *SPRING 2020*

COURSE DESCRIPTION

This **CME** Program is open to orthopaedic surgeons, residents, nurses, and members of the orthopaedic and allied health industries.

• This meeting will focus on both primary and revision outcomes, surgical approaches, current implant designs and materials including the clinical manifestations of metal-on-metal articulations and the use of tapers, as well as address problems of fixation, bone deficiency, instability, trauma, and infection for hip, knee, and shoulder replacement.

• Topics delve into a triad of design, patient factors, and technical proficiency responsible for achieving clinical longevity in hip, knee, and shoulder reconstruction.

• Hemi and total shoulder arthroplasty topics focus on improved instrumentation, design modularity, evolving surgical techniques, and optimal patient outcomes.

• An assemblage of contemporary thought leaders will probe the boundaries of these problems and offer solutions for joint pathologies where arthroplasty is indicated.

• Plenary commentary, didactic clinical reports, technique videos, debate, case challenges, and surgical procedures define the formats of presentation, which provide an optimal learning opportunity for orthopaedic surgeons and other allied professionals involved in joint reconstruction.

LEARNING OBJECTIVES

As a result of attending this CME program, the participant will be able to:

• Appreciate current trends in the application of robotics, outpatient surgery, in-situ component placement, and the increasing use of 3D printed porous metals for fixation and bone loss in hip, knee, and shoulder arthroplasty.

• Appraise evolving surgical techniques and implant technologies through didactic and interactive live presentation as well as evaluate early and long-term clinical outcomes.

• Discuss diagnostic approaches to assess and treat patient specific: post-operative function limitations, pain, peri-prosthetic joint infection, component-induced short- and long-term tissue responses, and peri-prosthetic fractures.

• Apply current solution options for hip, knee, and shoulder arthroplasty failure where revision is an endpoint and understand the contributory roles of component design, bone loss, soft tissue deficiency, and infection.

ACCREDITATION STATEMENT

The Current Concepts Institute is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

The Current Concepts Institute designates this live activity for a maximum of **18** *AMA PRA Category 1 Credits ™*. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

CERTIFICATION

Physicians (U.S. and Non-U.S. Physicians) - CME Certificate
To receive continuing medical education credits for this live activity, please go to www.**CCJR**.com/course-eval to complete the Course Evaluation and receive your CME Certificate. Must be completed by **June 22, 2020** to receive certification.

Non-Physicians - Certificate of Attendance
To receive documentation of hours of participation in this live activity, please go to www.**CCJR**.com/course-eval to complete the Course Evaluation and receive your Certificate of Attendance. Must be completed by **June 22, 2020** to receive certification.

VIDEO PROCEEDINGS

Exclusive access to the full length recording of the live proceedings will be available two weeks after the meeting at www.**CCJR**.com. Participants will be notified by e-mail.

DISCLAIMER

The information in this educational activity is provided for general medical education purposes only and is not meant to substitute for the independent medical judgment of a physician relative to diagnostic and treatment options of a specific patient's medical condition. The viewpoints expressed in this CME activity are those of the author/faculty. They do not represent an endorsement by the Current Concepts Institute. In no event will the Current Concepts Institute be liable for any decision made or action taken in reliance upon information provided through this CME activity.

FUTURE COURSE INFORMATION

CURRENT CONCEPTS IN JOINT REPLACEMENT® - *Winter - Orlando*

December 9 - 12, 2020 • December 8 - 11, 2021 • December 7 - 10, 2022

CURRENT CONCEPTS INSTITUTE

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CURRENT CONCEPTS IN JOINT REPLACEMENT® - *SPRING 2020*
PROGRAM AT A GLANCE

All times listed in the **CCJR - *Spring 2020* Online Live** program are in New York/EDT and the following tables provide alternative time zones for your convenience.

DOMESTIC

LOCATION	TIME ZONE	MEETING TIMES	GMT DIFFERENCE
NEW YORK	EDT	10:00am – 6:30pm	-04:00
CHICAGO	CDT	9:00am – 5:30pm	-05:00
DENVER	MDT	8:00am – 4:30pm	-06:00
LOS ANGELES	PDT	7:00am – 3:30pm	-07:00

INTERNATIONAL

LOCATION	TIME ZONE	MEETING TIMES	GMT DIFFERENCE
LONDON	BST	3:00pm – 11:30pm	+01:00
CENTRAL EUROPE	CEST	4:00pm – 12:30am	+02:00
NEW DELHI	IST	7:30pm – 4:00am	+05:30
BEIJING	CST	10:00pm – 6:30am	+08:00
SYDNEY	AEST	12:00am – 8:30am * May 19, 2020	+10:00

MONDAY, MAY 18, 2020

10:00a.m. - 10:05a.m. Welcome & Instructions
10:05 a.m. - 10:15a.m. Key Note
10:15a.m. - 11:00a.m. SESSION I - *Surgical Procedure: Shoulder Reconstruction*
11:00a.m. - 11:30a.m. Break *#1*
11:30a.m. - 12:30p.m. SESSION II - *Orthopaedic Crossfire® I: Controversies in Shoulder Reconstruction*
12:30p.m. - 1:00p.m. Break *#2*
1:00p.m. - 2:00p.m. SESSION III - *Complications in Shoulder Arthroplasty: "Dealin' with Difficulties"*
2:00p.m. - 2:30p.m. Break *#3*
2:30p.m. - 3:30p.m. SESSION IV - *What Would YOU do? Challenges in Shoulder Surgery*
3:30p.m. - 4:00p.m. Break *#4*
4:00p.m. - 5:00p.m. SESSION V - *Surgical Procedure: Primary Knee Arthroplasty*
5:00p.m. - 5:30p.m. Break *#5*
5:30p.m. - 6:30p.m. SESSION VI - *Orthopaedic Crossfire® II: Controversial Issues in Knee Arthroplasty*
6:30p.m. - 8:00p.m. Exhibitor Symposium *#1*

TUESDAY, MAY 19, 2020

10:00a.m. - 10:05a.m. Welcome & Instructions
10:05a.m. - 10:15a.m. Key Note
10:15a.m. - 11:00a.m. SESSION VII - *Surgical Procedure: Primary Knee Arthroplasty*
11:00a.m - 11:30a.m Break *#6*
11:30a.m. - 12:30p.m. SESSION VIII - *Management Factorials in Primary Knee Arthroplasty: Ensuring a Winner!*
12:30p.m. - 1:00p.m. Break *#7*
1:00p.m. - 2:00p.m. SESSION IX - *What Would YOU do? Challenges in Knee Surgery*
2:00p.m. - 2:30p.m. Break *#8*
2:30p.m. - 3:30p.m. SESSION X - *Surgical Procedure: Revision Knee Arthroplasty*
3:30p.m. - 4:00p.m. Break *#9*
4:00p.m. - 5:00p.m. SESSION XI - *Periprosthetic Joint Infection (PJI): Drugs, Bugs & Solution Options*
5:00p.m. - 5:30p.m. Break *#10*
5:30p.m. - 6:30p.m. SESSION XII - *Problems After Knee Arthroplasty: Things That Go "Bump in the Night"*
6:30p.m. - 8:00p.m. Exhibitor Symposium *#2*

WEDNESDAY, MAY 20, 2020

10:00a.m. - 10:05a.m. Welcome & Instructions
10:05a.m. - 11:00a.m. SESSION XIII - *Surgical Procedure: Primary Hip Arthroplasty*
11:00a.m. - 11:30a.m. Break *#11*
11:30a.m. - 12:30p.m. SESSION XIV - *Hip Arthroplasty: Management Issues*
12:30p.m. - 1:00p.m. Break *#12*
1:00p.m. - 2:00p.m. SESSION XV - *What Would YOU do? Challenges in Hip Surgery*
2:00p.m. - 2:30p.m. Break *#13*
2:30p.m. - 3:30p.m. SESSION XVI - *Surgical Procedure: Primary Hip Arthroplasty*
3:30p.m. - 4:00p.m. Break *#14*
4:00p.m. - 5:00p.m. SESSION XVII - *Orthopaedic Crossfire® III: Controversial Issues in Primary & Revision Hip Arthroplasty*
5:00p.m. - 5:30p.m. Break *#15*
5:30p.m. - 6:30p.m. SESSION XVIII - *The Revision Hip: A Tolerance for Chaos*

CURRENT CONCEPTS IN JOINT REPLACEMENT® - *SPRING 2020*

MONDAY, MAY 18, 2020

10:00a.m. Welcome & Instructions
A. Seth Greenwald, D.Phil.(Oxon)

10:05 #1 Thanks for the Memories: *A Festschrift Remembering* **CCJR** — Lawrence D. Dorr, M.D.

SESSION I – Evan S. Lederman, M.D.

Surgical Procedure: Shoulder Reconstruction

10:15 #2 **Reverse Shoulder Arthroplasty: *Solution for Rotator Cuff Deficiency***
Mark A. Frankle, M.D. – *Surgeon*

11:00 Break *#1*

SESSION II – Thomas S. Thornhill, M.D.

Orthopaedic Crossfire® I: Controversies in Shoulder Reconstruction

11:30 Reverse TSA for Glenohumeral Arthritis: *Now the Standard of Care*
#3 Sumant G. Krishnan, M.D. – *Affirms*
#4 Eric R. Wagner, M.D., M.S. – *Opposes*

11:50 Irreparable Cuff Tear: *Superior Capsule Reconstruction is the Preferred Treatment*
#5 Evan S. Lederman, M.D. – *Affirms*
#6 Jon J.P. Warner, M.D. – *Opposes*

12:10 Four Part *Fx's* in Active <65-Year-Old Patients: *Best Treated with Reverse TSA*
#7 Leesa M. Galatz, M.D. – *Affirms*
#8 Evan L. Flatow, M.D. – *Opposes*

12:30 Break *#2*

SESSION III – Leesa M. Galatz, M.D.

Complications in Shoulder Arthroplasty: "Dealin' with Difficulties"

1:00	#9	Managing the Infected Arthroplasty: *Clean Out, 1-Stage or 2-Stage*	Eric R. Wagner, M.D., M.S.
1:05	#10	Avoiding Instability: *Getting the Soft Tissue Balancing Right*	Evan L. Flatow, M.D.
1:10	#11	Arthroscopic Debridement: *Best Friend/Worst Enemy*	Jon J.P. Warner, M.D.
1:15	#12	Peri-Prosthetic *Fx's*: *Repair, Replace or Treat Conservatively*	William H. Seitz, Jr., M.D.
1:20	#13	Complications of Reverse Arthroplasty: *Learning from Your Mistakes*	Sumant G. Krishnan, M.D.
1:25	#14	Humeral Cemented Revision: *Techniques for Safe Extraction*	Leesa M. Galatz, M.D.

1:30 Discussion

2:00 Break *#3*

SESSION IV – Eric R. Wagner, M.D., M.S.

2:30 #15 ***What Would YOU do? Challenges in Shoulder Surgery***
Leesa M. Galatz, M.D.
Evan S. Lederman, M.D.
William H. Seitz, Jr., M.D.
Jon J.P. Warner, M.D.

3:30 Break *#4*

SESSION V – William L. Walter, M.D., F.R.A.C.S., Ph.D.

4:00 #16 Why Knees Fail: *Patient, Surgeon or Device?* — Robert E. Booth, Jr., M.D.

Surgical Procedure: Primary Knee Arthroplasty

4:10 #17 **Medial Pivot TKA: *A Reflection of Normal Kinematics***
David Backstein, M.D., F.R.C.S.(C), M.Ed. – *Surgeon*

5:00 Break *#5*

SESSION VI – Daniel J. Berry, M.D.

Orthopaedic Crossfire® II: Controversial Issues in Knee Arthroplasty

5:30 Optimal UKA Outcomes Require Robotic Use
- #18 Robert L. Barrack, M.D. – *Affirms*
- #19 R. Michael Meneghini, M.D. – *Opposes*

5:50 Outpatient TJA Surgery: *The Best Sum of All Things*
- #20 Richard A. Berger, M.D. – *Affirms*
- #21 Alejandro Gonzalez Della Valle, M.D. – *Opposes*

6:10 The Cementless Tibia: *Emergent Game Changer*
- #22 Kenneth A. Gustke, M.D. – *Affirms*
- #23 Gwo-Chin Lee, M.D. – *Opposes*

6:30 End of Day 1

6:30 Exhibitor Symposium *#1*

TUESDAY, MAY 19, 2020

10:00a.m. Welcome & Instructions
A. Seth Greenwald, D.Phil.(Oxon)

10:05 #24 Biologic Therapies 2020: *Where's the Beef?* — Aaron G. Rosenberg, M.D.

SESSION VII – Stephen M. Howell, M.D.

Surgical Procedure: Primary Knee Arthroplasty

10:15 #25 **A Calipered Kinematically Aligned TKA**
Ryan G. Molli, D.O. – *Surgeon*

11:00 Break *#6*

SESSION VIII – Gwo-Chin Lee, M.D.

Management Factorials in Primary Knee Arthroplasty: Ensuring a Winner!

11:30 #26 The Custom Total Knee Replacement: *A Bespoke Solution* — Jose A. Rodriguez, M.D.
11:36 #27 Decoding the Varus Knee: *Are They All the Same?* — Ashok Rajgopal, F.R.C.S.(Ed), M.S.
11:42 #28 The Role of the Tourniquet in 2020 — R. Michael Meneghini, M.D.
11:48 #29 Peri-Operative Pain Management: *Assuring a Happy Patient* — Paul F. Lachiewicz, M.D.
11:54 #30 Blood Conservation Strategies: *The Impact of TXA* — Thomas P. Schmalzried, M.D.
12:00 #31 DVT Prophylaxis: *Think of the Old Aspirin* — Antonia F. Chen, M.D., M.B.A.
12:06 Discussion
12:30 Break *#7*

SESSION IX – Steven J. MacDonald, M.D., F.R.C.S.(C)

1:00 #32 ***What Would YOU do? Challenges in Knee Surgery***
Stephen M. Howell, M.D.
Denis Nam, M.D.
Ashok Rajgopal, F.R.C.S.(Ed), M.S.
Aaron G. Rosenberg, M.D.
Thomas P. Sculco, M.D.

2:00 Break *#8*

SESSION X – George J. Haidukewych, M.D.

2:30	#33	**OREF/CCJR** Clinical Award Paper	Nicolas S. Piuzzi, M.D.

Surgical Procedure: Revision Knee Arthroplasty

2:40 #34 **Revision Rotating Platform TKA: *A Bone Loss Solution***
Michael B. Cross, M.D. – *Surgeon*

3:30 Break *#9*

SESSION XI – Thorsten Gehrke, M.D.

Periprosthetic Joint Infection (PJI): Drugs, Bugs & Solution Options

4:00	#35	Infection Prevention: *Modifiable Risk Factors*	C. Anderson Engh, Jr., M.D.
4:06	#36	Diagnosing PJI: *A Step-by-Step Evaluation Protocol*	Antonia F. Chen, M.D., M.B.A.
4:12	#37	DAIR: *An Emerging Alternative for PJI*	Fares S. Haddad, M.D., F.R.C.S.
4:18	#38	An *Inadvertent* One Stage Solution	Donald S. Garbuz, M.D., F.R.C.S.(C)
4:24	#39	Continuous Intra-Articular Antibiotic Administration: *Inhibiting the Bio-Film*	Leo A. Whiteside, M.D.
4:30	#40	The Two-Stage Standard: *Techniques, Timing & Statistics*	Daniel J. Berry, M.D.
4:36		Discussion	
5:00		Break *#10*	

SESSION XII – Robert E. Booth, Jr., M.D.

Problems After Knee Arthroplasty: Things That Go "Bump in the Night"

5:30	#41	Managing Wound Complications: *A Knee is Not a Hip*	Gwo-Chin Lee, M.D.
5:36	#42	The Unstable Knee: *Manifestations, Reasons & Corrective Actions*	William L. Walter, M.D., F.R.A.C.S., Ph.D.
5:42	#43	The Management of Extensor Mechanism Complications	Denis Nam, M.D.
5:48	#44	The Post-Operative Painful Knee: *Finding Causation/Realizing Remedy*	Robert L. Barrack, M.D.
5:54	#45	Peri-Prosthetic Femoral *Fx's*: *ORIF Remains the Gold Standard*	George J. Haidukewych, M.D.
6:00	#46	Bone Loss Management: *Building It Back Up*	David G. Lewallen, M.D.
6:06		Discussion	
6:30		End of Day 2	
6:30		Exhibitor Symposium *#2*	

WEDNESDAY, MAY 20, 2020

10:00a.m. Welcome & Instructions
A. Seth Greenwald, D.Phil.(Oxon)

SESSION XIII – Atul F. Kamath, M.D.

10:05	#47	Early Prophylactic Intervention: *Avoiding or Deferring Arthroplasty*	Atul F. Kamath, M.D.

Surgical Procedure: Primary Hip Arthroplasty

10:15 #48 **Optimizing the Anterior Approach Through Advancing Technologies**
William G. Hamilton, M.D. – *Surgeon*

11:00 Break *#11*

SESSION XIV – Adolph V. Lombardi, Jr., M.D.

Hip Arthroplasty: Management Issues

11:30	#49	The Use of Smart Tool Technology: *Improves Intra-Operative Execution*	Stephen B. Murphy, M.D.
11:36	#50	Cemented Femoral Fixation: *Optimal Hybrid Solution*	Alejandro Gonzalez Della Valle, M.D.
11:42	#51	Are All Cementless Stems Created Equal: *Which for What?*	Matthew P. Abdel, M.D.
11:48	#52	Acetabular Protrusio: *A Problem in Depth*	Kenneth A. Gustke, M.D.
11:54	#53	Hip Fusion Conversion: *The Why, the How, the Outcomes*	Allan E. Gross, M.D., F.R.C.S.(C)
12:00		Discussion	
12:30		Break *#12*	

SESSION XV – Lawrence D. Dorr, M.D.

1:00 #54 ***What Would YOU do? Challenges in Hip Surgery***
C. Anderson Engh, Jr., M.D.
Donald S. Garbuz, M.D., F.R.C.S.(C)
Richard E. Jones, M.D.
Adolph V. Lombardi, Jr., M.D.
Leo A. Whiteside, M.D.

2:00 Break *#13*

SESSION XVI – David J. Mayman, M.D.

2:30 #55 Bone Grafts & Their Substitutes: *Understanding the Three O's* — Edwin P. Su, M.D.

Surgical Procedure: Primary Hip Arthroplasty

2:40 #56 **Ceramicized Metal Dual Mobility THA: *Reducing Wear & Dislocation***
Adolph V. Lombardi, Jr., M.D. – *Surgeon*

3:30 Break *#14*

SESSION XVII – Thomas S. Thornhill, M.D.

Orthopaedic Crossfire® III: Controversial Issues in Primary & Revision Hip Arthroplasty

4:00 The Direct Anterior Approach: *Emergent Exposure for All THA Patients*
#57 Jose A. Rodriguez, M.D. – *Affirms*
#58 Brad L. Penenberg, M.D. – *Opposes*

4:20 The Dual Mobility Cup: *First Choice for the High Risk & Recurrent Dislocator*
#59 Matthew P. Abdel, M.D. – *Affirms*
#60 Thomas P. Schmalzried, M.D. – *Opposes*

4:40 Pelvic Discontinuity & Bone Loss: *The Triflange Cup, Treatment of Choice*
#61 Michael D. Ries, Sc.M., M.D. – *Affirms*
#62 Steven J. MacDonald, M.D., F.R.C.S.(C) – *Opposes*

5:00 Break *#15*

SESSION XVIII – David G. Lewallen, M.D.

The Revision Hip: A Tolerance for Chaos

5:30	#63	The Painful THA: *Determining Etiology Will Direct Treatment*	Steven J. MacDonald, M.D., F.R.C.S.(C)
5:36	#64	Classifying Femoral Bone Deficiency: *Choosing the Right Implant*	Wayne G. Paprosky, M.D.
5:42	#65	Cemented Stems in Revision 2020: *What Problems Do They Solve?*	Fares S. Haddad, M.D., F.R.C.S.
5:48	#66	The Modular Stem: *The Right Implant for the Difficult Revision*	Matthew P. Abdel, M.D.
5:54	#67	The Jumbo Cup: *Cementless Solution for Acetabular Bone Loss*	Paul F. Lachiewicz, M.D.
6:00	#68	The Role of Cages: *Lord of the Ring*	Allan E. Gross, M.D., F.R.C.S.(C)

6:06 Discussion

6:30 Adjourn

MEETING PROVISIONS

EXCLUSIVE ACCESS TO THE FULL LENGTH RECORDING OF THE LIVE PROCEEDINGS WILL BE AVAILABLE TWO WEEKS AFTER THE MEETING CLOSES AT www.CCJR.com

FOR A CONTINUING MEDICAL EDUCATION (CME) CERTIFICATE OR CERTIFICATE OF ATTENDANCE FOR THIS LIVE ACTIVITY, PLEASE GO TO www.CCJR.com/COURSE-EVAL PRIOR TO JUNE 22, 2020

PAST PROGRAMS CAN ALSO BE VIEWED AT www.CCJR.com.

CURRENT CONCEPTS IN JOINT REPLACEMENT® - *SPRING 2020*

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Evan S. Lederman, M.D. - University of Arizona College of Medicine, Phoenix, Arizona
Gwo-Chin Lee, M.D. - University of Pennsylvania, Philadelphia, Pennsylvania
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Nicolas S. Piuzzi, M.D. - Cleveland Clinic, Cleveland, Ohio
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Eric R. Wagner, M.D., M.S. - Emory University, Atlanta, Georgia
William L. Walter, M.D., F.R.A.C.S., Ph.D. - Sydney Hip & Knee Surgeons, Waverton, Australia
Jon J.P. Warner, M.D. - Harvard Medical School, Boston, Massachusetts
Leo A. Whiteside, M.D. - Missouri Bone & Joint Center, St. Louis, Missouri

PLANNING COMMITTEE MEMBERS

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Aaron G. Rosenberg, M.D. - Rush University Medical Center, Chicago, Illinois

Twenty-First Annual

CURRENT CONCEPTS IN JOINT REPLACEMENT®

Spring 2020

Online Live Meeting

May 18 - 20, 2020

Notes:

SESSION I

Surgical Procedure:
Shoulder Reconstruction

PAPER #1

Thanks for the Memories:
A Festschrift Remembering CCJR

10:05 AM - 10:15 AM

Lawrence D. Dorr, M.D.

This is a celebration of the 37 years of Seth's educational contribution to orthopaedics and the surgeons he helped grow in their reputation, and who helped his course become the leader in joint replacement education in the world.

Notes:

SESSION I

Surgical Procedure:
Shoulder Reconstruction

Evan S. Lederman, M.D. - Moderator

PAPER #2

Reverse Shoulder Arthroplasty:
Solution for Rotator Cuff Deficiency

10:15 AM - 11:00 AM

Mark A. Frankle, M.D.

This presentation is a revision of a symptomatic failed anatomic total shoulder arthroplasty to a reverse total shoulder arthroplasty. There is a brief clinical vignette preceding the surgical intervention that includes history, pre-operative imaging, and pre-operative video of the patient's active range of motion in four planes (forward flexion, abduction, external rotation, and internal rotation). The surgical video will highlight surgical approach, implant removal, and implant placement. The presentation will conclude with post-operative radiographs and range of motion video at 1 year to demonstrate the functional improvements after surgical intervention.

Notes:

SESSION II

Orthopaedic Crossfire® I: Controversies in Shoulder Reconstruction

Thomas S. Thornhill, M.D. - Moderator

PAPER #3

Reverse TSA for Glenohumeral Arthritis: *Now the Standard of Care – Affirms*

11:30 AM - 11:36 AM

Sumant G. Krishnan, M.D.

Fact #1: glenoid deformity is a multiplanar pathology

Fact #2: "anatomic" humeral reconstruction may not function anatomically

Fact #3: "anatomic" total shoulder arthroplasty is not as durable as originally reported

Fact #4: "reverse" total shoulder arthroplasty is no longer the same procedure
- 2019 AAOS Shoulder and Elbow Registry: 60.3% Reverse TSA
- 2003-2019 Baylor Shoulder Service: Reverse TSA similar linear increase
- 2019 AAOS Shoulder and Elbow Registry: age 50-60 y.o. is the crossing point
- 2003-2019 Baylor Shoulder Service: age 50 is the critical age

What is the "future"?
- Artificial intelligence driven reconstruction
- "Anatomic Reverse" Total Shoulder Arthroplasty

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Notes:

SESSION II

Orthopaedic Crossfire® I: Controversies in Shoulder Reconstruction

PAPER #4

Reverse TSA for Glenohumeral Arthritis: *Now the Standard of Care – Opposes*

11:36 AM - 11:42 AM

Eric R. Wagner, M.D., M.S.

Reverse shoulder arthroplasty (RSA) has grown exponentially in the last decade due to its expanding indications.[1] One of these indications, glenohumeral osteoarthritis, represents one of the biggest shifts towards RSA from the traditional anatomic total shoulder arthroplasty (aTSA). There are many reasons for this shift, but at the center involves innovations of both implant design and surgical techniques, potentially making the RSA a more forgiving operation than aTSA. This is particularly true in the setting of glenohumeral osteoarthritis in the setting of posterior or superior glenoid bone loss. The concern for aTSA in this setting is that if the subluxation is not perfectly corrected, edge loading will lead to a "rocking-horse" pattern of early glenoid loosening in the setting of too much glenoid retroversion.[2] However, similar to the innovations in RSA have expanded its indications, the innovations in aTSA have similarly overcome many of these historical challenges and continue to make it the preferred implant to RSA in most cases:

1. Glenoid Bone Loss: One major innovation to over the earlier failure rates in the setting of bone loss involves the use of augments. For example, the revision rates of aTSA for patients with Walch B2 glenoids is much better when utilizing posterior augments (0%), compared to posterior bone grafting (9%) or asymmetric reaming (16%).[3] This potentially overcomes the previous concerns about aTSA in the setting of mild-moderate glenoid bone loss.
2. Revision Procedures: Revision of a RSA continues to be one of the most challenging procedures a shoulder surgeon faces.[4] However, recent implant design and surgical technical innovations have improved our ability to revise a failed aTSA. With the encouraging results of the stemless humerus design[5] and grafting of central bone defects after polyethylene removal,[6] the revision of a failed aTSA is exponentially easier than revision of a failed RSA.
3. Clinical Outcomes + Internal Rotation: Although innovations in surgical technique and implant design have markedly improved the patients expected clinical outcomes after RSA, it still remains a non-anatomic procedure. And patients still continue to report limitations in daily activities, particularly any involving internal rotation of the shoulder. Alternatively, without having to worry about impingement, notching, or tight soft tissues, the aTSA continues to replicate the normal shoulder motion and function. Therefore, the clinical and patient reported outcomes after aTSA continue to be significantly outperform those after RSA in every study to date, with early recovery rates and higher overall ceilings of function.[7] Additionally, internal rotation behind a patient's back is predictable in most patients after aTSA.

While we have made great strides as a field in improving our ability to perform RSA, and therefore, expanding its indications, it still falls short of a well done aTSA in many measures. Clinically, the mean shoulder motion, strength, and patient reported outcomes measures are consistently superior after aTSA compared to RSA. Furthermore, the revision of the aTSA is much easier than that of a failed RSA. And finally, with the innovation of augments, the indications for aTSA have also expanded, potentially

overcoming the concern for the edge-loading after attempted eccentric reaming. Although the RSA remains the implant of choice for cases of glenohumeral osteoarthritis with severe glenoid bone loss or rotator cuff insufficiency, the aTSA should remain the gold standard for most other indications involving glenohumeral arthritis.

References:

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Notes:

SESSION II

Orthopaedic Crossfire® I: Controversies in Shoulder Reconstruction

PAPER #5

Irreparable Cuff Tear: *Superior Capsule Reconstruction is the Preferred Treatment – Affirms*

11:50 AM - 11:56 AM

Evan S. Lederman, M.D.

When surgery is required for management of an irreparable tear of the rotator cuff the options to consider include arthroscopic debridement, tendon transfers (latissimus dorsi or lower trapezius), reverse shoulder arthroplasty and, soon to be available, the biodegradable balloon spacer.

Arthroscopic superior capsular reconstruction as proposed by Mihata[1] has modified the techniques previously performed to attach a graft between the glenoid and the greater tuberosity. This technique has been shown biomechanically to be a superior construct to resist superior translation from the unopposed force of the deltoid and to restore kinematics to a near normal state in biomechanical testing.[2] Early clinical results as published by Mihata have demonstrated significant improvement in range of motion, functional outcome scores and preservation of the acromial humeral interval in mid-term follow up.[1] Initially, Mihata utilized a fascia lata autograft folded into a thick graft. The US experience is primarily centered around the use of human dermal allograft. Biomechanically the human dermal allograft compares favorably to fascia lata.[3] Several studies are now available looking at the United States results utilizing human dermal allograft. The ideal candidate includes the supraspinatus deficient shoulder with an intact subscapularis and teres minor and minimal arthritis with improved results in Hamada grade one and two versus Hamada 3 or 4.[4,5] SCR has been reported capable of reversing pseudo-paralysis.[6] Additionally, histologic evaluation has shown gradual revascularization of the graft.[7]

SCR is a reasonable option to consider in the younger with an irreparable posterior superior rotator cuff tear. In short term follow-up reasonable outcomes can be achieved for motion and patient reported outcome scores comparable to reverse shoulder arthroplasty.

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Notes:

SESSION II

Orthopaedic Crossfire® I: Controversies in Shoulder Reconstruction

PAPER #6

Irreparable Cuff Tear: *Superior Capsule Reconstruction is the Preferred Treatment – Opposes*

11:56 AM - 12:02 PM

Jon J.P. Warner, M.D.

Superior Capsular Reconstruction (SCR) is currently a popular procedure; however, the evidence remains limited for its true efficacy in managing irreparable massive Rotator Cuff Tears (RCT). In contrast, tendon transfers have a longer track record and evidence as a viable and reliable method of treatment.

Popularity: The number of Google searches through April of 2020 for SCR was 365,000 compared to 50,800 for tendon transfers when looking for treatment of "irreparable rotator cuff tears." On the website www.vumedi.com there were 107,709 views since 2015 of videos on how to perform SCR compared to 86,312 views of videos since 2008 on how to do a tendon transfer.

Evidence: A review of pubmed.gov demonstrated that since 2017 there have been 12 articles (3 meta-analyses) of which only two were negative on outcomes. A total of 258 patients have been reported with most having good outcomes. The main exception is an article that looked at learning curves among five surgeons and found an early failure rate of 65%.

A review of pubmed.gov demonstrated that since 2001 there were a total of 34 articles of which 6 were negative on results. A total of 1197 cases have been reported with mostly good outcomes.

Conclusion: Given that both SCR and Tendon Transfer are almost exclusively reported as retrospective cohort Level 4 studies, and that there may be a cognitive bias in such reporting, the current conclusion is that the weight of evidence supports the latter due to the volume of studies and positive outcomes. It remains to be determined through stronger scientific evidence and larger studies, if SCR fulfills the promise of its popularity.

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Orthopaedic Crossfire® I: Controversies in Shoulder Reconstruction

PAPER #7

Four Part *Fx's* in Active <65-Year-Old Patients: *Best Treated with Reverse TSA – Affirms*

12:10 PM - 12:16 PM

Leesa M. Galatz, M.D.

The treatment of proximal humerus fractures remains controversial. The literature is full of articles and commentary supporting one method over another. Options include open reduction and internal fixation, hemiarthroplasty, and reverse shoulder arthroplasty. Treatment options in an active 65-year-old are exceptionally controversial given the fact that people in this middle-aged group still wish to remain active and athletic in many circumstances. A hemiarthroplasty offers the advantage of a greater range of motion, however, this has a high incidence of tuberosity malunion or nonunion and this is a very common reason for revision of that hemiarthroplasty for fracture to a reverse shoulder replacement. One recent study showed a 73% incidence of tuberosity malunion or nonunion in shoulders that had a revised hemiarthroplasty to a reverse shoulder replacement. Progressive glenoid wear and erosion is also a risk after a hemiarthroplasty in the younger patient, especially someone who is young and active. In addition, studies show shorter operative time in hemiarthroplasty. The range of motion is highly dependent on proper tuberosity healing and this is often one of the most challenging aspects of the surgical procedure as well as the healing process. A reverse shoulder replacement in general has less range of motion compared to a hemiarthroplasty with anatomically healed tuberosities, however, the revision rate is lower compared to a hemiarthroplasty. (This is likely related to few were options for revision). The results after a reverse shoulder replacement may not be as dependent on tuberosity healing, however, importantly the tuberosities do need to be repaired and the results are significantly better if there is healing of the greater tuberosity, giving some infraspinatus and/or teres minor function to the shoulder. Complete lack of tuberosity healing forces the shoulder into obligate internal rotation with attempted elevation and this can be functionally disabling. Academic discussion is beginning surrounding the use of a reverse shoulder replacement in the setting of glenohumeral joint arthritis in a primary setting as it is believed that the glenosphere and baseplate may have greater longevity than a polyethylene glenoid. Along with this discussion, we will likely see greater application of the use of a reverse shoulder replacement in the setting of fracture for younger patients.

In general, open reduction internal fixation should still remain the treatment of choice in the setting of a fracture that can be fixed. However, a strong argument can be made that if an arthroplasty is necessary, a reverse shoulder replacement is the implant of choice.

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Notes:

SESSION II

Orthopaedic Crossfire® I: Controversies in Shoulder Reconstruction

PAPER #8

Four Part *Fx's* in Active <65-Year-Old Patients: *Best Treated with Reverse TSA – Opposes*

12:16 PM - 12:22 PM

Evan L. Flatow, M.D.

Displaced proximal humerus fractures remain a difficult clinical problem, and techniques as diverse as percutaneous pinning, locked plating, intramedullary nailing, and shoulder arthroplasty have been proposed. In recent years, reverse total shoulder arthroplasty (RTSA) has become a very popular option to fix just about any fracture. However, RTSA is not without risk, with complications ranging from infection, instability, acromial stress fractures, aseptic loosening, notching and more. In a 2017 study on 39 patients, Tokish et al. compared non-operative treatment to reverse shoulder arthroplasty for displaced 3- and 4-part fractures. There was no difference in pain, range of motion or outcome scores between the two groups. Among the patients who underwent RTSA, there was no difference between early (<30 days) and late (>30 days) surgery suggesting that it could be safe to attempt a non-operative trial in most patients and see how they do. This is also supported by a 2016 study by Sanchez-Sotelo et al. in which they compared 18 patients with primary RTSA to 26 patients with failed ORIF who underwent salvage RTSA. There was no difference in ASES score, ROM and overall satisfaction between both groups suggesting that an ORIF can be attempted in many patients without the fear of compromising a revision RTSA. And although RTSA may provide more predictable results, in a properly selected patient, a well executed hemiarthroplasty can outperform an RTSA. In a study from Molé et al., 38 patients were randomized to either RTSA or to a hemiarthroplasty. In the hemiarthroplasty group, half of the patients had <90 degrees of forward elevation and half the patients had >120 degrees of forward elevation showing a bi-modal distribution dependent on tuberosity healing. In the RTSA group, however, while having an average of 115 degrees of forward elevation, 68% of patients had less than 120 degrees of forward elevation. While RTSA is a great tool to treat complex displaced comminuted fractures in elderly patients with poor bone quality, it should not be blindly applied to all fractures types and all patients.

References:

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Notes:

SESSION III

Complications in Shoulder Arthroplasty: "Dealin' with Difficulties"

Leesa M. Galatz, M.D. - Moderator

PAPER #9

1:00 PM - 1:05 PM

Managing the Infected Arthroplasty: *Clean Out, 1-Stage or 2-Stage*

Eric R. Wagner, M.D., M.S.

The management of a failed shoulder arthroplasty secondary to infection remains a difficult and controversial decision. Historically, surgeons followed the guidelines set forth in hip and knee arthroplasty, despite often having a very different microbium. This has changed in recent years, as many more studies have evaluated the various treatment options for periprosthetic shoulder infection, including irrigation and debridement and component retention, single-stage component exchange, two-stage component exchange, resection arthroplasty, and even three stage exchange. Many of these studies have focused on the pathogen guiding the preferred treatment approach.

In patients with a suspected or confirmed periprosthetic infection, there remains controversy on the ideal treatment algorithm. Antibiotic suppression alone has failure rates between 60-75%, and should not be considered. For truly acute infections, irrigation and debridement with component retention has been successful in up to 70% of cases and should be considered. And although resection arthroplasty has good success at treating the infection, it leaves the patients with severe functional limitations. In most cases, the surgeon should consider either single-stage or two-stage exchange.

The single stage procedure involves component removal, extensive debridement with or without peroxide and betadine soaks, and a new component reimplantation in a single procedure. Historically, the outcomes of single-stage exchange were reserved to small case series of medically complex patients. However, in the last decade, there is emerging evidence that this is a very reasonable, and maybe even the preferred option when treating less virulent organisms, such as C. Acnes and S. Epidermidis.[1] In fact, it appears single-stage exchange for a known less virulent organism has a lower complication rate, but similar infection treatment success rate and ultimate functional outcomes.[2] In one study, single stage exchange for C. Acnes infections has similar functional rates to aseptic revision shoulder arthroplasties.[3] Furthermore, it has the potential for substantial cost-savings compared to two-stage exchange.[4] The length of the course of IV and oral antibiotics is also controversial, with adverse side effects from these antibiotics occurring in up to 19% of people.[5]

The two-stage procedure involves component removal and antibiotic spacer placement in the first stage, followed by 6-12 weeks of IV antibiotics and reimplantation once the final cultures are negative. For the two-stage exchange, the spacer permits the delivery of local antibiotics in a delayed fashion, maintains soft-tissue tension and allows patient to perform therapy prior to reimplantation. The spacer works so well in some patients that some choose permanent retention of the spacer.[6] However other studies have reported lower satisfaction and functional gains, despite promising eradication rates.[7] This has caused some surgeons to reserve this procedure for difficult to treat infections, such as staphylococcus aureus, enterococcus and fungi. For these organisms, a two stage exchange remains the gold standard[1] while for those with recurrent infections, a three-stage procedure has been proposed.[8]

My treatment algorithm:

1. Acute Infection (<6 weeks of surgery or <2 weeks of hematogenous spread): irrigation and debridement with polyethylene exchange, retention of any well-fixed components and revision of any grossly loose components.
2. Less Virulent Organism (E.g. C. Acnes, S. Epidermidis): Single-stage exchange with hydrogen peroxide and dilute betadine soaks and new sterile drapes prior to reimplantation.
3. Difficult to Treat Organism (E.g. S Aureus, Enterococcus, Fungal): Two-stage exchange with antibiotic spacer placement for 8-12 weeks, with therapy beginning at 2 weeks after spacer placement. Aspiration and lab work has to be negative prior to reimplantation.
4. Suspected Infection with No Known Organism: Two-stage exchange with duration dependent on the organism. For example, C Acnes will be spaced out by 6 weeks, while S Aureus will be spaced out by 3 months.
5. Recurrent Infection after Failed Prior Revision Attempts: Three-stage exchange involving resection and antibiotic spacer placements (1st stage), irrigation and debridement with spacer exchange and open biopsy (2nd stage), and reimplantation after negative aspiration (3rd stage).
6. Low Suspicion for Infection but 2+ intra-operative cultures for same organism: 3 weeks of oral antibiotics (my protocol for all revisions), changed to IV antibiotics for 6 weeks once cultures turn positive.

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Notes:

SESSION III

Complications in Shoulder Arthroplasty: "Dealin' with Difficulties"

PAPER #10

Avoiding Instability: *Getting the Soft Tissue Balancing Right*

1:05 PM - 1:10 PM

Evan L. Flatow, M.D.

Total shoulder arthroplasty has gone through several generations, as instruments and implant designs have given surgeons both more options in the alignment of the components and more guidance in the best choices to make. However, while the measurement of alignment has become more sophisticated,[1] the importance of particular aspects of alignment to actual patient comfort and function has been less completely characterized.[2]

Overstuffing of the joint and proud humeral heads have been most associated with clinical failure. The efforts to avoid this can be divided into two camps:

1. The anatomic school, who believe an experienced surgeon can divine the correct anatomy that existed before the distortions of arthritis began, and that the surgeon should make free-hand cuts and alignments to restore the normal anatomy.
2. The cutting-guide school, who believe that average versions and positions avoid error and that soft-tissue balancing requires occasional deviations from "normal" anatomy.

Reverse total shoulder replacement, in contrast, is a semi-constrained implant, with built-in "internal impingement" at the extremes of motion,[3] which can cause notching and/or instability (levering out). Initial European experience favored placing the humeral component in 0 degrees, but most surgeons have gravitated toward 15-20 degrees of retroversion to allow easy conversion from/to a hemiarthroplasty as needed. Increased retroversion may block internal rotation and increased anteversion limits external rotation.

References:

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SESSION III

Complications in Shoulder Arthroplasty: "Dealin' with Difficulties"

PAPER #11

Arthroscopic Debridement: *Best Friend/Worst Enemy*

1:10 PM - 1:15 PM

Jon J.P. Warner, M.D.

The Problem: Young active patients with arthritis who may not be optimum candidates for shoulder replacement. What is the success and what is the durability? What does the literature show? What does experience show? What is the evidence?

Experience: Short-term from experts and review papers support this approach.

Evidence: A total of 17 articles were published from 2000-2018 of which 8 were level 4 and 7 were level 5 evidence. The articles suggesting good outcomes numbered 3 while negative articles number 4. The remaining articles were review or opinion papers. A total of 262 cases were reported including the addition of biological resurfacing of the glenoid in addition to debridement.

Comparison of other joints: There is no evidence for arthroscopic debridement in the knee.

Conclusion: Positive opinion is short term without significant scientific method to support this approach. Several level 4 papers show poor outcome with follow-up. Current recommendation is on a case-basis decision with no firm evidence to support arthroscopic debridement.

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SESSION III

Complications in Shoulder Arthroplasty: "Dealin' with Difficulties"

PAPER #12

Peri-Prosthetic *Fx's: Repair, Replace or Treat Conservatively*

1:15 PM - 1:20 PM

William H. Seitz, Jr., M.D.

Fractures occurring about the shoulder in the presence of prosthetic implants have been dominated historically by fractures involving the humerus. The recent upsurge in the application of Reverse Total Shoulder Arthroplasty (RTSA), however, has led to the evolution of more scapular sided fractures more recently. Periprosthetic fractures on both sides of Total Shoulder Arthroplasty (TSA) present challenges both in decision making as well as surgical management. In rare cases with minimal displacement and relative stability, conservative care may be employed. In most, however, surgical intervention is needed. Depending on the quality of the surrounding bone, the health of the patient, the stability of the existing implant, and the integrity of the surrounding soft tissues, options for management include open reduction and internal fixation, long stem intramedullary fixation with implants, bone grafting, strut and cable fixation, or a combination of all these techniques. In some cases, complete revision arthroplasty may be indicated. An updated approach to surgical decision making, operative techniques and avoidance of complications will be presented.

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Notes:

SESSION III

Complications in Shoulder Arthroplasty: "Dealin' with Difficulties"

PAPER #13

Complications of Reverse Arthroplasty: *Learning from Your Mistakes*

1:20 PM - 1:25 PM

Sumant G. Krishnan, M.D.

Incidence of instability after Reverse TSA; up to 31%

Timing of occurrence: usually within 3 months post-operatively

Etiology:
1. Loss of Compression
2. Loss of Containment
3. Impingement

Clinical Evaluation:
- Bilateral humeral scanogram x-rays
- Glenoid CT scan with 3D reconstruction
- EMG (deltoid function/axillary nerve)
- Pre-operative "planning" worksheet

Solutions:
- Lateralized glenoid sphere
- Glenoid bone graft
- Augmented glenoid baseplate
- Larger/constrained polyethylene insert
- Augmented humeral metaphysis
- All prosthetic construct

Be prepared to revise everything!

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Notes:

SESSION III

Complications in Shoulder Arthroplasty: "Dealin' with Difficulties"

PAPER #14

Humeral Cemented Revision: *Techniques for Safe Extraction*

1:25 PM - 1:30 PM

Leesa M. Galatz, M.D.

Extraction of a cemented humeral stem can be challenging. The humerus has limited bone stock, especially proximally, making removal of a cemented stem very challenging. In some instances, a stem will be loose secondary to infection. In these cases, the stem will come out with relative ease. However, in cases where a shoulder arthroplasty is revised for glenoid or rotator cuff failure, removal of a well-fixed stem is arguably the most difficult part of the procedure. Removal of a cemented stem takes careful planning and a number of useful instruments available in order to perform this safely.

Specialized instrumentation such as special flexible osteotomes can be of help in removing a cemented stem. Circumferentially loosening the proximal cement with the osteotomes may allow removal with an impactor. A heat-based cement remover (Biomet Ultradrive) can be used to remove distal cement plugs. This is very risky and should only be used in experienced hands as the radial nerve in particular is at great risk. The surgeon should also have a detailed knowledge of the stem that is being removed. Many stems have certain characteristics and areas where cement can collect and make removal particularly difficult. A set of impactors of varying sizes can also be helpful. A drill or a Midas Rex can be used to create a notch in a solid stem in order to create an area to lever with an osteotome or impactor.

The proximal humerus is at significant risk of fracture during extraction of a cemented stem. The cortical bone around the proximal humerus is very thin and comprises the attachment of the very important rotator cuff muscles. If the rotator cuff is to be preserved, then special care should be taken in order to avoid fracturing the greater and lesser tuberosities during removal.

When all other techniques have failed, a cortical window can be created in the humerus. The hardest bone in the proximal humerus is in the bicipital groove. A saw or an osteotome can be used to make an osteotomy. Often, this is adequate to loosen the stem so it can be removed. A cortical window can also be used. The cement can then be removed and this gives access to the distal tip of the prosthesis. This bone window is preserved for later repair when the new prosthesis is seated.

This talk will present several techniques for humeral extraction. This is one of the more difficult procedures in shoulder surgery and care should be taken using these various techniques.

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Notes:

SESSION IV

What Would YOU do?
Challenges in Shoulder Surgery

PAPER #15

2:30 PM - 3:30 PM

Eric R. Wagner, M.D., M.S. - Moderator

Leesa M. Galatz, M.D.
Evan S. Lederman, M.D.
William H. Seitz, Jr., M.D.
Jon J.P. Warner, M.D.

Although shoulder reconstruction has made tremendous strides due to innovations in technology and surgical techniques, there remains many controversial and challenging questions surgeons face. In this session, we will focus on 5 controversial topics, going through important considerations when treating these challenging topics from our panel of experts. The topics include the following:

1. Posterior Glenoid Bone Loss Associated with Retroversion and Posterior Subluxation in Primary Shoulder Arthroplasty. Glenoid bone loss represents a common and challenging topic in the primary setting. When associated with glenoid retroversion and humeral head posterior subluxation, the normal shoulder mechanics is markedly altered. There is controversy regarding the ideal treatment for their patients. The concern for anatomic total shoulder arthroplasty (aTSA) in this setting is that if the subluxation is not perfectly corrected, edge loading will lead to an edge-loading pattern of early glenoid loosening in the setting of too much glenoid retroversion.[1] The reverse shoulder arthroplasty overcomes this concern via its semi-constrained design and baseplate ingrowth surface. However, the concern for reverse shoulder arthroplasty (RSA) is that aTSA has consistently shown superior clinical outcomes and range of motion to RSA.[2] Furthermore, the use of aTSA augments have improved the ability to treat Walch B2 glenoids.[3] This potentially overcomes the previous concerns about aTSA in the setting of mild-moderate glenoid bone loss. What is the threshold to utilize aTSA (with or without augments) versus RSA?

2. Massive Irreparable Posterosuperior Rotator Cuff Tear in a Young Patient. The management of massive posterosuperior rotator cuff tears is controversial, with no gold standard. In certain settings, the tears are considered irreparable, given the high failure rates associated with attempted repair. The treatment options for these irreparable tears include partial rotator cuff repairs, biceps tenodesis or tenotomy, augmentation or bridging with allografts, superior capsular reconstruction, subacromial balloon, or shoulder tendon transfers.[4] Although there are multiple case series examining each of these techniques, there remains a lack of high quality, prospective comparisons studies to help better elucidate a treatment algorithm. Furthermore, with the evolution of the RSA and continually improving outcomes, many people are performing this procedure in younger and younger patients.[5] Therefore, what is the ideal procedure for the irreparable tears?

3. Early (6 weeks) Subscapularis Failure after Anatomic Total Shoulder Arthroplasty. Subscapularis failure represents one of the most common early complications and modes of implant failure in aTSA.[6]. This is particularly appealing given that aTSA has been demonstrated to consistently have better

clinical outcomes and range of motion than RSA.[2] When this is diagnosed early in the post-operative setting, there remains controversy on whether to repair or reconstruct the subscapularis in an attempt to salvage the aTSA or to convert to an RSA. Nonetheless, subscapularis repair alone after aTSA has a historically high rate of failure.[7] One consideration that has emerged in recent years is the success of tendon transfers and graft augmentation for the treatment of irreparable rotator cuff tears, as would be seen in the setting of a prior shoulder arthroplasty.[8] Therefore, would an augmented (graft or tendon transfer) subscapularis repair be equivalent or superior to an RSA?

4. Humeral Bone Loss in Revision Shoulder Arthroplasty. Humeral bone loss remains a challenging and controversial topic in shoulder arthroplasty. Patients with either prior proximal humerus nonunions or failed arthroplasties that lose the tuberosities and proximal humerus bony support are prone to poor outcomes after arthroplasty. The lack of bone stock both de-tensions the deltoid and loses any attachment for the anterior or posterior rotator cuff, leading to an increased risk of instability after RSA. Furthermore, without the soft tissue drivers of internal and external rotation, combined with the loss of deltoid tension, the patient's motion is often very limited. Treatment of humeral bone loss >5 cm is controversial, involving either a standard RSA, proximal humerus endoprosthesis, or allograft prosthetic composite (APC) RSA.[9] Yet there remains a paucity of studies comparing these treatment options. Therefore, when would an endoprosthesis be reasonable compared to a regular RSA or APC RSA?

5. Glenohumeral Arthritis in a Young (~30-year-old) Patient. The treatment of glenohumeral arthritis in a young patient is challenging, given the 15-year survival rates of hemiarthroplasty or total shoulder arthroplasty is 77%.[10] Given the high demand and activity level of these patients, many surgeons prefer any attempt to prolong the arthroplasty for as long as possible. The comprehensive arthroscopic management (CAM) procedure preserves the joint, while treating multiple pain generators, including the inferior osteophyte, biceps tendon, degenerative cartilage, loose bodies, subacromial impingement and axillary nerve irritation. However, there remains a paucity of information on its long-term outcomes. Alternatively, shoulder arthroplasty is very predictable to relieve the patient's pain and motion early on, but there remain concerns over its long-term viability over the patient's lifetime. Therefore, when should a CAM procedure be considered, versus an arthroplasty, and which arthroplasty is preferable in these young patients?

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SESSION V

Surgical Procedure: Primary Knee Arthroplasty

William L. Walter, M.D., F.R.A.C.S., Ph.D. - Moderator

PAPER #16

Why Knees Fail: *Patient, Surgeon or Device?*

4:00 PM - 4:10 PM

Robert E. Booth, Jr., M.D.

Although the number of total knee arthroplasties is rising dramatically throughout the world, the incidence of revisional surgeries is rising even faster. Aseptic loosening, infection, and instability – in that order – have remained the primary causes of failure for at least two decades. True prosthetic failure is now almost eradicated, polyethylene degradation has been dramatically diminished, and many would hope/claim that the number of technical "outriders" is decreasing. Interestingly, the percentages of aseptic loosening are decreasing, while infection and instability are increasing. Fractures and stiffness ("arthrofibrosis") remain about the same, but are still significant factors in failure. The reduction in aseptic loosening may be from the radical reduction of osteolysis through polyethylene improvements or from more aggressive techniques of fixation. It is well known that infection and DVT are linearly related to the length of surgeries, thus the more complex techniques and technologies of today's knee arthroplasties undoubtably play some role in the rise of these complications.

While it takes one major error to undo a total hip, multiple minor errors are usually the reason for a failed total knee. Patterns of error are usually prevalent among individual surgeons, internal rotation of the tibia and/or femur being the most common. Tibial malrotation is diminished by the availability of handed components, with malrotation of the femur close behind. The extension first, flexion last, concept promulgated by MIS surgery may account for the flexion instability that is epidemic in failed knees. Axial alignment is far more accurate than it has ever been, on the other hand there is now controversy as to whether precise mechanical alignment is desirable – particularly in unicompartmental or kinematic designs. Prioritizing flexion, balancing and restoring the anterior posterior femoral "offset" has been a significant advance, but these concepts have not yet penetrated the orthopaedic community completely.

Unfortunately, the operating surgeon remains the greatest variable in a successful total joint. Experience, volume, and efficiency have a great deal to do with the biologic and mechanical consequences of a joint replacement. The surgeon's prejudices or choices also have a great impact. The small but still significant differences between PS/CR, fixation, sequence of steps, component design, incision size, etc. are all cumulative, in my mind. A lower percentage option at each decision point often leads to a lamentable outcome. Total knee arthroplasty remains a relatively sophisticated procedure which works best in the hands of experienced surgeons who can pre-operatively and intra-operatively make the decisions and adjustments that culminate in a successful total knee.

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Notes:

SESSION V

Surgical Procedure:
Primary Knee Arthroplasty

PAPER #17

4:10 PM - 5:00 PM

Medial Pivot TKA:
A Reflection of Normal Kinematics

David Backstein, M.D., F.R.C.S.(C), M.Ed.

Traditional kinematic theory of the knee has revolved around the concept of the "four bar linkage". Investigators including O'Connor and Goodfellow theorized that normal, taut cruciate ligaments are required to guide the femur posteriorly as the knee flexes. These authors stated that "because of the crossed form of the cruciate ligaments, flexion of the knee is accompanied not only by a sliding movement of the femoral condyles upon the tibia but also by an obligatory rolling movement which carries the contact areas backwards on the tibia in flexion and forwards in extension".[1] As a result, traditional total knee replacement (TKR) designs were all non-conforming in order to avoid a "kinematic conflict". Despite decades of satisfactory TKR outcomes, 20% of patients report being dissatisfied with their result.[2] It is also known, based on fluoroscopic studies, that normal femoral rollback rarely occurs with traditional total knee arthroplasty (TKA).[3] Thus, suboptimal patient satisfaction outcomes may be due to a degree of instability and "paradoxical motion".

More recently, research utilizing dynamic MRI has revealed that between 10 and 120 degrees of flexion, the articulating surfaces of the femoral condyles are circular in sagittal section and rotate around their center. In fact, it has been demonstrated that the medial condyle does not move antero-posteriorly and virtually all rollback occurs on the lateral side of the knee.[4]

It is reasonable to believe that a knee prosthesis with kinematics and stability which are closer to normal, will function more like the normal knee. Therefore, the kinematics and stability of a TKR should be as close as possible to those of the actively moving normal knee. The medial pivot (MP) design for TKA recognizes that there is not one path of motion of the knee. The knee is in fact free to move many different ways but it is guided by the compliance of the two compartments. MP TKA allows rotation around the medial side while maintaining a large contact area, regardless of motion. The lateral contact point may change in order to optimize lever arms. MP TKA surgery does not require traditional ligament balancing due to the medial conformity. Therefore extensive disruption and alteration of collateral ligament tension is not required.

MP designed TKA has now been available for more than 20 years and numerous research studies have demonstrated no cost in terms of survivorship or polyethylene wear rates. Macheras, et al. has published 98.8% survivorship with of one medial pivot design at 17 years follow-up.[5] In a systematic review, Fitch, et al. found a 99.2% and 97.6% survivorship at 5 and 8 years, respectively.[6] Samy, et al. with an MP-TKA in a retrospective comparison to a traditional posterior stabilized design found superior high-end function and patient satisfaction in the MP knee, as shown by the significantly higher FJS-12 score.[7]

In summary, the normal knee is more stable and less compliant on the medial side than the lateral side. Traditional TKR was designed to avoid a non-existent kinematic conflict. Better outcomes are likely if TKR designs more closely mimic the normal knee kinematics.

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Notes:

SESSION VI

Orthopaedic Crossfire® II: Controversial Issues in Knee Arthroplasty

Daniel J. Berry, M.D. - Moderator

PAPER #18

Optimal UKA Outcomes Require Robotic Use – *Affirms*

5:30 PM - 5:36 PM

Robert L. Barrack, M.D.

The great dilemma with partial knee replacement is the variability in results because of the requirements of an exacting surgical technique. Standard manual instruments have been inconsistent across numerous investigator reports as well as in all national registries reporting results of partial and total knee replacement. One very experienced, high volume knee surgeon reported 13% revision rate at 5 years compared to a 2% revision rate at 7 years for his primary total knee replacements.[1,2] Similar results were reported from Vancouver with 10-year revision rates for mobile bearing knee replacement of 18% and fixed bearing knee replacement at 12%.[3] Consistently inferior results have been reported for partial knee replacement compared to total knee replacement from registries including the United Kingdom, Australia and Scandinavia. A study performed at Washington University found similar results with 15% revision rates for both fixed and mobile bearing knees at only 5-10 year follow up.[4] This is also confirmed in a study from Lonner, et al. that reported on the Medicare database recently with a 10-year survival rate of only 75%- 80% for partial knee replacement compared to over 95% for total knee replacement. The same results were reported but in the Market Scan non-Medicare database with virtually identical results.[5]

The study from Washington University revealed the major risk factor for early revision was inaccuracy in placement of the components. All radiographic targets were hit less than 20% of the time with manual instruments. A follow up study from the same institution reported about 70% success in achieving ALL radiographic targets with robotic arm assistance. This improved accuracy is highly likely to result in a much lower revision rate. This is being confirmed in the early results in the Australian registry which have achieved short term revision rates of about 2%, equivalent to that of total knee replacement. While the occasional report in the literature does appear to achieve a good 5-10 year survival in the hands of very experienced high volume surgeons utilizing manual instruments, this is the exception rather than the rule. The overwhelming majority of independent reports from non-designer surgeons and all registries indicate that with manual instruments the revision rate with partial knee replacement is unacceptably high. Recent reports with robotic arm control indicate that partial knee replacement can be consistently highly accurate, and this will undoubtedly lead to improved results in terms of clinical outcomes and long-term survival. The future of partial knee replacement is highly likely to be restricted to performance with robotic assistance.

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Notes:

SESSION VI

Orthopaedic Crossfire® II: Controversial Issues in Knee Arthroplasty

PAPER #19

Optimal UKA Outcomes Require Robotic Use – *Opposes*

5:36 PM - 5:42 PM

R. Michael Meneghini, M.D.

Unicompartmental knee arthroplasty (UKA) continues in popularity and is increasing at a rate greater than TKA. Further, component alignment is critical to success, but in early function and in longer term survivorship. While it has been shown in some studies that robotic-assisted unicompartmental knee arthroplasty (UKA) can improve accuracy and optimize implant position,[1-3] robotic-assisted surgery is the latest expensive technology that lacks data-derived value and is prematurely driven by industry. Unfortunately, the peer-reviewed literature on the subject of robotic-assisted knee arthroplasty is replete with industry bias.[4] In a recent meta-analysis of peer-reviewed studies on robotic-assisted knee arthroplasty, the authors reported that robotic-assisted UKA manuscripts were more likely to be industry funded or be written by authors with financial conflicts of interest and published in less prestigious journals without an impact factor.[4] Further, multiple recent non-biased meta-analyses have demonstrated that robotic assistance has not translated into improved functional or patient outcomes, as has been purported by the proponents of robotic assistance.[5-7]

Like so many procedural outcomes regardless of surgical specialty, UKA outcomes are consistently optimized by surgeon experience and annual volume. There is data to support that improved UKA survivorship is associated with higher volume surgeons and a greater usage rate of UKA.[8-10] A meta-analysis of 12,520 mobile-bearing UKAs revealed that a usage rate of at least 20% resulted in optimal long-term survivorship, irrespective of annual surgeon UKA procedure volume.[8] UKA procedure usage rate as the dominant predictor of long term survivorship was further supported in a national registry analysis of 41,986 UKA (69.5% mobile bearing), which demonstrated an optimal usage rate of at least 20% and a higher revision rate if UKA procedure usage rate was less than 5%.[10] The authors further noted that the mobile-bearing design was more sensitive to usage rate than fixed-bearing designs.[10] Recently, in a study of 14,814 propensity match medial UKAs, an excellent 10-year survival rate of 94-97% was reported for high volume surgeons, which is comparable to the best performing TKA survival rates.[11] These outcomes would be nearly impossible to improve upon with robotics due to the ceiling effect.

The aforementioned survivorship data can be supported by the fact that surgical and technical skill can be optimized with training, experience and consistent repetition of the procedure by surgeons with appropriate psychomotor capacity and three-dimensional orientation ability. This is particularly relevant in terms of comparison to robotic-assisted UKA with regard to accuracy of implant position, as the UKA procedure is performed with all necessary "data points and boundary limits" within the surgeon's field of view. To this end, it has recently been shown that an experienced surgeon can match, and in some metrics actually exceed robotic-assisted accuracy in UKA component position.[12]

As with all emerging technology, the potential downsides and increased risks associated with robotic assistance in UKA compared to traditional UKA are now becoming known. Increased surgical time

and surgical team stress is consistently observed during the "robotic learning curve" and has been reported to last the first 6 to 36 surgical cases.[13] Potentially a sequelae of increased operative time for robotic-assisted UKA, a recent study has also demonstrated an increased infection rate compared to manual UKA with a hazard ratio of 3-5.5 depending on the comparison cohort.[14]

Finally, the post-COVID world mandates procedural efficiency to optimize access, as well as dramatic cost-containment to offset both the economic downturn and severe hospital losses from lack of profitable elective surgical procedures and bearing the financial burden of COVID-19 treatment. Robotic-assisted surgery for UKA has negligible relevance in 2020 and for the foreseeable future, especially with the emergence of data suggesting increasing operative time and increase risk of early revision for infection. If you are a surgeon who does not have the experience with performing UKA to enact optimal outcomes, you have two options: become more proficient by performing more UKA procedures or send the appropriate patient to someone with more surgical experience in UKA.

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Notes:

SESSION VI

Orthopaedic Crossfire® II: Controversial Issues in Knee Arthroplasty

PAPER #20

5:50 PM - 5:56 PM

Outpatient TJA Surgery: *The Best Sum of All Things – Affirms*

Richard A. Berger, M.D.

Historically total joint arthroplasty was an inpatient procedure, requiring a long hospitalization. However, with minimally invasive surgery, combined with multimodal pain control, better rehabilitation, and education, I began same day total joint replacement in 2001. Since then I have performed over 11,000 same day joint replacements. In 2019, 76% of my primary joint replacements were done as same day cases.

Although initially met with skepticism 2 decades ago, more recently, there has been an ongoing shift toward performing total joint arthroplasty as a same day procedure. Many surgeons have shown performing total joint arthroplasty can be done safely in an outpatient environment.[1-6] While same day surgery can be performed in three different environments; 1) standard hospital operating room, 2) hospital outpatient department and, 3) free-standing ambulatory surgery centers (ASC), most surgeons who are preforming same day joint replacement are performing this at an ASC.

The impetus for this shift is multifactorial. ASCs represent a lower-cost alternative to hospitals for outpatient procedures.[4,7-9] ASCs are designed to accommodate high volume efficiently and provide surgeons an environment to perform more cases in less time than a traditional hospital environment, with more personal control. There may be opportunities for surgeons to participate as equity partners in certain facilities which provide additional revenue. Patients enjoy efficiency at ASCs and report high patient satisfaction. These represent a few of the reasons for the increased utilization of ASCs among surgeons.

That being said, safely performing total joint arthroplasty in an ASC is not without its challenges. Understanding the fundamental differences inherent in performing a same day total joint arthroplasty at an ASC is critical for success, patient safety, and quality. Those who have not yet started to perform same day joint arthroplasty should begin slowly. It is helpful to slowly reduce the length of stay in a hospital environment, implementing all the critical steps discussed in the presentation. When the surgeon is comfortable with an overnight stay, then beginning with healthy patients, start same day total joint arthroplasty in the hospital setting (either in a standard hospital operating room or a hospital outpatient department). Finally, when the surgeon is comfortable with outpatient total joint arthroplasty in the hospital, then should same day total joint arthroplasty in an ASC be contemplated.

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Notes:

SESSION VI

Orthopaedic Crossfire® II: Controversial Issues in Knee Arthroplasty

PAPER #21

Outpatient TJA Surgery: *The Best Sum of All Things – Opposes*

5:56 PM - 6:02 PM

Alejandro Gonzalez Della Valle, M.D.

The hospitalization time in patients undergoing total joint arthroplasty has been steadily decreasing since the 1990s.[1] This phenomenon has been the consequence of improvements in surgical and anesthesia techniques, and in peri-operative care. In addition, over the last few decades there has been a better understanding of the pre-operative factors that would increase the peri-operative risks, leading to a personalized care in which human and material resources are assigned with the goals of optimizing patients for elective surgery, and implementing proactive measures to avoid the likely post-operative complications.[2]

Coupled with these gestures, which have predominantly been improvements in medical care; there have been pharmacologic and technical advancements including the use of tranexamic acid, periarticular injections, indwelling peripheral nerve catheters, telemedicine enabled by cellular technology, and anterior approaches to total hip arthroplasty. These additional factors have proven to further reduce problems like pain and anemia that usually prolong hospitalization time. As hospitalization time shortened, some of the in-patient care has been shifted to an outpatient setting. This has resulted in the development of home physical therapy and visiting nurse programs, as well as in the proliferation of rehabilitation centers.

The quest to reducing hospitalization time has been further facilitated since the mid-1980s by the development of "fast track" recovery protocols. Implementation of these protocols has resulted in better, safer and less expensive patient care.[2]

So far, with reduction in hospitalization time, patients and the healthcare systems have benefited alike. With the latter seeing a reduction in the overall cost of care per beneficiary. The main question remains: how much can hospitalization time be reduced without adding risk to patients; particularly the risk of developing life-threatening complications that could be more effectively treated in a hospital setting.

In a quest to further reduce hospitalization time, ambulatory joint arthroplasty has gained momentum in the United States during the last five years. The interest in ambulatory surgery can be attributed to a number of factors, including the need to further reduce in-hospital cost, increasing productivity, and increased interest in "ambulatory surgical centers" by large private healthcare players and small investors alike.[3,4]

Since 2017, the Centers for Medicare and Medicaid Services is no longer considering total knee replacement as an "in-patient only" procedure. This decision, which is likely to be adopted by payors in the private sector has placed additional pressure on institutions and physicians to further reduce hospitalization time.

Under these circumstances, as a portion of the in-patient care is being shifted to an outpatient setting, institutions may have resources available to assure patient care, safety and satisfaction are not negatively affected. The resources include capability for patient monitoring, and early detection assessment and treatment of cardiovascular instability and other life-threatening complications.[3] This is of particular concern in patients with no obvious risk factors to develop life-threatening complications. Such patients are the most likely to be discharged home on the same day.

At the present time, the majority of elective joint replacements in the US are performed in an in-patient setting; with less than 15% being performed in an ambulatory setting. Identification of patients at a high risk to develop early complications as well as understanding the urban, social, cultural and infrastructure-related factors that play a role in the safe use of ambulatory surgery.

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SESSION VI

Orthopaedic Crossfire® II: Controversial Issues in Knee Arthroplasty

PAPER #22

6:10 PM - 6:16 PM

The Cementless Tibia: *Emergent Game Changer – Affirms*

Kenneth A. Gustke, M.D.

Total knee replacements are being more commonly performed in active younger and obese patients. Fifteen-year survivorship studies demonstrate that cemented total knee replacements have excellent survivorship, with reports of 85 to 97%.[1] But cemented knee arthroplasties are eventually doomed to fail due to loss of cement-bone interlock over time.[2] Inferior survivorship has been noted in younger patients [3,4] and obese patients [5,6] who would be expected to place increased stress on the bone cement interfaces. Roentgen stereophotogrammetric analysis (RSA) studies have predicted that cementless fixation should perform better than cemented fixation in the long-term.[7,8] However, cementless fixation for total knee replacement has not gained widespread utilization due to the plethora of poor results reported in early series.[9,10] The poor initial results with cementless total knee replacement have occurred largely due to poor implant designs with cobalt chrome low-porosity interfaces, poor initial tibial component stability, lack of continuous porous coating, poor polyethylene, and use of metal-backed patellae.

I have used cementless fixation for total knee replacements since 1986 for young, active, and heavy patients when durability over 20 years is desirable. My series of over 1,400 cementless TKRs represents about 20% of the 7,000 total knees I have performed from 1986 to 2019. I did see initial failures in my series due to the use of metal-backed patellae with thin polyethylene, older generation polyethylene, and use of screws with the tibial components which provided access to the metaphyseal bone for ingress of back-side polyethylene wear debris. Overall the incidence of implant fixation failures were still significantly low due to the use of implants with a highly porous titanium surface on both the tibial and femoral components.[11] Since the advent of utilization of implants with continuous porous surfaces, highly cross-linked polyethylene, and elimination of use of metal-backed patellae and tibial screws, I have only had one revision due to aseptic loosening or osteolysis in the last 1,169 cementless total knee arthroplasties performed since 2002.

Almost 50% of total knees are now performed on patients under the age of 65. A 55-year-old patient has a 30-year life expectancy. Modern total knee replacement design has made biological fixation predictable for young and heavy patients.[12,13] Because it is a biological interface, it should respond better than cement to the increased stresses that will be applied over many years by our younger, more active and heavier total knee population.

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SESSION VI

Orthopaedic Crossfire® II: Controversial Issues in Knee Arthroplasty

PAPER #23

6:16 PM - 6:22 PM

The Cementless Tibia: *Emergent Game Changer – Opposes*

Gwo-Chin Lee, M.D.

Cemented fixation in TKA remains the gold standard with low rates of loosening and excellent survivorship in several large clinical series and joint registries.[1] While cementless knee designs have been available for the past 3 decades, changing patient demographics (i.e. younger patients), improved implant designs and materials, and a shift towards TKA procedures being performed in ambulatory surgery centers has rekindled the debate of the role of cementless knee implants in TKA.

The drive towards achieving biologic implant fixation in TKA is also driven by the successful transition from cemented hip implants to uncemented THA. However, new technologies and new techniques must be adopted as a result of an unmet need, significant improvement, and/or clinical advantage. Thus, the questions remain: 1) Why switch; and 2) Is cementless TKA more reliable, durable, or reproducible compared to cemented TKA?

Cementless knee implants have had an inconsistent track record throughout history. While some have fared very well, others have exhibited early failures and high revision rates. Behery, et al. reported on a series of 70 consecutive cases of cementless TKA matched with 70 cemented TKA cases based on implant design and demographics and found that cementless TKA was associated with a greater risk of aseptic loosening and revision surgery at 5 years follow up.[2] Finally, to date, there has not been a randomized controlled clinical trial demonstrating superiority of cementless fixation compared to cemented fixation in TKA.[3]

Improvements in materials and designs have definitely made cementless TKA designs viable. However, concerns with added cost, reproducibility, and durability remain. Cement fixation has withstood the test of time and is not the main cause of TKA failure. Therefore, until there is significant data showing that cementless TKA is more durable, reliable, and reproducible compared to cemented TKA, the widespread use of these implants cannot be recommended.

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Notes:

SESSION VII

Surgical Procedure:
Primary Knee Arthroplasty

PAPER #24

Biologic Therapies 2020:
Where's the Beef?

10:05 AM - 10:15 AM

Aaron G. Rosenberg, M.D.

Inflammation appears to play a central role in the pathogenesis and progression of osteoarthritis, however, many of the underlying physiological mechanisms are still unclear and therapeutic treatments remain far from ideal. Biological therapies are highly tolerable with potential regenerative, anti-inflammatory and immunomodulatory effects. These bioactive anabolic and anti-catabolic molecules that modify the arthritic or regenerative process range from Hyaluronate preparations (HA) to cytokine and Autologous Protein Solution (APS) preparations. These formulations can vary by levels of growth factors, anti-inflammatory mediators, and cytokine levels. Additional biologic therapies are being studied, which includes; platelet-rich plasma (PRP) with varying leukocyte levels, marrow and adipose-based stem cells, Bone Marrow Aspirate Concentrate (BMAC) preparations, along with a number of autologous and allogeneic stem cell formulations.

FDA regulation of drugs, devices and autologous products affects the introduction and marketing of these products, as does the fact that consumer demand drives supply. While their efficacy in knee osteoarthritis (OA) remains controversial, there is no shortage of direct to consumer advertising and promotion of these products to patients, which are sold to patients for "cash only payments". Direct-to-consumer marketing efforts of largely unproven "biologic" treatments may diminish the public trust as well as inhibiting responsible platelet-rich investment and have resulted in comment from professional organizations and governing bodies. Websites devoted to the promotion of these products have been studied and are noted to be severely inadequate from the standpoint of educating patients about the role of these biological therapies in the treatment of musculoskeletal pathophysiology. Their language has been noted to be "intentionally imprecise and exploits the vulnerability of patients with debilitating diseases".

These products are commonly offered by orthopaedic surgeons, as well as a broad range of other physicians. Their use has been coupled with ultrasound guided injections to insure "accurate" delivery and has been associated with an increased cost of care. In a survey of 186 board certified orthopaedic surgeons' offices 18% offered PRP and 12% stem cells treatments; 61% were transparent on PRP pricing, while 32% gave a price for stem cell therapy. Mean cost for a PRP injection was $887 and $2800 for a stem cell injection. Corticosteroids and HA are generally reimbursed (except in 15 states where non-coverage decisions exist for HA). Biologics, however, have unproven benefit and are still considered investigational; 3rd party payers routinely do not reimburse for the procedure or the substance injected. Medicare considers these as non-covered services.

While most of these treatments remain at best experimental, factors which seem to be amplifying the demand include; some data supporting symptom modification, promotion of some as autologous and therefore inherently safe and "natural", as well as the lack of confidence in effective therapeutic alternatives accompanied by a generalized desire to avoid surgery. As the number of available treatments,

and the complexity of these issues is likely to increase, understanding of the clinical, ethical, financial, and medicolegal issues regarding these treatments is essential for those dealing with musculoskeletal health.

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Notes:

SESSION VII

Surgical Procedure:
Primary Knee Arthroplasty

Stephen M. Howell, M.D. - Moderator

PAPER #25

A Calipered Kinematically Aligned TKA

10:15 AM - 11:00 AM

Ryan G. Molli, D.O.

Total knee arthroplasty (TKA) procedures are classically considered to be one of the most successful operations that are done by orthopaedic surgeons. Although the majority of patients typically demonstrate significant satisfaction and objective clinical/functional improvements after total knee replacement, there are still ~20% of patients that state that they are "dissatisfied" with the results.[1,2] Several theories exist as to the source of this dissatisfaction, with most pointing towards unfulfilled expectations, persistent pain, and/or a knee that doesn't "feel" normal.[1,2] Although Mechanical Alignment (MA) techniques have long been deemed as the gold standard surgical technique for TKA, over the past decade, other techniques have been described to help improve patient satisfaction and Patient Reported Outcome Measures.[3-5] One such technique that has become much more popular over the past several years is Kinematic Alignment (KA).

Calipered Kinematic Alignment (KA) is a precise surgical technique that individually restores the native and pre-arthritic anatomy of each patient.[5] This technique utilizes conventional instrumentation and precise measurements obtained by a caliper to re-establish each patient's:

1. Native tibio-femoral joint line and its native obliquity
2. 3 native kinematic axes of the knee
3. Distal Lateral Femoral Angle (DLFA)
4. Proximal Medial Tibial Angle (PMTA)

The mid- and long-term clinical results thus far have been extremely promising. This technique demonstrates long term implant survivorship not only equivalent to Mechanical Alignment techniques, but has shown to be superior to MA with regards to survivorship.[5] Some of the clinical benefits of KA over MA include: less pain, no need for ligamentous release during surgery, more stable knees, restoration of normal/native knee kinematics, improved ROM (especially earlier when compared with MA), more "normal feeling" knees.[5,6]

We are presenting a surgical technique demonstrating the key steps to a calipered kinematically aligned total knee arthroplasty using conventional KA surgical technique and instruments. Continued long-term outcome and satisfaction studies are necessary to further assess the utility of this technique as it will likely continue to gain attention and acceptance and may even replace Mechanical Alignment techniques as the gold-standard technique in the future.

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Notes:

SESSION VIII

Management Factorials in Primary Knee Arthroplasty: Ensuring a Winner!

Gwo-Chin Lee, M.D. - Moderator

PAPER #26

11:30 AM - 11:36 AM

The Custom Total Knee Replacement: *A Bespoke Solution*

Jose A. Rodriguez, M.D.

The idea of restoring function by reproducing condylar anatomy and asymmetry has been gaining favor. More recent data on more closely matching the medial and lateral condylar geometry has shown clear functional benefit. The custom, individually made knee allows restoration of pre-arthritic articular condylar geometry, and thereby, more normal kinematics.

A CT scan allows capture of three-dimensional anatomical bony details of the knee. An engineer reviews each CT scan and the individual medial and lateral articular J curves are identified and corrected for deformity. They are then anatomically reproduced using a Computer-Aided Design (CAD) file of the bones and designed to maximally cover the bony surfaces and concomitantly avoid implant overhang. No options for modifications are offered to the surgeon, as the goal is anatomic restoration.

Given these ideals, to what extent are patients improved?

Kinematics
In comparing Custom TKR to off the shelf cruciate retaining implants, the kinematic patterns under deep knee bend and chair rise activities, and femoral rollback, were distinct in each implant design, but closest to normal in the custom cohort.

Clinical function – multi center, Sit to stand, Timed up and go, Timed stair climb (ALF)
All 3 measures of ALF were independently significantly different, and the overall ALF score was significantly faster in the Custom TKR group, even when controlling for age and post-op time.

Cost
The above noted functional benefits manifested in a net cost savings compared to off-the-shelf implants due to rehabilitation costs.

In summary, the use of custom knee technology to more closely reproduce an individual patient's anatomy holds great promise in improving the quality and reproducibility of post-operative function. Compromises of fit and rotation are minimized, and implant overhang is potentially eliminated as a source of pain. Early results have shown objective improvements in clinical outcomes. Time will reveal if this potential can become a reproducible reality. The ease of use and low inventory aspects of this technology also translate well to the ambulatory center as more surgery is shifted to outpatient in the post-COVID world.

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SESSION VIII

Management Factorials in Primary Knee Arthroplasty: Ensuring a Winner!

PAPER #27

Decoding the Varus Knee: *Are They All the Same?*

11:36 AM - 11:42 AM

Ashok Rajgopal, F.R.C.S.(Ed), M.S.

Varus knees constitute the largest cohort of deformed knees undergoing total knee arthroplasty. Several excellent articles are available in literature describing treatment options and techniques to correct these deformities and achieve a well-balanced, functional knee.

Thienpont, Parvizi described a new classification of the varus knee (JOA 2016). Current available treatment options to correct the varus knee include varying degrees of posteromedial soft tissue releases, reduction osteotomy, pie-crusting of the MCL, sliding osteotomy of the medial epicondyle and manipulating the femoral and tibial component placement by adjusting the cuts. Releasing the MCL has not been without its complications, despite several authors alluding to good outcomes using this option. There have been reports of over-releases and an increased incidence of MCL laxity in the coronal and sagittal plane and consequently a need for higher constrained implants.

Considering that the MCL is the most important and prime stabilizer for the knee, the authors explored and offered a template and a classification addressing different types of varus deformities. This morphological classification helps to understand the deformity and offers treatment options, wherein even the most severe varus deformity can be treated without violating the " MCL Complex". Our classification includes correctable and fixed varus deformities. The fixed varus cohort is further subdivided into knees with a) Angulation b) & c) Subluxation with and without torsions and d) Varus deformity with translation.

While the correctable varus and the fixed deformity with angulation and subluxation without torsion can be treated using standard soft tissue releases, the varus deformity with subluxation and torsion and the translational variety, needs releases and manipulating the posterolateral corner to achieve correction and a stable balanced knee. Releasing the posterolateral tether is critical to achieving satisfactory soft tissue balance in this cohort. Using this algorithm even the most severe varus deformities can be treated using primary CR/PS implant options with excellent stability and long term survivorship.

This presentation explains our procedural details and reflects on our own long tern results using this technique.

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Notes:

SESSION VIII *Management Factorials in Primary Knee Arthroplasty: Ensuring a Winner!*

PAPER #28 The Role of the Tourniquet in 2020

11:42 AM - 11:48 AM

R. Michael Meneghini, M.D.

Originally utilized to minimize blood loss and subsequent blood transfusions (irrelevant today with TXA), the use of tourniquets in primary total knee arthroplasty (TKA) remains controversial with mixed results in the literature. There are reports that suggest performing total knee arthroplasty without a tourniquet can reduce pain, minimize narcotic consumption, optimize quadriceps strength recovery, minimize distal DVT and enhance early function.[1-4] However, there are equivalent studies that demonstrate no difference in post-operative pain and patient outcomes regardless of whether a tourniquet is used during TKA.[5,6]

Exemplifying the lack of clarity on the use of tourniquets in TKA is the fact that 11 meta-analyses and 41 prospective studies on the topic since 2014.[7] Some important considerations that are variable in the literature and have been shown to affect outcomes with and without the use of tourniquets include tourniquet inflation pressure, inflation time and procedure duration. A consideration often mentioned is the ability to maintain an adequate cement mantle thickness during cemented TKA to enact long-term durability and survivorship, and it has been conclusively shown in the modern era that cement penetration is adequately maintained without using a tourniquet during TKA.[8,9]

In the era of tranexamic acid (TXA), the outcome of blood loss has become irrelevant. With modern peri-operative protocols that include TXA, clinically relevant blood loss that requires the use of transfusion is negligible in TKA regardless of whether a tourniquet is used or not.[3,10] With the ever increasing importance of pain control, early recover and rapid discharge, it is likely that the early time period after TKA that allows patients to discharge home with minimal pain and narcotic consumption is the most paramount of variables.

One patient variable has not been analyzed in most studies to date is the effect of tourniquet use during TKA on male or female patients. We have recently reported that not using a tourniquet in females enacted optimized pain control via decreased pain control and less opioid consumption after TKA.[3] Therefore, given other contra-indications to using a tourniquet such as vascular calcifications or suboptimal ABI's, in addition to the evidence supporting avoidance in females, from a uniform protocols standpoint, avoiding a tourniquet during TKA is the preferred methodology to minimize pain and optimize outcomes in 2020.

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Notes:

SESSION VIII

Management Factorials in Primary Knee Arthroplasty: Ensuring a Winner!

PAPER #29

Peri-Operative Pain Management: *Assuring a Happy Patient*

11:48 AM - 11:54 AM

Paul F. Lachiewicz, M.D.

Peri-operative management of the TKA patient begins pre-operatively, with education and appropriate expectations that it cannot be a completely pain-free procedure. Pre-operative use of opioid medication should be discouraged or eliminated, if possible. The use of a multimodal pain protocol should be embraced. A new AAHKS, ASRA, AAOS, and Knee Society Clinical Practice Guideline will be published in 2020. There appears to be "moderate" to "strong" evidence for the use of acetaminophen (po or IV), NSAIDs (po or IV), and limited oral opioid medication or tramadol peri-operatively. There is less data to support the use of gabapentinoids.

Surgeon-performed periarticular injection or anesthesiologist-performed femoral nerve or adductor canal block (ACB) with local anesthetic have been used in most multimodal pain management protocols for TKA patients. Anesthesiologist-performed ACBs are costly, time consuming, and may be unreliable. We investigated the feasibility of a surgeon-performed saphenous nerve ("adductor-canal") block from within the knee joint, in both basic science and clinical studies.

A retrospective analysis of 94 thigh-knee MRI studies was performed at HSS to determine the relationship between the width of the distal femur at the epicondylar axis and the proximal location of the saphenous nerve after its exit from the adductor canal and separation from the superficial femoral artery. After obtaining these data, TKA resections and trial component implantation were performed in the Duke HFTL, in 11 fresh cadaveric specimens. Using a blunt tip 1.5 cm needle, we injected 10 ml each of two different colored solutions at two different intra-articular medial injection locations, and after 30 minutes, dissected the femoral and saphenous nerve and femoral artery from the hip to the knee to determine the location of the injections. Based upon the MRI analysis, the saphenous nerve was located at a mean of 1.5 times the epicondylar width in females, and mean 1.3 times the epicondylar width in males, proximal to the medial epicondyle. After placement of TKA trial components and injection, the proximal injection site solution bathed the saphenous nerve in 8 of 11 specimens. The proximal blunt needle did not puncture the femoral artery and vein. This study suggested that a surgeon-performed injection of the saphenous nerve from within the knee is a feasible procedure.

We performed a retrospective two surgeon cohort study comparing short term peri-operative outcomes after primary TKA, in 50 consecutive patients with surgeon-performed high dose periarticular injection and intra-articular saphenous nerve block (60 mL 0.5% bupivacaine, 30 ml saline, 15 mg ketorolac) and 50 consecutive patients with anesthesiologist-performed ACB and catheter (0.25% bupivacaine 6 mL/hr infusion pump placed post-operatively with ultrasound guidance). The high-dose periarticular injection cohort had significantly lower pain scores in the PACU (mean difference 1.4, p=0.035) and on arrival to the inpatient ward (mean difference 1.7, p=0.013). There was no significant difference in pain score on POD#1 (mean difference 0.2), opioid use, day of discharge, or short-term complications. There were no adverse events related to the high dose of bupivacaine. In another study, a prospective randomized

trial, the surgeon administered adductor canal block (with PARI) was not inferior to anesthesiologist administered ACB with respect to range of motion, patient satisfaction, or opioid consumption.

This technique may be a useful alternative to ultrasound guided block. Newer, extended release anesthetic agents should be investigated with this technique.

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Notes:

SESSION VIII

Management Factorials in Primary Knee Arthroplasty: Ensuring a Winner!

PAPER #30

Blood Conservation Strategies: *The Impact of TXA*

11:54 AM - 12:00 PM

Thomas P. Schmalzried, M.D.

Blood loss and blood transfusion, both exceeding 1 liter, were an integral part of early total knee arthroplasty (TKA). Tranexamic acid (TXA) is an antifibrinolytic discovered in 1962. It is on the World Health Organization's List of Essential Medicines, the most effective and safe medicines needed in a health system. Side effects are rare and TXA is inexpensive. Almost 40 years after discovery, there is strong evidence that TXA reduces blood loss and transfusions in both primary and revision total knees with no increase in thrombotic complications.

Dosing ranges from 10-15 mg/kg (1-3 g) intravenous, 1-2 g in 30-100 ml normal saline topical, or 1-2 g oral. Although there are debates regarding dose and route(s) of administration, any administration of TXA is associated with reduced bleeding compared to no TXA. It is more effective to administer TXA pre-incision. There is conflicting opinion regarding multiple doses (i.e., pre-incision and again, in about 3 hours). Systemic plus topical may be more effective than either administration alone. Oral administration is the least expensive.

In a multicenter cohort study, TXA was associated with improved outcomes. Patients receiving TXA had a reduction in mean length of stay ($P < 0.0001$). TXA reduced the incidence of infection by approximately 50% ($P = 0.03$) and decreased incidence of revision surgery at 2 years ($P = 0.02$). There was no difference in the rate of pulmonary emboli ($P = 0.39$), myocardial infarction ($P = 0.55$), or stroke ($P = 0.77$).

TXA is safe for most total joint patients. In a study of >45,000 patients, TXA did not have a negative effect on the risk of cardiovascular events or death following total hip arthroplasty. Further safety evaluation should be directed toward patients at higher risk for complications after receiving TXA, such as those with previous coronary artery stents. Topical administration has been recommended for patients with a history of thrombo-embolic disease.

The combination of regional anesthesia with intentional hypotension and TXA has essentially eliminated the need for post-operative transfusion in primary TKA and many revisions.

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Notes:

SESSION VIII

Management Factorials in Primary Knee Arthroplasty: Ensuring a Winner!

PAPER #31

DVT Prophylaxis: *Think of the Old Aspirin*

12:00 PM - 12:06 PM

Antonia F. Chen, M.D., M.B.A.

A potential risk factor after total joint arthroplasty is the formation of deep vein thromboses (DVTs) secondary to immobility, manipulation of the vascular structures around a joint, or reaming of the intramedullary canal during surgery. To reduce the likelihood of developing DVTs after surgery, most orthopaedic surgeons give patients anticoagulation for 2-6 weeks following surgery. These anticoagulation agents commonly include injectable agents, such as heparin, enoxaparin (Lovenox), and fondaparinux (Arixtra), or oral agents, such as aspirin, warfarin (Coumadin), rivaroxaban (Xarelto), and apixaban (Eliquis). Historically, warfarin was common used, but the requirement for regular blood monitoring was often prohibitive. Enoxaparin was then utilized for a period of time; while use of enoxaparin did not require regular international normalized ratio (INR) laboratory tests, patients did not enjoy administering injections on a daily or twice daily basis.

With the increasing popularity of oral agents, some orthopaedic surgeons returned to using warfarin, while others started administering rivaroxaban and apixaban. These anticoagulants were popularized by cardiac patients, who were often placed on these medications when diagnosed with atrial fibrillation. While there was no monitoring necessary for these drugs, the only non-specific reversal agents for these potent anticoagulants was initially factor VIII inhibitor bypassing activity (FEIBA), prothrombin complex concentrates (PCC), and reverse factor 7a (rFVIIa). In 2018, andexanet alfa was approved by the Food and Drug Administration as a direct reversal agent for these direct factor Xa inhibitors. However, all of these reversal agents are expensive.

Aspirin has quickly become a favorite among orthopaedic surgeons as this oldie but goodie drug has a safety profile that is better than warfarin, and no blood product agents are needed to reverse the drug. Aspirin has officially been endorsed by the American Academy of Orthopaedic Surgeons (AAOS), American College of Chest Physicians (ACCP) and the American Society of Hematology (ASH) through their clinical practice guidelines process as acceptable anticoagulation after total hip and knee arthroplasty.

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Notes:

SESSION IX

What Would YOU do?
Challenges in Knee Surgery

PAPER #32

1:00 PM - 2:00 PM

Steven J. MacDonald, M.D., F.R.C.S.(C) - Moderator

Stephen M. Howell, M.D.
Denis Nam, M.D.
Ashok Rajgopal, F.R.C.S.(Ed), M.S.
Aaron G. Rosenberg, M.D.
Thomas P. Sculco, M.D.

This session will present a series of challenging and complex primary and revision cases to a panel of internationally respected knee arthroplasty experts.

The primary cases will include challenges such as patient selection and setting expectations, exposure, alignment correction and balancing difficulties. In the revision knee arthroplasty scenarios issues such as bone stock loss, fixation challenges, instability and infection management will be discussed.

This will be an interactive case-based session that at its conclusion should leave the attendee with a more thorough approach to these challenging issues.

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SESSION X

Surgical Procedure: Revision Knee Arthroplasty

George J. Haidukewych, M.D. - Moderator

PAPER #33

Developing a Personalized Outcome Prediction Tool for Knee Arthroplasty

2:30 PM - 2:40 PM

Nicolas S. Piuzzi, M.D.

Aims: The purpose of this study was to develop a personalized outcome prediction tool to be used with knee arthroplasty patients that predicts outcomes (lengths-of-stay [LOS], 90-day readmission, and 1-year patient-reported outcome measures (PROMs)) on an individual basis and allows for dynamic modifiable risk factor consideration.

Methods: Data was prospectively collected on all patients who underwent total or unicompartmental knee arthroplasty between July 2015 and June 2018. Cohort 1 (n=5,958) was utilized to develop models for LOS and 90-day readmission. Cohort 2 (n=2,391, surgery date 2015 to 2017) was utilized to develop models for 1-year improvements in Knee Injury and Osteoarthritis Outcome Score (KOOS) pain score, KOOS function score, and KOOS quality of life (QOL) score. Model accuracies within the imputed data set were assessed through cross-validation with root mean square errors (RMSE) and mean absolute errors (MAE) for the LOS and PROMs models, and the index of prediction accuracy (IPA) and area under the curve (AUC) for the readmission models. Model accuracies in new patient data sets were assessed with AUC.

Results: Within the imputed datasets, the LOS (RMSE 1.161) and PROMs models (RMSE 15.775, 11.056, 21.680 for KOOS pain, function, and QOL, respectively) demonstrated good accuracy. For all models, the accuracy of predicting outcomes in a new set of patients were consistent with the cross-validation accuracy overall. Upon validation with a new patient dataset, the LOS and readmission models demonstrated high accuracy (71.5% and 65.0%, respectively). Similarly, the 1-year PROMs improvement models demonstrated high accuracy in predicting 10-point improvements in KOOS pain (72.1), function (72.9%), and QOL (70.8) scores.

Conclusion: The data-driven models developed in this study offer scalable predictive tools that can accurately estimate the likelihood of improved pain, function, and quality life 1 year after knee arthroplasty as well as LOS and 90-day readmission.

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SESSION X

Surgical Procedure:
Revision Knee Arthroplasty

PAPER #34

2:40 PM - 3:30 PM

Revision Rotating Platform TKA: *A Bone Loss Solution*

Michael B. Cross, M.D.

The management of bone loss in revision total knee replacement (TKA) remains a challenge. To accomplish the goals of revision TKA, the surgeon needs to choose the appropriate implant design to "fix the problem," achieve proper component placement and alignment, and obtain robust short- and long-term fixation.[1-3] Proper identification and classification of the extent of bone loss and deformity will aid in pre-operative planning. Extensive bone loss may be due to progressive osteolysis (a mechanism of failure), or as a result of intra-operative component removal.[2] The Anderson Orthopaedic Research Institute (AORI) is a useful classification system that individually describes femoral and tibial defects by the appearance, severity, and location of bone defects.[4] This system provides a guideline to treatment and enables pre-operative planning on radiographs.

In Type 1 defects, femoral and tibial defects are characterized by minor contained deficiencies at the bone-implant interface. Metaphyseal bone is intact and the integrity of the joint line is not compromised. In this scenario, the best reconstruction option is to increase the thickness of bone resection and to fill the defect with cancellous bone graft or cement.[5-7] Type 2 defects are characterized by deficient metaphyseal bone involving one or more femoral condyle(s) or tibial plateau(s). The peripheral rim of cortical bone may be intact or partially compromised, and the joint line is abnormal. Reconstruction options for a Type 2A defect include impaction bone grafting, cement, or more commonly, prosthetic augmentation (e.g. sleeves, augments or wedges).[5-7] In Type 2B defects, metaphyseal bone of both femoral condyles or both tibial plateaus are deficient. The peripheral rim of cortical bone may be intact or partially compromised, and the joint line is abnormal. Options for a Type 2B defect include impaction grafting, bulk structural allograft, prosthetic augmentation, metaphyseal sleeves (in some cases), or metaphyseal cones.[5-7] Finally, in the presence of a Type 3 deficiency, both metaphyseal and cortical bone is deficient and there is partial or complete disruption of the collateral ligament attachments. In this case, the most commonly used reconstruction options include hinged implants or megaprostheses with or without bulk structural allograft, prosthetic augmentation, and/or metaphyseal/diaphyseal sleeves or cones.[5-7]

Today, we are fortunate to have a wide variety of options available to aid in reconstruction of a revision TKA with massive bone loss. Historically, use of cement, bone grafting, or use of a tumor-type or hinged implant were considered the main options for reconstruction. The development and adoption of highly porous sleeves and cones has given the surgeon a new and potentially more durable option for reconstruction of previously difficult to treat defects. Using radiographs and computed tomography, surgeons are able to pre-operatively classify bone loss and anticipate a reconstruction plan based upon the classification; however, it is always important to have several back-up options on hand during revision surgery in the event that the bone loss is worse than expected.

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Notes:

SESSION XI

Periprosthetic Joint Infection (PJI): Drugs, Bugs & Solution Options

Thorsten Gehrke, M.D. - Moderator

PAPER #35

Infection Prevention: *Modifiable Risk Factors*

4:00 PM - 4:06 PM

C. Anderson Engh, Jr., M.D.

The advent of bundled payment for total hip and knee replacement has demonstrated the importance of modifiable risk factors. The list of these "so called" modifiable risk factors seems to grow every week and depends on the database used to identify the risk. It is important to be aware, identify, and address relevant issues with each patient. This list is by no means comprehensive.

OBESITY: Multiple studies have identified obesity as a risk factor for infection. Two recent articles are noteworthy. D'Apuzzo et al. evaluated inpatient total knee infection using the National Inpatient Sample (NIS) database.[1] Morbidly obese (BMI >40) patients were matched with non-obese patients for commodities therefore isolating the effect of morbid obesity. Patients with BMI>40 had a modest 1.3 OR increase for inpatient infection. While the finding was significant, the modest increase suggested that medical comorbidities (controlled via matching) associated with BMI>40 are likely important contributors to infection. Ponnusamy et al, reported a systematic review and meta-analysis of THA revisions including septic revision as an endpoint.[4] Compared to non-obese patients the relative risk of septic revision for BMI 35-40, 40-50, and >50 was 3.17, 9.75, and 7.22, respectively. However, outcome scores were similar for all three obese groups.

MALNUTRITION: Golladay et al. summarized the definition, impact and options for correction of malnutrition.[6] The most commonly quoted indicators of malnutrition are serum albumin <3.5 or absolute lymphocyte count <1500. A NIS database analysis of total hip and knee replacements identified hypoalbuminemia in 4% of patients and they had a 2-fold increase in infection.[9] Hypoalbuminemia is associated with chronic disease and to the extent that simple nutritional interventions such as protein supplements, Iron, Vit. D, Vit. C and Zinc Sulfate, are not effective, these patients will need referral to specialists.

ANEMIA: Pre-operative anemia is present in a surprising high 22-44% of orthopaedic patients. Pre-operative anemia is an independent risk factor for infection.[2] Pre-operative lab evaluation 30 days prior to surgery allows treatment of iron deficiency with PO iron. However, anemia in the setting of GI bleeding or chronic disease can take more than 30 days. The majority of patients respond to PO iron over a 3-week period but if they do not respond consideration should be given to referral and rescheduling.

SMOKING: Smoking and a history of smoking increase the risk of wound complications.[10] All smokers are encouraged to stop smoking or substantially decrease their use. Consideration should be given to cotinine testing prior to surgery for smokers with additional comorbidities.

OPIOID USE: Bell et al. compared 5051 (21%) of 23,754 patients that used opioids prior to surgery. [11] Prior opioid users had a PJI rate of 1.4% compared to 0.86% in non-users. After controlling for confounding variables pre-operative opioid use was an independent risk factor for infection (OR 1.53).

Cancienne et al. used a national database to study 113,337 total knee patients of which 31,733 were prescribed narcotics prior to surgery.[5] Pre-operative narcotic use was a mild but significant risk factor for PJI within 1 year (OR 1.08).

DIABETES: Poorly controlled blood sugar has been associated with increased surgical site infection. In patients with known diabetes a HgbA1c>8 or fasting glucose >200 is associated with infection. Recently fructosamine has been identified as a better screening tool for surgical site infection in total hip and knee.[7] Patients with a level greater than 293 were 11.2 times more likely to develop a PJI. Thirty-seven percent of nondiabetic patients had a fructosamine >293.

PROPHYLACTIC ANTIBIOTIC CHOICE: Wiles et al. evaluated the risk of PJI when a prophylactic antibiotic other than a cephalosporin was used.[3] Knowing that the most common reason a cephalosporin was not used was a penicillin allergy they allergy tested these patients. Out of 29,695 THA and TKA patients 11.5% of patients were allergy tested. Ninety-seven percent of those tested were cleared for cephalosporin use. PJI was 32% lower in patients treated with cefazolin. Allergy testing of penicillin allergic patients increased the proportion of patients getting cefazolin prophylaxis by 27%. Therefore, antibiotic choice is modifiable risk factor for infection.

BENIGN PROSTATIC HYPERPLASIA: In a "first of its kind" study of primary and revision hip and knee arthroplasties Yazdy et al. compared 305 patients with symptomatic BPH to 10,258 without BPH. [12] Symptomatic BPH was defined as having been on or on a BPH related medication. A multivariate logistic regression analysis identified BPH (OR 5.27) and others as independently related to 1-year PJI. To address the multiple patient variables contributing to PJI in the first post-op year, BPH patients were matched 1:3 to patients without BPH. Symptomatic BPH patients continued to have a higher infection rate (OR 2.21, BPH 7.2% PJI vs Control 3.4%).

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SESSION XI

Periprosthetic Joint Infection (PJI): Drugs, Bugs & Solution Options

PAPER #36

Diagnosing PJI: *A Step-by-Step Evaluation Protocol*

4:06 PM - 4:12 PM

Antonia F. Chen, M.D., M.B.A.

The diagnosis of periprosthetic joint infection (PJI) always starts with a good history and physical exam. It's important to pay attention to the duration of symptoms, which include erythema, fever/chills, increased pain with range of motion and sinus tracts. Serum tests, such as erythrocyte sedimentation rate and C-reactive protein, can help screen for elevated inflammation in the body but is not specific to the hip or knee. To obtain more definitive information, a synovial fluid aspiration should be performed and sent for white blood cell count, polymorphonucleocytes, crystals and culture. Gram stain should not be performed on the fluid, and cultures should be held for a minimum of 14 days. If the results are equivocal according to the Musculoskeletal Infection Society definition of PJI, then additional synovial fluid testing or imaging may be beneficial.

With regards to imaging, x-rays should be obtained at baseline to evaluate for implant lucency; however, they do not have a high diagnostic value for PJI. Magnetic resonance imaging, computed tomography and nuclear medicine scans also provide minimal value for the diagnosis of PJI, while tagged white blood cell scans can be beneficial.

For further laboratory testing, synovial fluid biomarkers with high sensitivity and specificity for PJI include alpha-defensin, C-reactive protein, D-dimer, leukocyte esterase, fibrinogen and procalcitonin. Advanced molecular testing can be used to determine organisms that are present, especially in culture negative infections, including electrospray ionization mass spectrometry, polymerase chain reaction (PCR), fluorescent in situ hybridization (FISH), and next generation sequencing. By combining these different tests, the ability to diagnosis PJI becomes easier.

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Notes:

SESSION XI

Periprosthetic Joint Infection (PJI): Drugs, Bugs & Solution Options

PAPER #37

DAIR: *An Emerging Alternative for PJI*

4:12 PM - 4:18 PM

Fares S. Haddad, M.D., F.R.C.S.

Periprosthetic joint infection (PJI) can be a devastating event for the patient and is challenging to treat and expensive for all concerned. The primary aim of treatment is to restore a functioning joint. Whilst staged revision arthroplasty has been considered the standard treatment for PJI by many surgeons, Debridement, Antibiotics and Implant Retention (DAIR) should be considered as an alternative option in a selected group of patients.

The choice of surgery is determined by multiple factors. Patient fitness for surgery, co-morbidities, patient choice, the type of infection and its chronicity and the skillset and training of the surgical and infectious diseases team, all play a part.

Whilst two stage revision arthroplasty is still considered the standard treatment for PJI, single stage revision and DAIR are gaining popularity due to favorable reported outcome results.

Most studies report better than 60% infection control rate. Early post-operative and acute hematogenous infections (Tsukayama II and III), organisms sensitive to available antibiotics, selection of appropriate antibiotics targeting high virulence organisms, and exchange of any modular components are considered important factors for a better infection control rate.

The economic effects of different surgical strategies in the management of PJIs have been sparsely reported. Whilst exchange arthroplasty is well accepted by many studies, it is likely to have a higher rate of surgical morbidity and is more expensive than debridement and retention. Fisman et al. compared the effect of different treatment options on quality of life in infected THAs. Comparing implant retention vs. two stage revision (with median time to implantation of 2 months), patients undergoing debridement and retention were subject to a greater number of operations and also a higher infection recurrence rate. However, when age was taken into account (i.e. frail population over the age of 80), the quality adjusted life expectancy was superseded using the implant retention approach. In their study debridement and retention was shown to increase life expectancy by 2.2-2.6 quality adjusted life months and furthermore had a favorable cost-effectiveness ratio. On this basis it may be suggested that debridement and retention be a cost effective strategy for treatment of PJIs in the older population.

Due to lack of well-structured clinical trials drawing a robust conclusion on the effect of infecting organisms and timing of the intervention on the clinical outcome of DAIR and success in infection control is difficult, however, the majority of the published series suggest better outcomes with DAIR in early post-operative infections or acute hematogenous infection, and less favorable outcomes of DAIR in the presence of staphylococcal infections particularly Methicillin resistant ones. The role in well established infections with implants that are well fixed is still in debate. Whilst further well-structured studies are needed to clarify clear indications and predictive factors of successful DAIR

in PJI, we recommend DAIR with the exchange of modular components in highly selected patients including early post-operative infections and acute hematogenous PJI provided there is an appropriate multidisciplinary team in place.

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SESSION XI

Periprosthetic Joint Infection (PJI): Drugs, Bugs & Solution Options

PAPER #38

An Inadvertent One Stage Solution

4:18 PM - 4:24 PM

Donald S. Garbuz, M.D., F.R.C.S.(C)

Two stage exchange has been the gold standard in North America for the treatment of infected knee replacements. The choice of static versus articulated spacers has been debated for a number of years.

At our institution our choice of spacer for 2 stage exchanges is an articulated spacer. This allows motion between stages which facilitates recovery, and makes the second stage technically easier . In a study from our institution we followed 115 infected TKAs treated with the prostalac articulated spacer for 5-9 years. Success for eradication of infection was 88%. With a repeat two stage, overall infection control was 98%. In addition, we compared functional outcomes to a group of aseptic knee revisions and found no difference in functional outcomes with standard quality of life outcome scores.

While the articulated spacers was our treatment of choice in 2 stage exchange, around 2012 the company that manufactured the prostalac knee components ceased to manufacture them. At that time, based on the work of 2 previous studies (Hofmann, Lee), at our institution we continued to use articulated spacers. However, this was now the so-called Hofmann technique with a new standard femoral component with an all polyethylene tibia. The only difference from a standard knee revision was no stems and the utilization of high dose antibiotics. We also followed the principles from Europe of one stage exchange, such as wide debridement and soaking in dilute betadine for 15 minutes.

More recently as of Sept 2015 we have used an all poly tibia with a keel. The hope being that this will give a more stable tibia than previous and perhaps make a second stage unnecessary. Our first case was September 2015. In most cases the intention was not to do a second stage if the infection was eradicated and the patient had good pain relief and function. To date we have implanted 30 of these. Of these 19 patients (20 knees) had minimum 2 year follow-up when we reviewed them. Of these, 7 had the construct inserted as the planned first stage of a 2 stage exchange. This left 13 knees in 12 patients who the construct was inserted with no definite plan for a second stage. Of these 13, 11 have retained their implant, are infection free and enjoy good outcome. One patient had a second operation for loosening and one had further surgery for repeat infection. This so called “inadvertent one stage exchange” continues to be our treatment of choice for chronic knee infections.

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SESSION XI

Periprosthetic Joint Infection (PJI): Drugs, Bugs & Solution Options

PAPER #39

4:24 PM - 4:30 PM

Continuous Intra-Articular Antibiotic Administration: *Inhibiting the Bio-Film*

Leo A. Whiteside, M.D.

Infected total joint arthroplasty is catastrophic, but a high rate of success is possible with proper treatment. Two-stage revision with antibiotic-loaded cement spacer is the most widely accepted method of treatment for infection, and considered by some to be the best method; however, single-stage treatment currently is used widely and is gaining acceptance.[2] Although antibiotic-loaded cement is considered to be important for antibiotic delivery after surgery, cementless revision is equally successful with one- or two-stage procedures.[1,11]

Delivery of antibiotics with depot methods, such as cement or bone graft loaded with antibiotics, is considered to be effective, but the antibiotic concentration levels rapidly deteriorate after three days, leaving the cement itself vulnerable to colonization by resistant organisms.[7] Nephrotoxicity is uncommon, but it does occur,[5] and requires removal of the cement. This can be catastrophic if the implants are fixed with antibiotic-loaded cement.

Success rates of THA revision for infection can be as high as 98%, depending on the organism. Failure rates of 20% are the norm for resistant organisms such as methicillin-resistant Staphylococcus aureus [3] and the cost of failure is high.[4] Failure probably is due to the low concentration of antibiotics in the operative site. Antibiotic infusion into the operative site achieves concentrations that are hundreds of times higher than can be achieved with any other technique [6,8-10] and has the additional advantage of being stopped in the case of renal or auditory damage. 500 mg vancomycin is infused intraarticularly via Hickman catheter once or twice daily for 6 weeks. No IV antibiotics are used after the first 24 hours. Serum vancomycin levels are monitored to maintain levels between 3 and 10 µg/mL. Limited personal experience suggests that the failure rate of revision total hip with resistant organisms is significantly lower with intra-articular delivery than with other currently available methods.

Between Jan 2002 and July 2013, 9 patients (9 hips) presented with late-onset acute infection in cementless THA with bone-ingrown implants. All patients were more than 2 years from their original surgery and had acute symptoms of infection for 4-9 days. Two were the author's patients and 7 were referred from other institutions. None had symptoms until the onset of their infection, and none had post-operative wound complications, fever, or prolonged pain suggestive of a chronic process. All were treated with débridement and head/liner exchange, followed by catheter infusion of intra-articular antibiotics. All remained free of signs of infection at a mean follow-up of 74 months (range, 62–121 months).[10]

This same protocol was used in 18 knees (18 patients) with methicillin-resistant Staphylococcus aureus treated between Jan 2001 and Jan 2007 with one-stage revision that included débridement, uncemented revision of total knee components, and IA infusion. Minimum follow-up was 27 months (range, 27-75 months). Mean followup was 62 months, (range, 27–96 months). At 2-year follow-up, mean Knee

Society score was 83 ± 9. No radiographic evidence of implant migration has occurred. One knee reinfected with MRSA and was reoperated at 5 months. A necrotic bone segment was found, the knee was debrided and revised, and the antibiotic infusion protocol was readministered. The knee remained free of infection at 42 months post-operatively.

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SESSION XI

Periprosthetic Joint Infection (PJI): Drugs, Bugs & Solution Options

PAPER #40

4:30 PM - 4:36 PM

The Two-Stage Standard: *Techniques, Timing & Statistics*

Daniel J. Berry, M.D.

Two-stage treatment of chronically infected TKA is the most common form of management in North America and most parts of the world. One-stage management has pros and cons which will not be discussed in this lecture but are discussed in another lecture in this session.

There is great variation of techniques and timing of two-stage treatment and little data to definitively support one technique or timing approach versus another. Most methods are based on empirical success and logic.

At surgery, the first step is removal of infected implants. All metallic implants and cement should be removed. The most common places to leave cement behind inadvertently include patellar lug holes, femoral lug holes, and the anterior proximal tibia behind the tibial tubercle. Formal synovectomy should be performed. The next step is typically antibiotic-impregnated spacer placement. There are pros and cons of dynamic versus static spacers with no clear evidence of superiority of one versus another. Dynamic spacers work well (and maintain patient function during the resection interval) with mild to moderate bone loss. More severe bone loss usually is better treated with static spacers. Most antibiotic spacers are made of methylmethacrylate cement with addition of high-dose antibiotics. In most cases, doses of 4-8 gm of antibiotics per pack of cement are preferred. Antibiotic dosing depends on the specific antibiotic and the type of cement used. The most commonly used antibiotics are vancomycin and gentamycin. When the medullary canals have been instrumented, antibiotic-impregnated cement wands are placed in the medullary canal, as the canals have a high risk of residual bacteria being present.

The resection interval may vary and there is no clear evidence of a "best" resection interval. Practically speaking, most surgeons use a resection period of 8-16 weeks depending on the type of spacer utilized. During the resection interval, serum markers (ESR and CRP) are followed periodically. One looks for a decline or normalization of these parameters prior to second stage reimplantation procedure. There has not been a demonstrated advantage to reaspiration of the knee before reimplantation in most circumstances.

At the time of reimplantation, spacers are removed and the knee is redebrided. The key at reimplantation is to obtain good implant fixation but to also balance this with the potential for manageable extraction of the implants at some later date. Good implant fixation is important because failure rates due to mechanical failure are approximately equal to those of failure due to reinfection by ten years. It is important to remember that reinfection risk is at least 10% by ten years, and therefore extractability of implants is also important. Post-operative management typically includes IV antibiotics, followed by oral antibiotics until final intra-operative cultures are available. The role of extended antibiotic prophylaxis or selective long-term antibiotic suppression is under active investigation.

The results of two-stage reimplantation are reported in many series. Most show approximately 85-95% rate of successful eradication of infection in the first five years. Reinfections, often with different

organisms, may occur even late after reimplantation. By ten years after surgery survival free of mechanical failure and infection in most series drops to 80% or less due to recurrent infections and mechanical failures.

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SESSION XII

Problems After Knee Arthroplasty: Things That Go "Bump in the Night"

Robert E. Booth, Jr., M.D. - Moderator

PAPER #41

5:30 PM - 5:36 PM

Managing Wound Complications: *A Knee is Not a Hip*

Gwo-Chin Lee, M.D.

Infection following total knee arthroplasty (TKA) can cause significant morbidity to the patient and be associated with significant costs and burdens to the healthcare system.[1] Wound complications often initiate the cascade that can eventually lead to deep infection and implant failure. Galat et al. reported that wound complications following TKA requiring surgical treatment were associated with a 2-year cumulative risks of major reoperation and deep infection of 5.3% and 6.0%, respectively.[2] Consequently, developing a systematic approach to the management of wound problems following TKA can potentially minimize subsequent complications.

Unlike the hip, the vascular supply to the soft tissue envelope to the knee is less robust and more sensitive to the trauma of surgery.[3] Therefore, proper soft tissue handling and wound closure at the time of surgery can minimize potential wound drainage and breakdown post-operatively. Kim et al. showed using a meta-analysis of the literature that primary skin closure with staples demonstrated lower wound complications, decreased closure times, and lower resource utilization compared to sutures.[4] However, a running subcuticular closure enables the most robust skin perfusion following TKA.[5] Finally, the use of hydrofiber surgical dressings following surgery was associated with increased patient comfort and satisfaction and reduced the incidence of superficial surgical site infection.[6]

A wound complication following TKA needs to be managed systematically and aggressively. A determination of whether the extent of the involvement is superficial or deep is critical. Antibiotics should not be started without first excluding the possibility of a deep infection.[7] Weiss and Krackow recommended return to the operating room for wound drainage persisting beyond 7 days.[8] While incisional negative pressure wound therapy can occasionally salvage the "at risk" draining wound following TKA, its utilization should be limited only to the time immediately following surgery and should not delay formal surgical debridement if indicated.[9] Finally, early wound flap coverage and co-management of wound complications with plastic surgery is associated with increased rates of prosthesis retention and limb salvage.[10]

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SESSION XII

Problems After Knee Arthroplasty: Things That Go "Bump in the Night"

PAPER #42

5:36 PM - 5:42 PM

The Unstable Knee: *Manifestations, Reasons & Corrective Actions*

William L. Walter, M.D., F.R.A.C.S., Ph.D.

Background: Joint stability is one of the goals of any joint replacement. The contribution of prosthesis design to sagittal stability in total knee arthroplasty (TKA) has emerged as an area of interest. The purpose of this study was to evaluate the sagittal stability of four prosthesis types and determine the effect on patient reported outcome measures (PROMs).

Methods: A matched-cohort cross-sectional study was performed on 60 patients after TKA at 1-year follow-up. Three surgeons performed 10 medially stabilized (MS) TKA and 10 non-MS TKA. Sagittal stability was assessed by a blinded observer using a KT-1000 arthrometer, Lachman's test, and the anterior drawer test. PROMs (Oxford, Knee Injury and Osteoarthritis Outcome Score, Western Ontario and McMaster Universities Osteoarthritis Index, Forgotten joint score) and visual analog scale assessed function and satisfaction.

Results: MS TKA had significantly decreased translation on KT-1000 and improved stability compared with non-MS TKA ($P < 0.05$). Increased PROMs were demonstrated in the MS TKA group compared with the non-MS TKA group ($P < 0.05$). When divided based on objective stability, regardless of the prosthesis type, patients with a stable knee had superior PROMs ($P < 0.05$), particularly in sport-related questions.

Conclusion: The MS TKA had significantly greater sagittal stability, improved PROMs, and satisfaction compared with non-MS TKA. Independent of prosthesis design, patients with greater sagittal stability demonstrated improved PROMs.

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SESSION XII

Problems After Knee Arthroplasty: Things That Go "Bump in the Night"

PAPER #43

The Management of Extensor Mechanism Complications

5:42 PM - 5:48 PM

Denis Nam, M.D.

Complications involving the knee extensor mechanism and patellofemoral joint have a reported prevalence of 1% to 12%.[1,2] The majority of these complications occur post-operatively, but surgeons must be aware of intra-operative, post-operative, and patient-related factors that may increase the risk of an extensor mechanism complication. The six most commonly encountered extensor mechanism complications are patella tendon rupture, quad tendon rupture, patellar fracture, osteonecrosis of the patella, patella crepitus or clunk, and patellofemoral instability. Risk factors include patella malalignment, over-resection of the patella during resurfacing, prior surgeries that can compromise exposure (i.e. patella baja), and systemic disorders such as obesity, diabetes, and inflammatory disorders.[3] Complications involving the extensor mechanism can be devastating as their healing capacity is compromised by disruption of the vasculature surrounding the knee during implantation of a total knee arthroplasty.

Patella tendon rupture occurs in less than 1% of TKA cases and can present as a fall onto a hyperflexed knee or secondary to repetitive impingement of the patella tendon against the tibial tray. While patients with low functional demand can potentially be treated with bracing, most patients require surgical intervention. Primary reconstruction has been shown to have poor results and most often reconstruction requires some element of augmentation including allograft or synthetic mesh. Perhaps the most difficult aspect of treatment of most extensor mechanism disruptions involves the post-operative management, which often requires a long leg cast for a minimum of 8 weeks which is difficult to tolerate and prone to skin breakdown. Quadriceps tendon rupture occurs in approximately 0.1% of TKA cases,[3] and as with a patella tendon rupture often presents with a significant extensor lag. Primary reconstruction may have a greater potential for success given the improved surrounding blood supply (versus the patella tendon), but augmentation is again strongly suggested.[4]

Patellar fracture can occur in 0.7% to 5.0% of TKA cases with risk factors including aggressive resection during resurfacing, use of a metal-backed patella, implant malrotation, and osteoporosis. Non-operative management with bracing can be considered in the presence of a stable patella implant and a minimal extensor lag, but surgical management is required in the presence of a loose implant. Unfortunately, open treatment has been reported to have a 45-50% complication rate.[5] Patellar osteonecrosis can also occur due to compromise of the blood supply to the patella. Signs of osteonecrosis include sclerosis, flattening, and fragmentation of the patellar bone. In the symptomatic patient, treatment may include removal of a loose patellar component and removal of any loose osteonecrotic fragments, although clearly preservation of as much bone as possible is optimal.

Patellar crepitus and soft tissue impingement occurs in up to 25% of total knee arthroplasties and is highly dependent on prosthesis design.[6]. A true patellofemoral clunk can be treated with arthroscopic resection of the fibrous nodule, or open synovectomy, if necessary. Lastly, patellofemoral instability can

occur in up to 27% of TKA patients. However, with advances in implant design including deepening of the trochlear groove and presence of a lateral flange have likely decreased its prevalence.[2]

Complications involving the extensor mechanism following total knee arthroplasty can be difficult to manage. Patients should be counseled regarding their severity and expectations following treatment should be managed appropriately.

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SESSION XII

Problems After Knee Arthroplasty: Things That Go "Bump in the Night"

PAPER #44

5:48 PM - 5:54 PM

The Post-Operative Painful Knee: *Finding Causation/Realizing Remedy*

Robert L. Barrack, M.D.

In years past, the most common reason for revision following knee replacement was polyethylene wear.[1] A more recent study indicates that polyethylene wear is relatively uncommon as a cause for total knee revision counting for only 10% or fewer of revisions. The most common reason for revision currently is aseptic loosening followed closely by instability and infection. The time to revision was surprisingly short. In a recent series only 30% of knees were greater than 5 years from surgery at the time of revision. The most common time interval was less than 2 years.[2] This is likely because of the higher incidence of infection and instability that occurs most commonly at a relatively early time frame. Evaluation of a painful total knee should take into account these findings. All total knees that are painful within 5 years of surgery should be assumed to be infected until proven otherwise. Therefore, virtually all should be aspirated for cell count, differential, and culture. Alpha-defensin is also available in cases in which a patient may have been on antibiotics within a month or less, as well as cases in which diagnosis is a challenge for some reason. Instability can be diagnosed with physical exam focusing on mid-flexion instability which can be usually determined with the patient seated and the knee in mid-flexion, with the foot flat on the floor at which point sagittal plane laxity can be discerned. This is also frequently associated with symptoms of giving way and recurring effusions and difficulty descending stairs. A new phenomenon of tibial de-bonding has been described, which can be a challenge to diagnose.[3] Radiographs can appear normal when loosening occurs between the implant and the cement mantle. This seems to be more common with the use of higher viscosity cement. Obviously this is technique dependent since good results have been reported with the use of high viscosity cement.[4] Component malposition can cause stiffness and pain and relatively good results have been reported by component revision when malrotation has been confirmed with CT scan.[5] When infection, instability and loosening are not present, extra-articular causes should be ruled out including lumbar spine, vascular compromise, complex regional pain syndromes and fibromyalgia, and peri-articular causes such as bursitis, tendonitis, tendon impingement among others. One of the most common causes of pain following total knee is unrealistic patient expectations. Performing total knee replacement in early stages of arthritis with only mild to moderate symptoms and radiographic changes has been associated with persistent pain and dissatisfaction. It may be prudent to obtain the immediate pre-operative x-rays to determine if early intervention was undertaken and patients have otherwise normal appearing total knee x-rays and a negative work up. A recent study indicated that this was likely a cause or a major contributing factor to persistent pain following otherwise a well performed knee replacement.[6] A national multicenter study of the appropriateness of indications for TKA also indicated that early intervention was a major cause of persistent pain, dissatisfaction, and failure to improve following total knee replacement.[7]

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Notes:

SESSION XII

Problems After Knee Arthroplasty: Things That Go "Bump in the Night"

PAPER #45

5:54 PM - 6:00 PM

Peri-Prosthetic Femoral *Fx's*: *ORIF Remains the Gold Standard*

George J. Haidukewych, M.D.

Peri-prosthetic fractures above a TKA are becoming increasingly more common, and typically occur at the junction of the anterior flange of the femoral component and the osteopenic metaphyseal distal femur. In the vast majority of cases the TKA is well fixed and has been functioning well prior to fracture. For loose components, revision is typically indicated. Often, distal femoral mega prostheses are required to deal with metaphyseal bone loss. Good results have been reported in small series, however, complications, including infection remain concerning, and these implants are incredibly expensive. Although performing a mega prosthesis in the setting of a well-fixed TKA is not unreasonable due to immediate full weight bearing, in my opinion, prosthetic replacement should be limited to cases of failed ORIF (rare), or in cases where fixation is likely to fail (i.e severe osteolysis distally). For the majority of fractures above well-fixed components, internal fixation is preferred for the main reason that the overwhelming majority of these fractures will heal. Fixation options include retrograde nailing or lateral locked plating. Nails are typically considered in arthroplasties that allow intercondylar access ("open box PS" or CR implants) and have sufficient length of the distal fragment to allow multiple locking screws to be used. This situation is rare, as most distal fragments are quite short. If a nail is chosen, use of a long nail is preferred, since it allows the additional fixation and alignment that diaphyseal fill affords. Short nails should be discouraged since they can "toggle" in the meta-diaphysis and do not engage the diaphysis to improve coronal alignment. Plates can be used with any implant type and any length of distal fragment. The challenge with either fixation strategy is obtaining stable fixation of the distal fragment while maintaining length, alignment, and rotation. Fixation opportunities in the distal fragment can be limited due to obstacles caused by femoral component lugs, boxes, stems, cement mantles, and areas of stress shielding or osteolysis. Modern lateral locked plates can be inserted in a biologically friendly submuscular extra-periosteal fashion. More recent developments with polyaxial locked screws (that allow angulation prior to end-point locking) may offer even more versatility when distal fragment fixation is challenging. The goal of fixation is to obtain as many long locked screws in the distal fragment as possible. High union rates have been reported with modern locked plating techniques, however, biplanar fluoroscopic vigilance is required to prevent malalignments, typically valgus, distraction, and distal fragment hyperextension.

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SESSION XII

Problems After Knee Arthroplasty: Things That Go "Bump in the Night"

PAPER #46

6:00 PM - 6:06 PM

Bone Loss Management: *Building It Back Up*

David G. Lewallen, M.D.

Tibial or femoral bone loss is commonly seen during revision TKA and can vary from relatively minor to massive. Major bone damage can be caused by the original knee pathology (such as fracture or severe angular deformity), it can be iatrogenic due to excessive bone removal during prior arthroplasty, and it can be due to implant failure mechanisms (such as loosening, osteolysis or infection). Large defects can have a major impact on choice of reconstructive options during revision total knee arthroplasty (TKA). Massive bone loss can also threaten ligamentous attachments in the vicinity of the knee and may require use of components with additional constraint to compensate for associated ligamentous instability. Classification of bone defects can be helpful in predicting the complexity of the reconstruction required and in facilitating pre-operative planning and implant selection. One very helpful classification of bone loss associated with TKA is the Anderson Orthopaedic Research Institute (AORI) Bone Defect Classification System as it provides the means to compare the location and extent of femoral and tibial bone loss encountered during revision surgery. However, most systems of bone defect classification tend to neglect the quality of the bone that remains which can be an important factor in determining reconstruction options. In general, the higher grade defects (Type IIb or III) on both the femoral and tibial sides are more likely to require stemmed components, and may require the use of either structural graft or large augments to restore support for currently available modular revision components.

Options for bone defect management include:
1) Fill with cement; 2) Fill with cement supplemented by screws or K-wires; 3) Limited morselized bone grafting (for smaller, especially contained cavitary defects); 4) Small segment structural bone graft; 5) Impaction grafting (large cavitary defects); 6) Porous metal cones or sleeves; 7) Massive structural allograft-prosthetic composites (APC); 8) Modular segmental replacement implants; 9) Custom implants.

Each of these methods has distinct advantages and disadvantages. Currently extremely large bone defects are rarely treated with large structural allograft-prosthetic composites or custom devices because modular revision TKA component systems with special metal augments or segmental replacement modules have proven both effective and less time consuming. Use of uncemented highly porous metal metaphyseal cones in combination with a cemented (or partially cemented) femoral and tibial components provides versatile and highly durable results for a range of bone defects including those previously requiring structural bone graft.[2-5] The "hybrid" fixation of individual tibial or femoral components with both cement and cementless portions of the same device has emerged as a frequent and often preferred technique for achieving durable results. Initial secure and motionless interfaces are provided by the cemented portions of the construct, facilitating subsequent bone ingrowth to the cementless porous metal portion. As bone grows into the porous portions there is long term off-loading and protection of the cemented interfaces from mechanical stresses. While maximizing support on intact host bone has been a longstanding fundamental principle of revision arthroplasty this is greatly facilitated by the use of metaphyseal cones or sleeves. Used in combination with initial cementation of components into the periarticular bone and cemented or cementless stem engagement of the diaphysis, cones or sleeves dramatically improve the "3 zone fixation" recommended by Morgan-Jones et al. by restoring excellent fixation and mechanical support into the damaged metaphyseal zone.[6] The following basic steps are useful in revision knee arthroplasty especially in the case of major bone deficiency:
Step 1: Recreate the tibial platform . Reconstruction of the load-bearing surface of the tibia perpendicular to the long axis with both medial and lateral support for the tibial tray is the goal. This support can be provided by host bone, or alternatively on a cone. Central cavitary deficiencies can be managed by impaction grafting when too large to be managed by simple cement or standard metal wedge or block augments. As defects become larger and uncontained, additional alternatives include the use of large metal conical augments and structural grafts. Metaphyseal cones can be utilized with the potential for bone ingrowth to damaged host bone at the outer surface where tight contact against residual host bone is sought. Metal cones have the advantage of not undergoing resorption and mechanical failure as can occur with structural allograft over time. Massive segmental deficiencies involving the entire metaphysis can be reconstructed with allograft prosthetic

composites, metaphyseal cones in combination with revision components, or custom implants. These options can restore stable support for a tibial component and satisfactory function as long as the tibial tubercle and patellar tendon attachment remains intact to the tibia. Bone preparation and insertion of the highly porous metal cones preceded tibial implant placement and can involve burring, rasping or reaming of the host bone depending on the defect size, location, specific manufacturer and porous cone system used.

Step 2: Femoral reconstruction. Proper positioning and support for the femoral component on host bone is accomplished using the reconstituted tibial platform as a reference for proper restoration of the joint line and balancing of the flexion and extension gaps through adjustments in distal femoral build-up and femoral component sizing. Once the proper joint line location has been set by positioning the femoral component and proper sizing of the femoral component has been achieved, the extent and location of residual bone deficiencies can be fully appreciated and a reconstructive option sought. The same list of options for bone defect restoration exists for the femur as for the tibia, and in general smaller defects are managed with cement or cancellous graft packed into cavitary contained deficiencies, and/or with standard metal augments attached to the femoral component. More massive defects that cannot be managed with combinations of available off-the-shelf components can require use of some sort of structural support. This can take the form of a structural allograft or large metaphyseal cones. Use of porous metal metaphyseal cones can speed the reconstruction by avoiding the need for trimming and sizing of the allograft. Once healed such augments will not resorb as has occasionally occurred with some structural allograft in the past, and these implants do not carry with them the potential concern regarding disease transmission that exists with allograft.[1] Disadvantages include a set selection of available shapes and sizes, and also increased expense. Type III femoral defects, where loss of structural support has occurred on both the medial and lateral columns, generally are treated with allograft prosthetic composites or distal femoral replacement implants. In both instances, severe damage to ligamentous attachments on the femoral side may require use of a constrained rotating hinge-type implant. Highly porous metal augments designed to re-establish metaphyseal support and function in the manner of a prosthetic structural graft have been introduced or are under development by several manufacturers. Published reports of short term and recently intermediate term results out to 10 years have been encouraging for both the tibial side and for femoral augmentation as well.[2-5] It remains to be seen whether these implants will provide even longer term durability into the second decade.

Step 3: Determine the degree of implant constraint needed. In any revision TKA this is dictated by the soft tissues, and relative ligamentous stability of the reconstructed knee. The goal during these reconstructive procedures should always be to use only the constraint necessary reserving varus–valgus constrained and rotating hinges to instances where lesser constraint is inadequate.

Step 4: Choose the length and method of stem fixation needed. Whether to use cemented or cementless stems remains controversial and is often determined by personal surgeon preference. However, there is widespread consensus that extremely long cemented stems are generally not needed and should be avoided in order to prevent creation of a major reconstructive challenge if infection of the cemented long stem implant should occur. When combined with highly porous metaphyseal cones cemented stems of intermediate (and even shorter) length engaging the junction of the metaphysis to the diaphysis have been shown to provide durable intermediate term fixation, especially when stable axial support has been achieved on host bone. When cementless stems are utilized, diaphyseal engagement by a proper design that provides some degree of rotational control via flutes or slots is likely to yield higher rates of success than undersized or shorter stems that do not provide such stability. High rates of failure have been reported with uncemented stems of intermediate length which extend only up to the junction of the metaphysis with the diaphysis, and that technique should also be avoided.

In summary, multiple options exist for the management of bone defects encountered during revision TKA. Currently more major defects and even smaller or intermediate sized bone defects are preferentially treated with porous metal metaphyseal cones or sleeves as the resulting hybrid fixation of individual components (with cement for immediate stabilization, and porous metal ingrowth for long term durability) has the potential for very durable long term fixation.

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SESSION XIII

Surgical Procedure: Primary Hip Arthroplasty

Atul F. Kamath, M.D. - Moderator

PAPER #47

10:05 AM - 10:15 AM

Early Prophylactic Intervention: *Avoiding or Deferring Arthroplasty*

Atul F. Kamath, M.D.

Younger patients represent the fastest growing sector of the population undergoing hip replacement. [1] Obesity and other factors compound this rapid growth of younger patients presenting with hip pain and early-onset arthritis. However, joint replacement in the young carries inherent risks, such as wear of the bearing surface, loosening, and other prosthetic complications. Furthermore, younger patients have higher demands and higher expectations surrounding surgical interventions, and patient satisfaction may not be realized.

In order to meet the growing demands of patients with hip pain, early interventions and joint preservation strategies are needed.[2] These strategies must include non-surgical and surgical measures to address joint pain, optimize biology, and correct underlying structural/anatomic problems that lead to joint degradation and arthritis.[3]

Commonly encountered disorders include femoroacetabular impingement,[4] labral tears, dysplasia, sequelae of childhood disease (e.g. Legg-Calves-Perthes disease, slipped capital femoral epiphysis) [5], focal cartilage lesions, abductor injuries, and avascular necrosis. Acceptable candidates for joint preservation surgery are generally younger (age<40), have adequate cartilage quality, exhibit an acceptable BMI, and have the ability to meet the demands of rehabilitation.[3]

Surgical treatment options that will be presented include both arthroscopic and open techniques. Examples of these options include hip arthroscopy, periacetabular osteotomy (PAO),[6] surgical dislocation of the hip (SDH),[7] proximal femoral angular and derotational osteotomy, cartilage repair and transplantation, and core decompression with biologic augmentation. An understanding of applied surgical anatomy and bony and vascular anatomy [8] is essential for successful intervention.

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Notes:

SESSION XIII

Surgical Procedure:
Primary Hip Arthroplasty

PAPER #48

Optimizing the Anterior Approach Through Advancing Technologies

10:15 AM - 11:00 AM

William G. Hamilton, M.D.

The direct anterior approach to Total Hip Arthroplasty (THA) is growing in popularity. This growth is fueled by interest from surgeons and patients alike, both of whom are in search of improved outcomes in THA.

While the benefits of the approach are likely less pronounced than some marketing claims made, delivering a surgical recovery that has less pain and faster function is of significant value to today's patient. Published data has demonstrated subtle improvement in pain and function when compared with both the lateral and posterior approaches. Usually these clinical results are equivalent by 2 or 3 months post-op. This can lead to accelerated recovery, a shorter length of stay, and a more cost effective result. Some surgeons have utilized this approach as they implement outpatient THA as well.

Another added benefit is that a supine patient positioning allows for easy implementation of intra-operative fluoroscopy, which has been shown to reduce outliers in component positioning. Improved component positioning has the potential to reduce dislocation rates, lower bearing wear, and improve longevity. While image guided implant positioning can be used with any approach or patient position, it is efficient, affordable, and available to implement with the anterior approach. Using intra-operative imaging requires learning how to use and interpret the image, because incorrect utilization of fluoroscopy can be as harmful as it can be helpful.

Surgeons who are contemplating adapting the approach in practice must be aware of the potential pitfalls and learning curve, as studies have demonstrated increased operative time, blood loss, and peri-operative complications in the early cases. However, with appropriate training, patient selection, and implementation, the approach can be safely used in all THA patients.

This surgical demonstration will show the anatomy, bone preparation, implant placement, and use of intra-operative fluoroscopy via the anterior approach. The surgery will be done with a specialized traction table (Hana, Mizuho OSI) and software assisted implant placement (Radlink). Cementless implants will be placed with the assistance of a mechanical impactor (Kincise, DePuy Synthes).

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Notes:

SESSION XIV

Hip Arthroplasty: Management Issues

Adolph V. Lombardi, Jr., M.D. - Moderator

PAPER #49

The Use of Smart Tool Technology: *Improves Intra-Operative Execution*

11:30 AM - 11:36 AM

Stephen B. Murphy, M.D.

Personalized planning and accurate execution is a fast growing field, rapidly evolving to become a gold standard for hip reconstruction. Pre-operative 3D imaging allows for improved understanding of the spine-pelvis relationship and for detailed planning of leg length and offset correction, combined with acetabular and femoral sizing and placement, and range of motion/impingement calculation. Further, this detailed pre-operative understanding can be combined with accurate intra-operative tools so that these operative goals can be reliably accomplished. Neither intra-operative imaging nor non-patient specific intra-operative tracking technologies can perform these tasks.

The current presentation describes a web-based methodology that provides the surgeon with a detailed and yet flexible 3D surgery plan and associated software for each patient's surgery. Simple, efficient smart navigation tools allow for accurate cup placement, that is equal to or better than robotic systems, and leg length and offset restoration with no additional OR time and without the need for intra-operative imaging.

Evidence shows great advantage for pre-operative patient-specific intelligence combine with strategic intra-operative execution.

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Notes:

SESSION XIV

Hip Arthroplasty: Management Issues

PAPER #50

11:36 AM - 11:42 AM

Cemented Femoral Fixation: *Optimal Hybrid Solution*

Alejandro Gonzalez Della Valle, M.D.

In the 1960's Sir John Charnley introduced to clinical practice his low friction arthroplasty with a highly polished cemented femoral stem.[1] The satisfactory long term results of this and other cemented stems support the use of polymethylmethacrylate (PMMA) for fixation. The constituents of PMMA remained virtually unchanged since the 1960s. However, in the last three decades, advances in the understanding of cement fixation, mixing techniques, application, pressurization, stem materials and design provided further improvements to the clinical results.

The beneficial changes in cementing technique include femoral preparation to diminish interface bleeding, pulsatile lavage, reduced cement porosity by vacuum mixing, the use of a cement restrictor, pre-heating of the stem and polymer,[2] retrograde canal filling and pressurization with a cement gun, stem centralization and stem geometries that increase the intramedullary pressure and penetration of PMMA into the cancellous structure of bone. Some other changes in cementing technique proved to be detrimental and were abandoned, such as the use of Boneloc cement that polymerized at a low temperature, and roughening and pre-coating of the stem surface.[3]

In the last two decades there has been a tendency towards an increased use of cementless femoral fixation for primary hip arthroplasty. The shift in the type of fixation followed the consistent, durable fixation obtained with uncemented acetabular cups, ease of implantation and the poor results of cemented femoral fixation of rough and precoated stems.

Unlike cementless femoral fixation, modern cemented femoral fixation has numerous advantages: it is versatile, durable and can be used regardless of the diagnosis, proximal femoral geometry, natural neck version, and bone quality. It can be used in combination with antibiotics in patients with a history or predisposition for infection. Intra-operative femoral fractures are rare. However, the risk may be increased in collarless polished tapered stems.[4] Post-operative thigh pain is extremely rare. Survivorship has not been surpassed by uncemented femoral fixation and it continues to be my preferred form of fixation. However, heavy, young male patients may exhibit a slightly higher aseptic loosening rate.[5]

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Notes:

SESSION XIV

Hip Arthroplasty: Management Issues

PAPER #51

Are All Cementless Stems Created Equal: *Which for What?*

11:42 AM - 11:48 AM

Matthew P. Abdel, M.D.

Over the past several decades, cementless femoral fixation for primary total hip arthroplasties (THAs) has become more common in North America. It is estimated that nearly 90% of all primary THAs completed in the United States are cementless. In the Australian National Joint Replacement Registry, the use of cementless fixation has increased from 51.3% in 2003 to 63.3% in 2015. During the same time period, cemented fixation declined from 13.9% to 3.7%, but hybrid fixation was relatively stable at about 33%. This is likely related to the fact that multiple institutional and national registries have shown a higher rate of intra-operative periprosthetic femoral fractures with the use of cementless femoral components in certain patient populations. Those risk factors include patients greater than 65 years of age, female patients, and those with significant osteoporosis and Dorr C canals.

However, it is important to note that not all cementless femoral components are similar. In fact, there is great variation in not only the geometry of cementless femoral components, but also in the type and extent of the biologic ingrowth surfaces. Each design has unique advantages and disadvantages. While some cementless femoral components are indicated for the general population, some are more specific and tailored to complex primary THAs (such as developmental dysplasia of the hip [DDH] or post-traumatic arthritis with intra-operative concern for femoral version and thus hip stability) or revision procedures where distal fixation is needed (such as those with periprosthetic fractures or lack of proximal metaphyseal bony support).

In 2000, Berry first described the evolution of cementless femoral components based upon distinct geometries that govern where fixation is obtained. This was modified in 2011 by Khanuja et al. to include six general types of cementless femoral components based upon shape. These include the following:

Type 1: Single wedge
Type 2: Double edge with metaphyseal filling
Type 3: Tapered
- A: Tapered round
- B: Tapered spline/cone
- C: Tapered rectangle

Type 4: Cylindrical fully coated
Type 5: Modular
Type 6: Anatomic

Type 1, 2, and 6 cementless femoral components obtain fixation in the metaphysis, whereas Type 3 stems obtain fixation in the metaphyseal-diaphyseal junction. Type 4 stems obtain fixation in the diaphysis. Type 5 stems can obtain fixation in either the metaphysis or the diaphysis.

Within each type of stem, specific implant designs have had excellent long-term survivorship, while other specific implant designs have had higher than expected failure rates. Type 1 stems have the most

published reports, and most contemporary reports indicate a stem survivorship of greater 95% at 15-20 years. Similar findings have been documented with specific implants from other types of stems when appropriate indications and surgical technique are utilized. Of note, one class of stems that has shown early failures due to adverse local tissue reactions (ALTR) is that of dual-modular necks. On the other hand, modular fluted tapered stems continue to produce excellent long-term data in complex primary THAs, as well as difficult revision THAs.

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Notes:

SESSION XIV

Hip Arthroplasty: Management Issues

PAPER #52

11:48 AM - 11:54 AM

Acetabular Protrusio: *A Problem in Depth*

Kenneth A. Gustke, M.D.

Acetabular protrusio occurs from migration of the femoral head medial to Kohler's line. This occurs in inflammatory arthritis, osteoarthritis with coxa vara deformities, previous acetabular fracture, and in metabolic bone diseases such as osteomalacia, Paget's disease, Marfan's syndrome, and osteogenesis imperfecta. Total hip replacement in this situation is difficult due to the requirement to place the acetabular component opening at the level of the normal rim or the patient will be at risk for component-on-component or bone-on-bone impingement, resulting in dislocation or component loosening. The deficient medial wall and weak peripheral rim from stress-shielding may not resist cup subsidence and provide initial cup stability.

Many management options have been described including using cement, bulk bone graft, and particulate graft to support the cup medially, and use of a reinforcement ring cage to provide better rim support. Gates reported on a series of 36 primary total hip replacement with acetabular protrusio treated with cemented cups and medial particulate autograft with a mean follow-up of 12.8 years with 6 definitively loose, 3 probably loose, and 22 possibly loose.[1] Techniques that provides initial stability for a porous cup with potential for long-term biological fixation is preferred. Mullaji and Shetty reported 90% good and excellent results and no loosening or migration at a mean 4.2 years in 30 primary total hips with acetabular protrusio treated with oversized porous cups for rim support and medial particulate bone grafting.[2] Forty percent of their cases had protrusio greater than 15 mm medial to Kohler's line. For most primary total hips with protrusio, good rim support can be achieved with a few millimeters of peripheral over-ream to support a porous cup with medial particulate autografting. This is my preferred technique.

Large medial acetabular bone loss can also be present in revision total hip cases, such as Paprosky type 2C defects. Hansen and Ries reported no revisions using rim over-ream and medial bone graft technique in 19 revision total hips with an average follow-up of 2.8 years. However, they emphasized that this technique should only be used if the peripheral rim is intact, and if not adequate, to use a reconstruction cage.[3] In revision total hips with large medial acetabular bone defects, poor rim support is not uncommon. However, use of a reconstruction cage is not ideal since they do not provide biological fixation. Ilyas reported a 15.1% loosening rate using a cage for revisions with medial defects at a follow-up of 6 years.[4]

In revision cases and some primaries, when rim support is poor and the medial defect is greater than 10 mm, I have alternatively used a porous protrusio shell. The technique involves performing a cylindrical peripheral over-ream and a medial hemispherical ream. This provides greater host bone-to-shell contact for stability and a greater surface area for biological fixation, and fills much of the medial defect. I have used this technique successfully in 10 primary and 43 revision total hip cases with an average follow-up of approximately 4 years. There have been no revisions, no apparent cup migrations, and no progressive component bone radiolucencies.

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Notes:

SESSION XIV

Hip Arthroplasty: Management Issues

PAPER #53

11:54 AM - 12:00 PM

Hip Fusion Conversion: *The Why, the How, the Outcomes*

Allan E. Gross, M.D., F.R.C.S.(C)

Patients with longstanding hip fusion are predisposed to symptomatic degenerative changes of the lumbar spine, ipsilateral knee and contralateral hip.[4] In such patients, conversion of hip arthrodesis to hip replacement can provide relief of such symptoms.[2,3] However, this is a technically demanding procedure associated with higher complication and failure rates than routine total hip replacement.

The aim of this study was to determine the early functional results and complications in patients undergoing hip fusion conversion to total hip replacement, performed or supervised by a single surgeon, using a standardized approach and uncemented implants. We hypothesized that a satisfactory functional improvement can be achieved in following conversion of hip fusion to hip replacement.

Eighteen hip fusions were converted to total hip replacements. A constrained acetabular liner was used in 3 hips. Mean follow up was 5 years (2 to 15 years). Two (11%) hips failed, requiring revision surgery and two patients (11%) had injury to the peroneal nerve. Heterotopic ossification developed in 7 (39%) hips, in one case resulting in joint ankylosis. No hips dislocated.[1]

As of August 2017, we have converted 30 hips with an average follow-up of 6 years (2 – 26). We have performed 2 revisions to date.

Conversion of hip fusion to hip replacement carries an increased risk of heterotopic ossification and neurological injury. We advise prophylaxis against heterotopic ossification. When there is concern about hip stability we suggest that the use of a constrained acetabular liner is considered. Despite the potential for complications, this procedure had a high success rate and was effective in restoring hip function.

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Notes:

SESSION XV

What Would YOU do?
Challenges in Hip Surgery

PAPER #54

1:00 PM - 2:00 PM

Lawrence D. Dorr, M.D. - Moderator

C. Anderson Engh, Jr., M.D.
Donald S. Garbuz, M.D., F.R.C.S.(C)
Richard E. Jones, M.D.
Adolph V. Lombardi, Jr., M.D.
Leo A. Whiteside, M.D.

This is a case-based learning experience with experts on the panel who are given complex hip replacement cases and will give their surgical treatment solution. The moderator will force them to justify their choice.

Notes:

SESSION XVI

Surgical Procedure:
Primary Hip Arthroplasty

David J. Mayman, M.D. - Moderator

PAPER #55

Bone Grafts & Their Substitutes:
Understanding the Three O's

2:30 PM - 2:40 PM

Edwin P. Su, M.D.

Bone graft has been an invaluable tool for the orthopaedic surgeon ever since we started operating on the skeletal system. Healing bone requires 3 principles: osteoconduction, osteoinduction, and osteogenesis. Osteoconduction refers to the ability to provide a suitable scaffolding upon which bone can form, hence it is a structural property. Osteoinduction involves the recruitment of the proper immature cells and their differentiation into bone-forming osteoblasts. Finally, osteogenesis occurs when new bone is formed directly from vital cells in the bone graft material.

The ideal bone grafting material would have all three properties, lending itself to providing structural support, living cells, and differentiation factors that would further recruit host cells. An example of this is autogenous bone graft, either cancellous or cortical. However, because of the donor morbidity of using autogenous bone graft, substitutes have become more prevalent.

Allograft bone is probably the most frequently used graft material by the arthroplasty surgeon, and has osteoconductive and possibly some osteoinductive properties.

Bone morphogenic proteins (BMPs) are growth factors manufactured by recombinant techniques. As such, they are purified cytokines with osteogenic properties, that serve to induce the differentiation of mesenchymal cells into osteoblasts.

Bioceramics such as calcium sulfate, calcium phosphate, and bioactive glass are cheaper bone graft substitutes that are more readily available; these materials are solely osteoconductive. There are new composite bioceramics such as collagen/Beta-tricalcium phosphate that combines growth factors with the structural material, thus providing both osteoinductivity and osteoconductivity.

A series of cases will be shown that demonstrates the utility of bone graft and its substitutes in the realm of joint arthroplasty surgery.

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Notes:

SESSION XVI

Surgical Procedure:
Primary Hip Arthroplasty

PAPER #56

Ceramicized Metal Dual Mobility THA:
Reducing Wear & Dislocation

2:40 PM - 3:30 PM

Adolph V. Lombardi, Jr., M.D.

Introduction: There is new found interest in use of dual mobility implants in patients who are felt to be at increased risk of dislocation. With improved knowledge of the hip-spine relationship and the increased risk of dislocation in patients with stiff or fused spines, the utilization of dual mobility implants has increased over recent years.

There has been some concern with the use of modular dual mobility implants because of the interface between the titanium shell and cobalt chrome liner. There have been case reports of elevated cobalt and chromium ion levels as well as adverse soft tissue reactions.

The development of a ceramicized metal liner for a dual mobility implant has been undertaken in order to eliminate the risk of elevated cobalt and chromium ion levels.

Format: The presentation will review a case in which a dual mobility construct was chosen. Clinical indications as well as a radiographic review will be performed. Indications for choice of this implant type will be reviewed. Pre-operative surgical planning will be reviewed including measurements of spinal mobility and hip implant templating.

Design rationale and manufacturing processes for the ceramicized metal will be reviewed. This will include discussion of locking mechanism, center of rotation, coverage, range of motion prior to impingement, jump distance, and bearing surface. Sizing options will also be reviewed.

Animation's of technique for assembly of the implant will be displayed and reviewed, with explanation of the instruments required for assembly.

Post-operative radiographs and evaluation of the case will be discussed.

Post-operative rehabilitation including any post-operative precautions will be reviewed.

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SESSION XVII

Orthopaedic Crossfire® III: Controversial Issues in Primary & Revision Hip Arthroplasty

Thomas S. Thornhill, M.D. - Moderator

PAPER #57

The Direct Anterior Approach: *Emergent Exposure for All THA Patients – Affirms*

4:00 PM - 4:06 PM

Jose A. Rodriguez, M.D.

Total hip arthroplasty (THA) is a highly successful surgical procedure, however, we continue to search for ways to improve our outcomes. Surgery should be predictable, reproducible, and fun. The surgical exposure is, literally, only an approach to the operation – not the operation. But it is a variable that has been shown to provide documented benefit:

Speed of recovery[1]
Faster achievement of motor function[2]
Quicker discontinuation of ambulatory assists[3]

Consistent socket position – fluoroscopy[4]

Gait improvements[5]

Less muscle injury[6]

But … Learning Curve Issues[7]

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Notes:

SESSION XVII

Orthopaedic Crossfire® III: Controversial Issues in Primary & Revision Hip Arthroplasty

PAPER #58

The Direct Anterior Approach: *Emergent Exposure for All THA Patients – Opposes*

4:06 PM - 4:12 PM

Brad L. Penenberg, M.D.

There is no data driven reason to consider anterior approach for all total hips. One possible conclusion from a review of the existing literature, would be that we appear to have succumbed to a herd mentality in order to build a practice, or differentiate ourselves, or to "give patients what they ask for", in the absence of compelling data. If we are to justify use of DA in all hips, we would have to be convinced that there is no other approach to THA that is as good with regard to both safety and efficacy. DA, based on the preponderance of published studies, does not meet these standards with regard to its alleged advantages and perhaps more importantly, with regard to level of risk. Interest in DA appears to be based on the promise of a reduced dislocation rate, elimination of hip precautions, more precise cup placement, "faster recovery", more accurate limb length restoration, and initially, at the time of its introduction, the promise of an operation in which no tendons are cut. The existing body of literature does not validate these claims.[1-7] It has become clear that since the introduction of DA there have been modifications of the technique to the extent that one cannot consider it as the "cut no tendon" THA. This is how it has been presented to the orthopaedic community and to patients (see numerous websites). However, pyriformis, obturator internus, often the short head of rectus, as well as posterior capsule are typically released.

Perhaps it is a function of the acknowledged learning curve, but there is no escaping the continued appearance of studies identifying a significant complication rate associated with DA.[5] So why do "we" persist? The literature does suggest that there may be an advantage in very early recovery [6] when compared to traditional, or short incision, posterior approaches. This seems to make it a good option to serve the growing interest in outpatient THA. Of great interest is the fact that DA has yet to be measured against the increasingly popular, similarly ITB sparing, Direct Superior, PATH, or SuperPath approaches which are also believed to be associated with accelerated recovery. These latter options have the potential for a much more forgiving learning curve. Given that the significant difference between DA and mini-posterior is preservation of ITB integrity and not the short external rotators, one might postulate that this is the key anatomic structure that contributes to improved early functionality. With increasing use of DA it has undergone greater scrutiny. The fact that it seems to endure in spite of the apparent steep learning curve, would suggest that, yes it can be integrated successfully into the practices of higher volume specialists and fellowship trained surgeons. I would argue, however, based on an abundance of data, that the risks of the required learning curve and the emergence of alternative, more readily extensile, ITB sparing techniques make the DA unsuitable for all total hip arthroplasty procedures done by all orthopaedic surgeons.

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Notes:

SESSION XVII

Orthopaedic Crossfire® III: Controversial Issues in Primary & Revision Hip Arthroplasty

PAPER #59

The Dual Mobility Cup: *First Choice for the High Risk & Recurrent Dislocator – Affirms*

4:20 PM - 4:26 PM

Matthew P. Abdel, M.D.

Dislocation after revision total hip arthroplasty (THA) continues to be prevalent. Dislocations are also common after primary THAs in high-risk patients, such as those with substantial spine pathology. As with every hip arthroplasty, it is essential to optimize component positioning, minimize prosthetic, bony, and soft tissue impingement, and maintain the integrity of the abductor complex. However, in several revision circumstances (and some high-risk primary settings), additional strategies are required to mitigate the risk of dislocation, particularly those being revised for instability or those with cognitive or neuromuscular disorders.

One option employed during revision THAs (and high-risk primary THAs) to minimize the risk of dislocation is a dual-mobility construct. Dual-mobility constructs theoretically improve stability by increasing femoral head jump distance. Similarly, the dual articulation alters the kinematics and helps minimize the risk of dislocation. Ultimately, this allows for the decreased risk of re-revision for dislocation. There are several studies supporting the decreased dislocation rate in revision and conversion THAs with the use of dual-mobility constructs. In their Otto Aufranc Award paper, Hartzler et al. found that patients undergoing revision THA who received a dual-mobility construct had a lower risk of subsequent dislocation, re-revision for dislocation, and reoperation for any reason when compared to patients treated with a 40-mm large femoral head. Those findings were present despite the bias to use dual-mobility constructs in those at the highest risk for subsequent dislocation. Similarly, Chalmers et al. studied the incidence of dislocation and survival of large heads (36-mm and greater) and dual-mobility constructs in the conversion of THA after hip hemiarthroplasty. The authors reported a lower dislocation rate for the dual-mobility construct group at 2 years of follow-up. Recently, Reina et al. completed a systematic review of the English and French literature. The authors found that in primary and revisions THAs, the odds of a dislocation were 4.1-fold and 3.6-fold less common in the dual-mobility groups, respectively.

As with any prosthesis, there are potential concerns with the routine use of dual-mobility constructs in the primary and revision settings. These include the risk of intra-prosthetic dislocation, corrosion in modular versions of dual-mobility constructs, and the possibility of long-term wear and subsequent loosening.

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Notes:

SESSION XVII

Orthopaedic Crossfire® III: Controversial Issues in Primary & Revision Hip Arthroplasty

PAPER #60

The Dual Mobility Cup: *First Choice for the High Risk & Recurrent Dislocator – Opposes*

4:26 PM - 4:32 PM

Thomas P. Schmalzried, M.D.

The major point of objection is the characterization of dual mobility as the "First Choice". Further, the High Risk primary and the Recurrent Dislocator are different issues. Obtaining hip stability requires a stepwise approach. It is critical to understand the mechanics of that patient. The surgeon can then make the necessary anatomic and prosthetic adjustments. Strive for the simplest, most cost-effective solution.

It is recognized that certain patient characteristics are associated with an increased risk of dislocation. It is also important to recognize surgeon-associated risks which include approach, component positions, the biomechanics of the reconstruction, knowledge, and experience. The role of lumbar spine disease in altering spinopelvic mobility has been documented. The surgeon should recognize those patients "stuck sitting" vs. those "stuck standing". Acetabular cup position ideally is adjusted based on spinopelvic interactions. This can lower the rate of impingement and subsequent dislocation.

The role of femoral anteversion and combined anteversion (femur + socket) is underappreciated. The version of the femoral component has implications for the version of the socket (and vice versa). A neutral femur needs more cup anteversion and increased femoral anteversion needs less from the cup. Combined anteversion of 30 degrees +/- 10 degrees is a reasonable target. Component positioning should be patient specific. Intra-operative functional range of motion testing with trial components allows an assessment of the mechanics of the arthroplasty, and component positions can be adjusted, if necessary.

In the evaluation of the Recurrent Dislocator, think "MAAFIA": Mechanism, Approach, Acetabulum, Femur, Impingement, Abductor. Posterior dislocation results from anterior impingement: knee toward chest or vice versa. Anterior dislocation results from posterior impingement: hip extension (hyper-extension) with external rotation. A posterior approach risks posterior dislocation. An anterior approach risks anterior dislocation. Plane radiographs are sufficient to assess Acetabular and Femoral component positions as well as limb length and offset. Acetabular component position on a Johnson's lateral is surrogate for anteversion. This view also allows for the assessment of potential anterior and/or posterior impingement (intra- and extra-articular). Femoral version can be measure on a modified Budin view. Abductor function should be assessed as major deficiency can contribute to instability, including global instability.

Based on the above, a stepwise approach to obtaining hip stability includes: 1) Removing the impingement(s). 2) Increase the bearing diameter. 3) Trial with an augmented liner. 4) Revise / reposition the cup. Trial with an augmented liner. 5) Trial with a dual mobility construct. 5) Revise the femur for issues with femoral version, limb length and/or offset. 6) Digital radiographs to assess the reconstruction(s).

An augmented liner serves to increase the "jump distance" for the femoral head to escape from the socket, but in one direction only. It is therefore critical to understand the direction of instability. The

increase in the jump distance is a function of the design of the liner. A dual mobility construct increases impingement-free range of motion (in all directions) and jump distance in proportion to the size of the outer bearing.

Dual mobility is a choice – but not the first choice. The approach to hip stability should be patient specific. Appreciate the role of femoral version and combined anteversion. Understand the mechanics of each case and make the necessary anatomic and prosthetic adjustments. Strive for the simplest, most cost-effective solution.

References:

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Notes:

SESSION XVII

Orthopaedic Crossfire® III: Controversial Issues in Primary & Revision Hip Arthroplasty

PAPER #61

Pelvic Discontinuity & Bone Loss: *The Triflange Cup, Treatment of Choice – Affirms*

4:40 PM - 4:46 PM

Michael D. Ries, Sc.M., M.D.

Most common acetabular defects encountered during revision total hip arthroplasty can be treated with a cementless acetabular cup and screw fixation. However, larger defects with discontinuity often require more complex reconstruction techniques including distraction, a cup cage, or custom triflange component – which is a custom made implant that has iliac, ischial, and pubic flanges to fit the outer table of the pelvis. The iliac flange fits on the ilium extending above the acetabulum. The ischial and pubic flanges are smaller than the iliac flange and usually permit screw fixation into the ischium and pubis. The custom triflange is designed based on a pre-operative CT scan of the pelvis with metal artifact reduction, which is used to generate a three dimensional image of the pelvis and triflange component. The design of the triflange involves both the manufacturing engineer and surgeon to determine the most appropriate overall implant shape, screw fixation pattern, and cup location and orientation.

A plastic model of the pelvis, and triflange implant can be made in addition to the triflange component to be implanted, in order to assist the surgeon during planning and placement of the final implant in the operating room. A wide surgical exposure is needed usually including identification of the sciatic nerve. Proximal dissection of the abductors above the sciatic notch to position the iliac flange can risk denervation of the abductor mechanism. Blood loss during this procedure can be excessive.

In a systematic review of 579 custom triflange acetabular components, the all-cause revision-free survivorship was 82.7%. and the overall complication rate was 29%.[1] Dislocation and infection were the most common complications and nerve injuries had an incidence of 3.8%.

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Notes:

SESSION XVII

Orthopaedic Crossfire® III: Controversial Issues in Primary & Revision Hip Arthroplasty

PAPER #62

4:46 PM - 4:52 PM

Pelvic Discontinuity & Bone Loss: *The Triflange Cup, Treatment of Choice – Opposes*

Steven J. MacDonald, M.D., F.R.C.S.(C)

Revision total hip arthroplasty in the face of pelvic discontinuity and significant bone loss is one of the most challenging clinical scenarios to be faced by the arthroplasty surgeon. Prior to the development of custom implants and advanced ingrowth materials these cases would be dealt with via cementless shell with posterior column plating or reconstruction cages and bone grafting techniques. Unfortunately, these techniques were met with unpredictable midterm results. In 2020, there are 3 techniques that are commonly utilized for the pelvic discontinuity case:
- pelvic distraction in association with highly porous shells
- the cup-cage technique
- the custom triflange cup

It should be emphasized that each of these techniques has good mid-term and longer term follow up results and all have a <10% ten-year predicted revision rate. It then becomes an issue of pros and cons of each technique. This author favors the cup/cage technique. It, along with the custom triflange, have the longest term followups with multiple centers reporting results. The custom triflange is an excellent technique as a salvage procedure when there are simply no options remaining. The challenge with using it routinely in all pelvic discontinuity cases over the cup/cage technique include:

1) Cost – the custom triflange implant is very costly. At the author's institution it is over 5 times as expensive as a cup/cage construct. That cost is the implant alone, not including CT scans, etc.

2) Timeliness – by definition the triflange is a custom implant. So it is not on the shelf and readily available. There are cases with acute failures that require immediate reconstruction and can't be delayed for several weeks (at a minimum) awaiting a custom implant.

3) Exposure/Risks – to properly insert a custom triflange implant a much more extensive exposure is required than when performing a cup/cage. This leads to an increased risk of neurovascular injury and possibly infection.

4) Surgical Planning Time – while all of these challenging cases require surgical planning, there is significantly more planning time required of the surgeon for a custom implant as the model goes between the engineer and the surgeon.

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Notes:

SESSION XVIII

The Revision Hip: A Tolerance for Chaos

David G. Lewallen, M.D. - Moderator

PAPER #63

5:30 PM - 5:36 PM

The Painful THA: *Determining Etiology Will Direct Treatment*

Steven J. MacDonald, M.D., F.R.C.S.(C)

The Asymptomatic THA

The vast majority of total hip arthroplasty (THA) patients are pain free and have implants that will last them a lifetime. That being said, the question of how best to monitor these patients then remains controversial. To monitor all patients with an annual or semi-annual review is a very costly and time consuming proposition.

There are several key drivers to consider when determining the monitoring of the asymptomatic patient:

a) The Patient - Elderly lower demand patients are at a much lower risk of implant failure than the younger more active patients and in general require less robust monitoring.

b) The Implant/Bearing - Not all implants are created equally. What is the track record of the implant in question? Are we dealing with a highly cross-linked bearing which we have now almost 2 decades of clinical use without a known revision for polyethylene wear? Is it a recalled implant or device? Is it a metal-on-metal bearing?

c) The Practice - The majority of THAs performed globally are done in non-academic settings. Academic settings may elect for closer monitoring of patients as they seek to understand and publish on outcomes. An ideal scenario is for all patients to be entered into a national registry database so that all revisions are captured.

The Painful THA

Pain following total hip arthroplasty is a relatively rare event. Several series place the incidence of some degree of pain post THA at approximately 5%.

A systematic approach to determining etiology will direct treatment. Hip pain can be categorized as:

Extrinsic to the Hip:
- Spine +/- radiculopathy
- Vascular disease
- Metabolic (Paget's)
- Malignancy

Intrinsic to the Hip:
- Intracapsular/Implant
  - Loosening
  - Sepsis

- Prosthetic failure
- Osteolysis
- Instability
- Thigh pain
- Stem tip pain
- Hypersensitivity/ALVAL/Trunnionosis

- Extracapsular
- Iliopsoas tendonitis
- Snapping hip
- Trochanter problems (bursitis)
- Heterotopic ossification

A full history and appropriate physical exam will direct the clinician. The use of routine radiographs, blood tests, and special tests (i.e., blood metal ions, advanced imaging techniques) will be discussed in detail.

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Notes:

SESSION XVIII

The Revision Hip: A Tolerance for Chaos

PAPER #64

Classifying Femoral Bone Deficiency: *Choosing the Right Implant*

5:36 PM - 5:42 PM

Wayne G. Paprosky, M.D.

INTRODUCTION: As the number of patients who have undergone total hip arthroplasty rises, the number of patients who require surgery for a failed total hip arthroplasty is also increasing. It is estimated that 183,000 total hip replacements were performed in the United States in the year 2000 and that 31,000 of these (17%) were revision procedures. Reconstruction of the failed femoral component in revision total hip arthroplasty can be challenging from both a technical perspective and in pre-operative planning. With multiple reconstructive options available, it is helpful to have a classification system which guides the surgeon in selecting the appropriate method of reconstruction. A classification of femoral deficiency has been developed and an algorithmic approach to femoral reconstruction is presented.[1]

Type I: Minimal loss of metaphyseal cancellous bone with an intact diaphysis. Often seen when conversion of a cementless femoral component without biological ingrowth surface requires revision.

Type II: Extensive loss of metaphyseal cancellous bone with an intact diaphysis. Often encountered after the removal of a cemented femoral component.

Type IIIA: The metaphysis is severely damaged and non-supportive with more than 4 cm of intact diaphyseal bone for distal fixation. This type of defect is commonly seen after removal of grossly loose femoral components inserted with first generation cementing techniques.

Type IIIB: The metaphysis is severely damaged and non-supportive with less than 4 cm of diaphyseal bone available for distal fixation. This type of defect is often seen following failure of a cemented femoral component that was inserted with a cement restrictor and cementless femoral components associated with significant distal osteolysis.

Type IV: Extensive meta-diaphyseal damage in conjunction with a widened femoral canal. The isthmus is non-supportive.

DISCUSSION: An extensively coated, diaphyseal filling component reliably achieves successful fixation in the majority of revision femurs. The surgical technique is straightforward and we continue to use this type of device in the majority of our revision total hip arthroplasties. However, in the severely damaged femur (Type IIIB and Type IV), other reconstructive options may provide improved results. Based on our results, the following reconstructive algorithm is recommended for femoral reconstruction in revision total hip arthroplasty.

Type I: In a Type I femur, there is minimal loss of cancellous bone with an intact diaphysis. Cemented or cementless fixation can be utilized. If cemented fixation is selected, great care must be taken in removing the neo-cortex often encountered to allow for appropriate cement intrusion into the remaining cancellous bone.

Type II: In a Type II femur, there is extensive loss of the metaphyseal cancellous bone and thus fixation with cement is unreliable. In this cohort of patients, successful fixation was achieved using a diaphyseal fitting, extensively porous coated implant in 26 of 29 cases (90%). However, as the metaphysis is supportive, a cementless implant that achieves primary fixation in the metaphysis can be utilized.

Type IIIA: In a Type IIIA femur, the metaphysis is non-supportive and an extensively coated stem of adequate length is utilized to ensure that more than 4 cm of scratch fit is obtained in the diaphysis. In the series presented, this technique was successful in 20 of 22 reconstructions (91%) and we believe that this type of implant is most appropriate in these cases.

Type IIIB: Based on the poor results obtained with a cylindrical, extensively porous coated implant (with 4 of 8 reconstructions failing), our present preference is a modular, cementless, tapered stem with flutes for obtaining rotational stability. Excellent results have been reported with this type of implant and by virtue of its tapered design, excellent initial axial stability can be obtained even in femurs with a very short isthmus.[2] Subsidence has been reported as a potential problem with this type of implant and they can be difficult to insert. However, with the addition of modularity to many systems that employ this concept of fixation, improved stability can be obtained by impaction the femoral component as far distally as needed while then building up the proximal segment to restore appropriate leg length.

Type IV: In a Type IV femur, the isthmus is completely non-supportive and the femoral canal is widened. Cementless fixation cannot be reliably used in our experience, as it is difficult to obtain adequate initial implant stability that is required for osseointegration. Reconstruction can be performed with impaction grafting if the cortical tube of the proximal femur is intact.[3] However, this technique can be technically difficult to perform, time consuming and costly given the amount of bone graft that is often required. Although implant subsidence and peri-prosthetic fractures (both intra-operatively and post-operatively) have been associated with this technique, it can provide an excellent solution for the difficult revision femur where cementless fixation cannot be utilized. Alternatively, an allograft-prosthesis composite can be utilized for younger patients in an attempt to reconstitute bone stock and a proximal femoral replacing endoprosthesis used for more elderly patients.

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Notes:

SESSION XVIII

The Revision Hip: A Tolerance for Chaos

PAPER #65

Cemented Stems in Revision 2020: *What Problems Do They Solve?*

5:42 PM - 5:48 PM

Fares S. Haddad, M.D., F.R.C.S.

There has been an evolution in revision hip arthroplasty towards cementless reconstruction. Whilst cemented arthroplasty works well in the primary setting, the difficulty with achieving cement fixation in femoral revisions has led to a move towards removal of cement, where it was present, and the use of ingrowth components. These have included proximally loading or, more commonly, distally fixed stems. We have been through various iterations of these, notably with extensively porous coated cobalt chrome stems and recently with taper-fluted titanium stems. As a result of this, cemented stems have become much less popular in the revision setting.

Allied to concerns about fixation and longevity of cemented fixation revision, there were also worries in relation to bone cement implantation syndrome when large cement loads were pressurized into the femoral canal at the time of stem cementation. This was particularly the case with longer stems. Technical measures are available to reduce that risk but the fear is nevertheless there.

In spite of this direction of travel and these concerns, there is, however, still a role for cemented stems in revision hip arthroplasty. This role is indeed expanding.

First and foremost, the use of cement allows for local antibiotic delivery using a variety of drugs both instilled in the cement at the time of manufacture or added by the surgeon when the cement is mixed. This has advantages when dealing with periprosthetic infection. Thus cement can be used both as interval spacers but also for definitive fixation when dealing with periprosthetic hip infection.

The reconstitution of bone stock is always attractive, particularly in younger patients or those with stove pipe canals. This is achieved well using impaction grafting with cement and is another extremely good use of cement. In the very elderly or those in whom proximal femoral resection is needed at the time of revision surgery, distal fixation with cement provides a good solution for immediate weight bearing and does not have the high a risk of fracture seen with large cementless stems.

Cement is also useful in cases of proximal femoral deformity or where cement has been used in a primary arthroplasty previously. We have learnt that if the cement is well-fixed then the bond of cement-to-cement is excellent and therefore retention of the cement mantle and recementation into that previous mantle is a great advantage. This avoids the risks of cement removal and allows for much easier fixation. Stems have been designed specifically to allow this cement-in-cement technique. It can be used most readily with polished tapered stems - tap out a stem, gain access at the time of revision surgery and reinsert it. It is, however, now increasingly used when any cemented stems are removed provided that the cement mantle is well fixed. The existing mantle is either wide enough to accommodate the cement-in-cement revision or can be expanded using manual instruments or ultrasonic tools. The cement interface is then dried and a new stem cemented in place.

Whilst the direction of travel in revision hip arthroplasty has been towards cementless fixation, particularly with tapered distally fixed designs, the reality is that there is still a role for cement for its properties of immediate fixation, reduced fracture risk, local antibiotic delivery, impaction grafting and cement-in-cement revision.

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Notes:

SESSION XVIII

The Revision Hip:
A Tolerance for Chaos

PAPER #66

The Modular Stem:
The Right Implant for the Difficult Revision

5:48 PM - 5:54 PM

Matthew P. Abdel, M.D.

Modular fluted tapered (MFT) stems have become popular in the last decade due to favorable reported results, ease of use, and versatility. Pre-operative templating is essential for planning diameter and length of the fluted tapered portion of the stem, as well as length and offset of the proximal modular components. A prophylactic cable around the femoral shaft may be utilized prior to preparation or implantation of the fluted tapered portion of the stem to minimize risk of failure as hoop stresses are high during implantation. Obtaining immediate axial and rotational stability with the fluted tapered portion is key to success and preventing implant subsidence or loosening. The proximal modular portion of the component is then used to optimize anteversion, length, femoral offset, and hip stability. Of important note, an extended trochanteric osteotomy (ETO) helps provide good exposure for optimal femoral canal preparation, especially when there is proximal femoral deformity, a large femoral bow, and/or overhanging greater trochanter. The ETO allows canal preparation under direct vision, creation of a well-reamed supportive cone of bone, and optimal axial and rotation stability of the implant. The goal is for a supportive cone of bone to support the tapered stem; not for the stem to wedge by three point fixation (which provides less support against subluxation and less surface area for bone ongrowth). Intra-operative radiographs in orthogonal planes should be obtained with trial components in place, particularly to assess for diameter and length of the fluted tapered portion. Finally, MFT stems can be used for most femoral revisions so long as the femoral diaphyseal bone is sufficient to be reamed to a supportive tapered cone of bone that will provide good axial support and rotational stability of the implant.

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Notes:

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The Revision Hip:
A Tolerance for Chaos

PAPER #67

The Jumbo Cup:
Cementless Solution for Acetabular Bone Loss

5:54 PM - 6:00 PM

Paul F. Lachiewicz, M.D.

Using the Mayo Clinic definition (>62 mm in women and >66 mm in men), the "jumbo acetabular component" is the most successful method for acetabular revisions, even in hips with severe bone loss. There are numerous advantages: surface contact is maximized; weight-bearing is distributed over a large area of the pelvis; the need for bone grafting is reduced; and usually, hip center of rotation is restored. The possible disadvantages of jumbo cups include: acetabular bone may not be restored; surgeon may ream away the posterior column; screw fixation is required; the possibility of limited bone ingrowth and late failure; and a high rate of dislocation possibly due to acetabular size:femoral head ratio.

The techniques for a successful jumbo revision acetabular component involve: sizing-"reaming" of the acetabulum, careful impaction to achieve a "press-fit", and multiple screw fixation. Placement of an ischial screw, in addition to dome and posterior column screws, is strongly recommended. Use of a cup with an enhanced porous surface is now routine. There are few contra-indications for a jumbo cup. Using titanium fiber-metal mesh components, we reported the 15-year survival of 129 revisions. There was 3% revision for deep infection and 3% revision for aseptic loosening. There were 13 reoperations for other reasons: wear, lysis, dislocation, femoral loosening, and femoral fracture fixation. The survival was 97.3% at 10 years, but decreased to 82.8% at 15 years. Late loosening of this fiber metal mesh component is likely related to polyethylene wear and loss of fixation. Using an enhanced porous trabecular metal cup, we reported 90% success in very difficult acetabular revisions. Dislocation is the most common complication of jumbo revisions, approximately 10%, and these are multifactorial in etiology. We recommend use of an acetabular component with an enhanced porous coating (tantalum), highly cross-linked polyethylene, and large femoral heads or dual mobility for all jumbo revisions.

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Notes:

SESSION XVIII

The Revision Hip:
A Tolerance for Chaos

PAPER #68

The Role of Cages:
Lord of the Ring

6:00 PM - 6:06 PM

Allan E. Gross, M.D., F.R.C.S.(C)

Acetabular cages are necessary when an uncemented or cemented cup cannot be stabilized at the correct anatomic level. Impaction grafting with mesh for containment of bone graft is an alternative for some cases in centers that specialize in this technique.

At our center we use three types of cage constructs[1] –

(A) Conventional cage ± structural or morselized bone grafting. This construct is used where there is no significant bleeding host bone. This construct is susceptible to cage fatigue and fracture.[2] This reconstruction is used in young patients where restoration of bone stock is important.

(B) Conventional cage in combination with a porous augment where contact with bleeding host bone can be with the ilium and then by the use of cement that construct can be unified. The augment provides contact with bleeding host bone and if and when ingrowth occurs, the stress is taken off the cage.

In our first publication we managed acetabular bone loss with a cage augment reconstruction in 19 patients (22 hips) with an average follow-up of 39 months. We have performed 2 re-revisions for cage loosening. There has been 1 infection treated with irrigation and 1 dislocation requiring an open reduction.[3] As of November 2019, we have performed 41 cage augment reconstructions with 5 revisions to date.

(C) Cup Cage Construct – in this construct there must be enough bleeding host bone to stabilize the ultra-porous cup which functions like a structural allograft supporting and eventually taking the stress off the cage. This construct is ideal for pelvic discontinuity with the ultra-porous cup, i.e., bridging and to some degree distracting the discontinuity. If, however, the ultra-porous cup cannot be stabilized against some bleeding host bone, then a conventional stand-alone cage must be used.[4,5]

In our center the cup cage reconstruction is our most common technique where a cage is used, especially if there is a pelvic discontinuity.

Acetabular bone loss and presence of pelvic discontinuity were assessed according to the Gross classification. Sixty-seven cup-cage procedures with an average follow-up of 74 months (range, 24-135 months; SD, 34.3) months were identified; 26 of 67 (39%) were Gross Type IV and 41 of 67 (61%) were Gross Type V (pelvic discontinuity). Failure was defined as revision surgery for any cause, including infection.

The 5-year Kaplan-Meier survival rate with revision for any cause representing failure was 93% (95% confidence interval [CI], 83.1-97.4), and the 10-year survival rate was 85% (95% CI, 67.2-93.8). The

Merle d'Aubigné-Postel score improved significantly from a mean of 6 pre-operatively to 13 post-operatively ($p < 0.001$). Four cup-cage constructs had non-progressive radiological migration of the ischial flange and they remain stable.[4] As of November 2019, we have performed 131 cup cage reconstructions with 8 revisions to date.

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Flatow, Evan	Innomed, Inc. - Royalties for instrument design; Zimmer Biomet - Royalties for prosthesis design
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Garbuz, Donald	DePuy Synthes - Fellowship support; Stryker - Consulting fee for speaking/fellowship support
Gehrke, Thorsten	CeramTec Medical Products - Consulting for speaking; Merete - Consulting fee for consulting; Waldemar Link GmbH & Co. KG, Zimmer Biomet - Consulting, royalties, for design, teaching
Gonzalez Della Valle, Alejandro	Intellijoint Surgical Inc. - Consulting fee for research; Johnson & Johnson - Consultant; Link Bio - Consulting fee for design; OrthoDevelopment - Consulting fee and royalties for design; OrthoSensor - Consulting fee and royalties for research design
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Lombardi, Adolph	Compression Solutions, Kinamed, Inc., Kinetic Concepts, OrthoSensor, Pacira Pharmaceuticals Inc., SPR Therapeutics, Zimmer Biomet - Institutional support for research; Elute, Inc., Elutibone, Joint Development Corp, Oration, Prescribe Fit, SPR Therapeutics, VuMedi - Investments for investment interests; Innomed, Inc., OrthoSensor, Zimmer Biomet - Royalties for development; OrthoSensor, Pacira Pharmaceuticals Inc., Zimmer Biomet - Consulting fee for consulting; Zimmer Biomet - Consulting fee for speaking and teaching
MacDonald, Steven	CurvaFix - Stocks; DePuy Synthes - Royalties for intellectual property transfer, consultant fees for teaching; Hip Innovation Technologies, JointVue, PSI - Stock
Mayman, David	CyMedica Orthopedics, Inc., HS2, LLC, Imagen Technologies - Ownership interest in a public or non-public company (e.g., stocks, stock options, or other ownership interest); InSight Medical - Ownership interest in a public or non-public company (e.g., stocks, stock options, or other ownership interest), inventor; OrthAlign - Royalties from intellectual property, ownership interest in a public or non-public company (e.g., stocks, stock options, or other ownership interest), Consultant; OrthoSensor, Inc. - Research support; Smith & Nephew - Research support, royalties from intellectual property, consultant; Wishbone - Designer, ownership interest in a public or non-public company (e.g., stocks, stock options, or other ownership interest)
Meneghini, R. Michael	DJO, OsteoRemedies - Consulting fee, royalties for design, development; Emovi, MuveHealth - Options for scientific advisory board; KCI - Consulting fee for speaking and teaching; Olio Health - Options for Scientific Advisory Board
Molli, Ryan	Medacta - Consulting and royalties for speaking, teaching and design
Murphy, Stephen	MicroPort Orthopedics, Inc. - Royalty, consulting for patents, teaching; Surgical Planning Associates, Inc. - Principal officer, patents
Nam, Denis	Acelity Inc., Stryker - Paid consultant; Acelity,Inc., Zimmer Biomet - Research support
Paprosky, Wayne	CeramTec, Convatec, Intellijoint Surgical Inc., Stryker, Zimmer Biomet - Consultant; Innomed, Inc., Stryker, Zimmer Biomet - Royalties; Intellijoint Surgical Inc. - Stockholder; Intellijoint Surgical Inc., Stryker, Zimmer Biomet - Speakers bureau
Penenberg, Brad	Microport Orthopedics, Inc., Zimmer - Royalties for intellectual property license; Radlink - Nothing for board member/shareholder; United Orthopedics - Consulting fee for MD advisory board
Piuzzi, Nicolas	RegentLab, Orthopaedic Research and Education Foundation, Zimmer Biomet - Research support
Rajgopal, Ashok	Smith & Nephew, Inc. - Consulting contract, consulting fee for teaching; Zimmer Biomet - Royalty contract - Royalty
Ries, Michael	Smith & Nephew, Inc. - Royalties and consulting fees for patents and consulting; Stryker - Royalties for patents
Rodriguez, Jose	Conformis, Inc., Exactech, Inc., Medacta International SA, Smith & Nephew, Inc. - Consulting fee, royalty for consulting, design; Wishbone Medical - Stock - investment for investor
Rosenberg, Aaron	Zimmer Holdings - Royalty for implant design, consulting
Schmalzried, Thomas	DePuy, Johnson & Johnson - Royalty
Sculco, Thomas	Exactech - Royalty for design work; Lima - No fee consultant for design work
Seitz, William	Kapp Surgical Instruments, Surgionix, Zero-Cast - Consulting fee for speaking and teaching
Su, Edwin	OrthAlign, Inc. - Consulting fee for speaking and teaching, Royalties for product development; Smith & Nephew, Inc., United Orthopedic - Consulting fee for speaking and teaching
Thornhill, Thomas	Conformis, Inc. - Stock options, former scientific advisory board; DePuy Synthes - Royalty for intellectual property, consultant for product development agreement
Wagner, Eric	None indicated
Walter, William	DePuy Synthes, MatOrtho, Stryker - Institutional support; MatOrtho, Stryker - Consulting fee, royalty, consulting fee for product development; Navbit - Shareholder
Warner, Jon J.P.	Arthrex, Smith & Newphew, Inc. - Fellowship support; Wright Medical - Consulting fee for product development, royalty for shoulder implant;
Whiteside, Leo	Signal Medical Corp., Royalties; Smith & Nephew, Inc. - Royalty for implant design team, consulting fee for royalty

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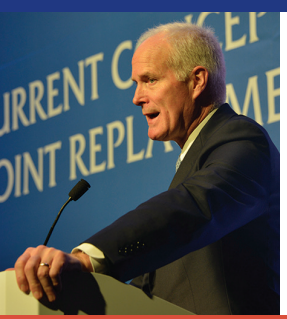

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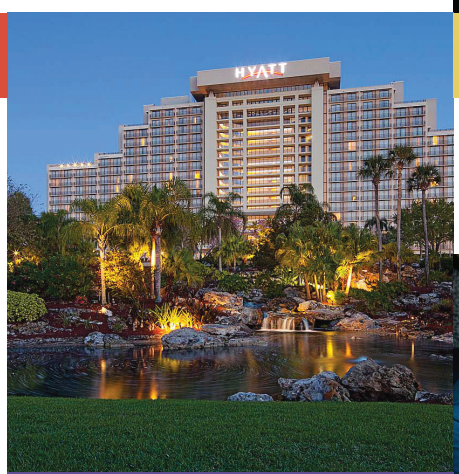

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Current Concepts in Joint Replacement - Winter 2020

The Hip Society was established in 1968, by Frank Stinchfield, MD, as a by-invitation-only academic society together with twenty elite hip surgeons. The mission of The Hip Society is to advance the knowledge and treatment of hip disorders to improve the lives of our patients.

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