THANK YOU TO AAHKS SPRING MEETING FACULTY

Bryan D. Springer, MD, Chair William A. Jiranek, MD, FACS, Co-Chair

FACULTY

Matthew P. Abdel, MD
William P. Barrett, MD
Daniel J. Berry, MD
Stefano A. Bini, MD
Michael P. Bolognesi, MD
Kevin J. Bozic, MD
Peter Cacavallo, MD
John J. Callaghan, MD
John C. Clohisy, MD
Craig J. Della Valle, MD
Stephen T. Duncan, MD

Thomas K. Fehring, MD
Nicholas B. Frisch, MD
Mark I. Froimson, MD
William L. Griffin, MD
Jean-Louis Horn, MD
James I. Huddleston, III, MD
William A. Jiranek, MD
Richard F. Kyle, MD
Jay R. Lieberman, MD
Frank Liporace, MD
Adolph V. Lombardi, MD

Steven J. MacDonald, MD
R. Michael Meneghini, MD
Joseph T. Moskal, MD
Mark W. Pagnano, MD
Brian S. Parsley, MD
Javad Parvizi, MD, FRCS
Gregory G. Polkowski, MD
Bryan D. Springer, MD
Thomas P. Vail, MD

VOLUNTEER FOR AAHKS 2017!

We are seeking volunteers to review abstracts, posters and surgical technique videos for the 2017 AAHKS Annual Meeting. Please contact Sigita Wolfe, Director of Education, at swolfe@aahks.org to sign up.
Course Description

The 2017 AAHKS Spring Meeting is intended to equip practicing orthopaedic surgeons with state-of-the-art information and cutting-edge strategies aimed at enhancing the care of patients with arthritis and degenerative disease. It combines general and breakout sessions, emphasizing case-based learning in small group setting for most effective results.

Welcome ASRA and OTA

The American Society of Regional Anesthesia (ASRA) takes part in a co-branded symposium focusing on the latest trends in multimodal pain management techniques. The Orthopedic Trauma Association (OTA) collaborates with AAHKS faculty to discuss current trends and management of periprosthetic fractures around total hip and knee arthroplasty.

Objectives

- Analyze total hip and knee arthroplasty cases
- Investigate the patterns contributing to effective total hip and knee arthroplasty and revision
- Determine the strategies contributing to optimal perioperative and post-operative care, including complication management
- Consider effective practice management tips and related healthcare policy
- Report the highlights of the 2016 Annual Meeting

CME

The American Association of Hip and Knee Surgeons (AAHKS) is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

The American Association of Hip and Knee Surgeons (AAHKS) designates this live activity for a maximum of 15.5 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.
Spring Meeting Program Schedule
Times and topics are subject to change.

Thursday, May 4, 2017

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Faculty</th>
<th>Room</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:00 – 9:00 p.m.</td>
<td>Arrivals/Registration and Opening Reception</td>
<td></td>
<td>California East/West Foyer and California East</td>
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</table>

Friday, May 5, 2017

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
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<th>Room</th>
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<tbody>
<tr>
<td>7:00 – 7:50 a.m.</td>
<td>Breakfast and Case Discussions with Faculty</td>
<td></td>
<td>California East</td>
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<tr>
<td>7:50 – 8:00 a.m.</td>
<td>Welcome and Introduction</td>
<td>William A. Jiranek, MD</td>
<td>California West</td>
</tr>
</tbody>
</table>
| 8:00 – 8:30 a.m. | Highlights of 2016 AAHKS Annual Meeting              | Moderator: John C. Clohisy, MD
Panelists: Brian S. Parsley, MD, Greg G. Polkowski MD, Joseph T. Moskal, MD | California West |
<table>
<thead>
<tr>
<th>Time</th>
<th>Event Description</th>
<th>Moderator</th>
<th>Panelists</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30–9:50 a.m.</td>
<td>Breakout 1 Primary Total Hip Arthroplasty THA: Simple to Complex</td>
<td>Stephen T. Duncan, MD William P. Barrett, MD</td>
<td>Elizabethan A/B/C/D</td>
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<tr>
<td>9:50–10:00 a.m.</td>
<td>Break</td>
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<td>California East</td>
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<tr>
<td>10:00–11:00 a.m.</td>
<td>Symposium I Perioperative Optimization</td>
<td>Moderator: R. Michael Meneghini, MD</td>
<td>Panelists: Bryan D. Springer MD Peter Cacavallo, MD</td>
<td>California West</td>
</tr>
<tr>
<td>11:00 a.m.–12:20 p.m.</td>
<td>Breakout 2 Primary Total Knee Arthroplasty TKA: Simple to Complex</td>
<td></td>
<td></td>
<td>Elizabethan A/B/C/D</td>
</tr>
<tr>
<td>12:20–1:00 p.m.</td>
<td>Lunch Presentation: Health Policy Fellow Update</td>
<td>Nicholas B. Frisch, MD</td>
<td></td>
<td>California West</td>
</tr>
<tr>
<td>1:00–2:00 p.m.</td>
<td>Symposium II Periprosthetic Joint Infection</td>
<td>Moderator: Javad Parvizi, MD</td>
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<td>California West</td>
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<tr>
<td>Time</td>
<td>Event</td>
<td>Panelists</td>
<td>Location</td>
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<tr>
<td>2:00–2:10 p.m.</td>
<td>AAHKS Research Grant Award</td>
<td>Javad Parvizi, MD, Mark I. Froimson, MD</td>
<td>California West</td>
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<tr>
<td>2:10–2:20 p.m.</td>
<td>Break</td>
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<td>California East</td>
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<tr>
<td>2:20 – 3:40 p.m.</td>
<td>Non-Arthroplasty Hip or UKA</td>
<td></td>
<td>Non-arthroplasty Hip-Elizabethan A, UKA-Elizabethan B/C/D</td>
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</tr>
<tr>
<td>3:40-4:50 p.m.</td>
<td>Symposium III Making the Transition to Value: Factors for Success</td>
<td>Moderator: Kevin J. Bozic, MD, MBA Panelists: Mark I. Froimson, MD, MBA, Jay R. Lieberman, MD</td>
<td>California West</td>
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</tr>
<tr>
<td>4:50–5:00 p.m.</td>
<td>Closing Remarks</td>
<td>Bryan D. Springer, MD</td>
<td>California West</td>
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<tr>
<td>5:00 – 6:30 p.m.</td>
<td>Reception</td>
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<td>California East</td>
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<td>Time</td>
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<tr>
<td>6:15–6:50 a.m.</td>
<td>Breakfast and Case Discussions with Faculty</td>
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<td>California West</td>
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<tr>
<td>6:50–7:00 a.m.</td>
<td>Welcome and Introduction</td>
<td>William A. Jiranek, MD</td>
<td>California West</td>
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<tr>
<td>7:00–7:30 a.m.</td>
<td>Highlights of the AAOS, Hip and Knee Society Closed Meetings</td>
<td>Moderator: Mark W. Pagnano, MD</td>
<td>California West</td>
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<td>Panelists: Craig J. Della Valle, MD</td>
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<td>Steven J. MacDonald, MD</td>
<td>California West</td>
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<td></td>
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<td>Adolph V. Lombardi Jr., MD, FACS</td>
<td>California West</td>
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<td></td>
<td>John J. Callaghan, MD</td>
<td>California West</td>
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<tr>
<td>7:30–8:50 a.m.</td>
<td>Revision Total Hip Arthroplasty THA: Simple to Complex</td>
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<td>Elizabethan A/B/C/D</td>
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<td>Break</td>
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<td>California East</td>
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<tr>
<td>9:00–10:00 a.m.</td>
<td>Periprosthetic Fractures of the Femur AAHKS/OTA</td>
<td>Moderator: Frank Liporace, MD</td>
<td>California West</td>
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<td>Panelists:</td>
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<tr>
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<tr>
<td>10:00 a.m. – 11:20 p.m.</td>
<td>Revision Total Knee Arthroplasty TKA: Simple to Complex</td>
<td>Elizabethan A/B/C/D</td>
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<tr>
<td>11:20 – 12:00 p.m.</td>
<td>Lunch</td>
<td>California East</td>
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<tr>
<td>12:00 – 1:00 p.m.</td>
<td>Symposium V: Perioperative Pain Management AAHKS/ASRA</td>
<td>California West</td>
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<tr>
<td>1:00 – 1:20 p.m.</td>
<td>Break</td>
<td>California West</td>
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<tr>
<td>1:20 – 2:40 p.m.</td>
<td>Breakout 6: Managing Complications in Hip and Knee Arthroplasty</td>
<td>Elizabethan A/B/C/D</td>
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<tr>
<td>2:40 – 3:50 p.m.</td>
<td>Symposium VI: Step by Step: Key Choices and Techniques in the Revision THA and Revision TKA</td>
<td>California West</td>
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</tbody>
</table>

**Moderators:**
- Richard F. Kyle, MD
- Daniel J. Berry, MD
- Stefano A. Bini, MD
- William A. Jiranek, MD
- Daniel J. Berry, MD
- John J. Callaghan, MD

**Panelists:**
- James I. Huddleston III, MD
- Jean-Louis Horn, MD

**Moderators:**
- William A. Jiranek, MD
- Daniel J. Berry, MD
<table>
<thead>
<tr>
<th>Time</th>
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<tr>
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<td>Bryan D. Springer, MD</td>
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</tbody>
</table>

William L. Griffin, MD  
Thomas P. Vail, MD  
Michael P. Bolognesi, MD
ACR-AAHKS Guideline for the Perioperative Management of Anti-rheumatic Medications in Patients with Rheumatic Diseases Undergoing Elective Total Hip or Knee Arthroplasty

Bryan D. Springer, MD

Thank You AAHKS Members

• 3 years in the making
• Weekly conference calls of Core Leadership Team
• Literature Review Team
• Expert Panel
• Voting Panel
• Patient Panel

Chick Yates, MD
Matt Abdel, MD
Vin Dasa, MD
Jeremy Gilliland, MD
Antonio Chen, MD
Alex Sah, MD
Louis Stryker, MD
Mark Goodman, MD
Scott Sporer, MD
Michael Mont, MD
Peter Sculco, MD

Rates of Arthroplasty Remain High among Rheumatic Disease Patients

• The widespread use of DMARDs and biologics has not decreased the utilization of arthroplasty
• 34-58% of RA patients undergo orthopedic surgery including arthroplasty over 30 years1,2
• Rates of arthroplasty are increasing for SLE and Spondyloarthritis (Psoriatic, Ankylosing Spondylitis) patients

Historical and projected number of total THA, TKA, and total THA + TKA procedures in the United States (2001-2020). The dashed lines represent the projected values per surgery type.

Prosthetic Joint Infection Rate

RA and SLE Patients have an Increased Risk of Perioperative Infections

- RA pooled meta-analysis
  - HR 1.47-1.83 for PJI
- 90 day readmission increasing: most commonly for infection
- 2009: OR 0.89 (95% CI 0.46-1.87)
- 2010: OR 1.34 (95% CI 0.69-2.61)
- 2011: OR 1.74 (95% CI 1.16-2.60)
- SLE: Sepsis OR 3.43 (95% CI 2.48-4.74)

Surgery in Rheumatoid Arthritis

Increased medical and surgical complexity

Disease specific risks
- Co-morbidity burden
- Age, gender
- Disease Activity
- Disease Severity
- Overall disability
- Presence of a prosthetic joint
- Medications: most accessible modifiable infection risk factor
### SLE Severity/Activity Predicts Post-Op Clinical Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>OR</th>
<th>95% CI</th>
<th>OR</th>
<th>95% CI</th>
<th>OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI</td>
<td>0.97</td>
<td>0.41-2.28</td>
<td>1.62</td>
<td>0.52-4.78</td>
<td>1.56</td>
<td>0.52-4.78</td>
</tr>
<tr>
<td>Renal failure</td>
<td>1.54</td>
<td>0.95-2.56</td>
<td>1.87</td>
<td>1.36-2.57</td>
<td>2.23</td>
<td>1.52-3.23</td>
</tr>
<tr>
<td>PE</td>
<td>2.29</td>
<td>0.63-8.32</td>
<td>3.63</td>
<td>0.93-14.54</td>
<td>4.86</td>
<td>1.20-19.7</td>
</tr>
<tr>
<td>Sepsis</td>
<td>1.14</td>
<td>0.80-1.56</td>
<td>2.99</td>
<td>2.03-4.42</td>
<td>3.43</td>
<td>2.36-5.04</td>
</tr>
<tr>
<td>Stroke</td>
<td>0.71</td>
<td>0.51-1.0</td>
<td>1.59</td>
<td>1.13-2.27</td>
<td>2.01</td>
<td>1.28-3.22</td>
</tr>
<tr>
<td>Any above</td>
<td>0.99</td>
<td>0.82-1.15</td>
<td>1.94</td>
<td>1.62-2.32</td>
<td>2.10</td>
<td>1.89-2.30</td>
</tr>
<tr>
<td>30-day</td>
<td></td>
<td></td>
<td>2.50</td>
<td>1.28-4.54</td>
<td>2.10</td>
<td>1.28-4.54</td>
</tr>
</tbody>
</table>

Analysis using Taiwan's national insurance research database, age and sex matched controls and stratified by SLE severity.

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### High Perioperative Exposure to Immunosuppressants

- 75% -84% of RA undergoing THR or TKR take DMARDs or biologics
- 80% of RA patients undergoing orthopedic surgery take glucocorticoids
- 75% pf patients with SLE are on immunosuppressant medications at the time of surgery

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### TNFi Treated Arthroplasty Group More Likely to Develop SSI

<table>
<thead>
<tr>
<th>Study</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kubota et al, 2013</td>
<td>2.47 (1.66, 3.68)</td>
</tr>
<tr>
<td>Galloway et al, 2011</td>
<td>1.69 (0.71, 4.88)</td>
</tr>
<tr>
<td>Scherrer et al, 2013</td>
<td>2.56 (0.92, 6.17)</td>
</tr>
<tr>
<td>den Broeder et al, 2007</td>
<td>1.84 (0.91, 3.53)</td>
</tr>
<tr>
<td>Kawakami et al, 2010</td>
<td>7.74 (0.94, 354.10)</td>
</tr>
<tr>
<td>Ruyssen-Witrand et al, 2007</td>
<td>0.14 (0.00, *)</td>
</tr>
<tr>
<td>Momohara et al, 2011</td>
<td>6.14 (2.30, 15.45)</td>
</tr>
<tr>
<td>Bongartz et al, 2008</td>
<td>1.25 (0.23, 4.46)</td>
</tr>
<tr>
<td>Hirano et al, 2010</td>
<td>1.15 (0.17, 6.29)</td>
</tr>
<tr>
<td>Johnson et al, 2013</td>
<td>2.12 (0.35, 14.78)</td>
</tr>
<tr>
<td>Giles et al, 2006</td>
<td>5.56 (1.11, 35.64)</td>
</tr>
<tr>
<td>Combined (random)</td>
<td>2.47 (1.66, 3.68)</td>
</tr>
</tbody>
</table>

Post hoc data: SSI-positive and TNFi exposure and OR3.83 (CI 1.38-10.03) OR P=0.0031

Odds ratio meta-analysis plot (random effects)
Infliximab within 4 weeks of THA or TKA was not associated with a higher risk of serious infection

Retrospective cohort study of 4288 Medicare patients who received infliximab within 6 months of THA or TKA

George AC&R 2017

Inconsistent Perioperative Use
Timing of use of anti-tumor necrosis factor (anti-TNF) medication perioperatively

<table>
<thead>
<tr>
<th>Anti-TNF</th>
<th>Stop Time</th>
<th>Restart Time</th>
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</thead>
<tbody>
<tr>
<td>Etanercept (n=58)</td>
<td>2.4 ± 2.4 (n=39) range 1-14</td>
<td>2.1 ± 1.1 (n=15) range 1-14</td>
</tr>
<tr>
<td>Gertinumab (n=7)</td>
<td>8.2 (n=1) range N/A</td>
<td>1.5 (n=1) range N/A</td>
</tr>
<tr>
<td>Adalimumab (n=25)</td>
<td>5.2 ± 5.8 (n=20) range 1-24</td>
<td>2.7 ± 1.9 (n=3) range 1-3</td>
</tr>
<tr>
<td>Infliximab (n=18)</td>
<td>4.8 ± 4.2 (n=11) range 2-9</td>
<td>4.4 ± 4.8 (n=4) range 2-4</td>
</tr>
</tbody>
</table>

Management of Anti-rheumatic Medication may Mitigate Risk

- Periprosthetic joint infection (PJI) remains one of the most common modes of failure following arthroplasty
  - Associated with increased morbidity, significant healthcare expenditure, poor function outcomes, and mortality

- Most infection risk factors are not modifiable - age, disease severity, overall disability
How to Manage These Medications?

- No current guidelines to direct physicians and patients on management of these medications in the perioperative period
- Guidance is needed for common clinical situations even where data is sparse
- This project brought together major stakeholders – arthroplasty surgeons, rheumatologists, methodologists and patients

Guideline Development Process

1. Define team/project scope, identify important questions and outcomes
2. Obtain feedback via public comment on project plan document
3. Search for relevant evidence
4. Evaluate strengths and weaknesses of individual studies
5. Evaluate strength of body of evidence for outcomes
6. Weigh benefits and harms
7. Decide direction and strength of recommendation
8. Draft guideline
9. ACR/AAHKS + journal peer review and approved
10. Public disseminate guideline
11. Periodic lit search updates, annual reevaluation re: need for updating/revision

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Guideline Scope

- Adults with RA, SpA, including ankylosing spondylitis (AS) and psoriatic arthritis (PsA), adults with juvenile idiopathic arthritis (JIA), or SLE who are undergoing elective THA or TKA
  - Should anti-rheumatic medications be withheld prior?
  - If withheld, when should they be stopped?
  - If withheld, when should they be restarted after surgery?
  - In patients using GCs, what dose should be administered at time of surgery?
All Recommendations in this Guideline are Conditional due to the Quality of the Evidence
• There were no RCTs for periop use of biologics
• Observational studies are typically rated as low
• Conditional recommendations are preference sensitive and warrant shared decision-making
  — Require estimating the relative value patients place in the outcomes
  — Apply to the majority, but not all
  — Additional research might change the recommendation

Patient Panel: Estimating the Relative Value of the Outcomes
• Patient panel – 11 adults with RA and JA
  — All had THA or TKA (1-8)
  — 1 reported prosthetic joint infection

Patients carefully reviewed data, recognized that flares were quite common and infection was rare
Patients were MUCH more willing to risk flare than infection
Patient panel - 100% concordant with the expert panel

Flares vs. Infection Risk?
• 65% of RA patients flare after THA and TKA
• Effect on long term arthroplasty outcome unknown

65% Flare
Pharmacokinetics vs Pharmacodynamics

<table>
<thead>
<tr>
<th>Drug</th>
<th>Serum half life</th>
<th>Dosing schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adalimumab</td>
<td>2 weeks</td>
<td>Every other week</td>
</tr>
<tr>
<td>Etanercept</td>
<td>102 hours (single 25mg dose)</td>
<td>Weekly or twice weekly</td>
</tr>
<tr>
<td>Golimumab</td>
<td>2 weeks</td>
<td>Monthly (SQ)</td>
</tr>
<tr>
<td>Infliximab</td>
<td>7-7.5 days</td>
<td>Every 4-8 weeks</td>
</tr>
<tr>
<td>Abatacept</td>
<td>13.1 days (IV)</td>
<td>Monthly (IV)</td>
</tr>
<tr>
<td>Tocilizumab</td>
<td>Up to 11 days</td>
<td>Every 4-6 weeks</td>
</tr>
<tr>
<td>Secukinumab</td>
<td>19-31 days</td>
<td>Every 4 weeks</td>
</tr>
<tr>
<td>Ustekinumab</td>
<td>14-45.6 days</td>
<td>Every 12 weeks</td>
</tr>
<tr>
<td>Rituaximab</td>
<td>18 days</td>
<td>Two doses every 4-6 months</td>
</tr>
</tbody>
</table>

1. RA, SpA, JIA or SLE: Continue methotrexate, leflunomide, hydroxychloroquine, and/or sulfasalazine

- RCTs of continuing vs. discontinuing DMARDs revealed decreased risk of infections when DMARDs were continued, (RR of 0.39 (95% CI 0.17-0.91))
- Infection risk low DMARDs in settings other than THA and TKA
- Continuing DMARDs decreases the risk of flare [RR 0.06 (95% CI 0.0-1.10)]


- 54 yo woman with severe RA with R knee pain and deformity, on weekly methotrexate, adalimumab every 2 weeks, and prednisone 7.5 mg daily.
- She was indicated for TKR, which was performed 2 1/2 weeks after the last dose of adalimumab, she continued MTX, and received prednisone 7.5 mg on the morning of surgery.
- Surgery was uneventful, she resumed adalimumab on post-op day 14, after sending a photo of the wound to her surgeon.
2. RA, SpA, JIA, or SLE

Withhold all biologics prior to surgery
Plan the surgery at the end of the dosing cycle for that specific medication

EXAMPLE: SLE patients treated with rituximab every 6 months would schedule their surgery when possible in the week after the first withheld dose during month 7. Patients receiving belimumab, which is given every 4 weeks, would schedule their surgery during week 5.
EXAMPLE: Patients treated with adalimumab, routinely dosed at 2-week intervals, would plan their surgery during week 3, while patients treated with infliximab, when dosed every 8 weeks, would schedule their surgery in the week after the first withheld dose during week 9.

Rationale: Withhold Biologics

- Not answered in the literature
- The evidence from non-surgical RCTs demonstrated an increase in infection risk associated with use of all biologics
  - Most odds/hazards/risk ratios ~ 1.5 (range, 0.61 to 8.87)
- SLR did not support a differential risk for serious infection among biologics

Rationale: Withhold Biologics

- Infection risk for biologics is strongly associated with high-dose therapy (higher than standard) and may not be associated with low-dose biologics
- Serum half-life may not correspond to the duration of the immune-suppressant effect, so the dosing cycle was chosen as more relevant

44 yo woman with sero-positive RA presented in a wheelchair on leflunomide and golimumab.

Exam revealed flexion deformities of both knees. She was indicated for BTKR.

Leflunomide was continued and the surgery was planned 5 weeks after her golimumab dose.

Her course was complicated by a PE, but she ultimately did well and by week 3 was ambulating with a walker. Her meds were re-started post-op week 2.

Rationale: Withhold Biologics in SLE

- Not answered in the literature
- Observational studies - patients with active or severe SLE are at a higher risk for post-op adverse events
- Rituximab is not FDA approved for use in SLE
- Belimumab is not approved for manifestations of severe SLE
- Data did not support separating the biologics

3. RA, SpA, or JIA: Withhold tofacitinib at least 7 days prior to surgery

- SLR and meta-analysis show an increased risk of serious infections
  - Incidence rate (IR) 2.91 (95% CI 2.27-3.74)
- Little is known about the duration of immunosuppression
- Indirect translational data suggests that host defense returns to normal at 7 days
4. Severe SLE: Continue mycophenolic acid, azathioprine, cyclosporine, or tacrolimus

- Indirect evidence with organ transplant patients who continue anti-rejection therapy
- **Caveat** – time course of organ rejection after withholding immunosuppressant medication may be different from the time to SLE flare
- Decisions regarding elective surgery in patients with severe SLE should be made on an individual basis with the patient’s rheumatologist

5. SLE (not-severe): Withhold the current dose of mycophenolic acid, azathioprine, mizoribine, cyclosporine, or tacrolimus

- Withhold 7 days prior to surgery through 3-5 days after surgery, in absence of wound healing complications or any infection

6. Restart biologic therapy once the wound shows evidence of healing (± 14 days), sutures/staples are out, no significant swelling, erythema or drainage, no clinical evidence of non-surgical site infections

- The decision to restart therapy should be based on evaluation of the patient’s wound status and clinical judgment for absence of surgical and non-surgical site infections
7. Continue the current daily dose of glucocorticoids in adult patients with RA, SpA, or SLE, who are receiving glucocorticoids for their rheumatic condition, rather than administering perioperative supra-physiologic glucocorticoid doses.

**Rationale: Glucocorticoids**

- SLR of RCT and observational studies demonstrated no significant hemodynamic difference, between patients given their daily glucocorticoid dose compared to those receiving “stress-dose steroids”
- Observational studies demonstrate an increase in infection risk following TJA for users of chronic glucocorticoids above 15 mg/day.
- Optimizing the patient for elective THA and TKA should include minimizing the daily glucocorticoid dose prior to surgery.


**No Hemodynamic Difference with Stress Dose Steroids**

2 RCTs
- Chronic steroid treatment: CS stopped pre-op
- Lower steroid levels
- Stable hemodynamics

Rationale: Glucocorticoids

- The recommendation specifically refers to adults who are receiving glucocorticoids for their rheumatic condition
- Does not refer to patients with JIA who may have received glucocorticoids during development
- Does not refer to patients receiving glucocorticoids for primary adrenal insufficiency or primary hypothalamic disease.

Guideline Strengths

- This project brought together major stakeholders – orthopaedists, rheumatologists, methodologists and patients – to create a patient-centric, expert-led group to determine optimal management of these high-risk patients through a group consensus process, and established a framework for further research
- Clear preference of the patient panel guided the strength and direction of the recommendations

Limitations

- Paucity of high-quality, direct evidence re: medications and perioperative risk
- Used indirect evidence from RCTs performed on patients who were not undergoing surgery to determine infection risk associated with included drugs and applied the data to these recommendations
Summary: Anti-rheumatic Medications and Arthroplasty

- Rate of arthroplasty remains high for patients with rheumatic diseases
- Use of DMARDs and biologics high at the time of surgery
- Complications are increased
- TNFi: increased infection risk consistently observed and significant when data are pooled
- Insufficient evidence to separate biologics
- Additional factors such as disease activity and severity, as well as smoking, corticosteroid use and diabetes may influence this increased risk

Conclusions

Unique perioperative challenges

- Optimal perioperative management requires close collaboration between orthopedists and rheumatologists
- Infection: medications appear to contribute to the risk of infection
  - Traditional DMARDs- MTX, HCQ, LEF appear safe in the perioperative period
  - Biologics should be withheld prior to surgery
  - SLE may need different management strategy

NEED FOR RESEARCH

- There is little direct evidence for medication related adverse events after THA or TKA
- Low incidence of surgical site infection increases practical challenges
- Will need multicenter studies to address these questions
Perioperative Optimization

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Internal Medicine
Perioperative Orthopedic Hospitalist
Director of Indianapolis Perioperative Medicine
2003-Present
ppcaccav@yahoo.com

Disclosures
- Faris Medical – consultant
- DJO - consultant

Topics
- What is a Orthopedic Perioperative Specialist?
- Diabetes Screening
- Inpatient Diabetes Management
- Nutrition Screening
Perfect Patient

- Ideal weight
- Non-smoker
- Exercises regularly
- Proper nutrition
- Controlled cholesterol
- Controlled BP
- Controlled medical problems
- See MDs regularly

Typical Patient

- Obese
- Sedentary
- Non-compliant
- Diabetes
- CAD
- Poor nutrition

Good old days
What is a Orthopedic Perioperative Specialist?

Perioperative Medicine

- Improved outcomes
- Fewer delays/cancellations
- Decreased length of stays
- Reduced testing
- Increased patient satisfaction
The challenge is not how to manage a medical problem but rather how to manage the problem with an orthopedic patient.

The Effects of a Hospitalist Comanagement Model for Joint Arthroplasty Patients in a Teaching Facility

"Any potential benefit of a hospitalist comanagement model for this patient population may be outweighed by increased cost."
Routine Workup of Postoperative Pyrexia Following Total Joint Arthroplasty Is Only Necessary in Select Circumstances

- 25k patients
- POP occurred 46% of TJA
- 0.2% had positive CXR
- CXR responsible for $4,613,182.00 (99.5% of total workup costs)

$384,431.83/year

Number of tests/procedures/consults ordered on 1,000+ patients:

- CT angiograms: less than 5
- Renal ultrasounds: less than 5
- Head CT: less than 5
- Cardiology consults: less than 5
- Non dialysis renal consults: less than 5
- Hematology consults: less than 5
Topics

- What is a Orthopedic Perioperative Specialist?
- Diabetes Screening
  - Inpatient Diabetes Management
  - Nutrition Screening
Diabetes and Hyperglycemia

There have been many studies linking diabetes with increased risk. Studies have shown that diabetes is associated with increased risk of deep infection, MI, DVT, PE, readmission, mortality, length of stay, and cost.

Study limitations:
- Retrospective studies
- Wide variance of study designs and outcome measures
- Lack of correction for comorbidities
- Inconsistent patient populations
- Small N of complication rates
Diabetes and Hyperglycemia

Two questions:
- Is it truly a risk factor?
- What is the risk factor?
  - Hyperglycemia
  - Diabetes
  - Uncontrolled diabetes
  - Diabetes with secondary disease

Diabetes and Hyperglycemia

Surgical Outcomes of Total Knee Replacement According to Diabetes Status and Glycemic Control, 2001 to 2009.

Conclusions: No significantly increased risk of:
- Revision
- Deep infection
- DVT
- Incident MI
- All cause rehospitalization

Diabetes and Hyperglycemia

Relationship of Hyperglycemia and Surgical-Site Infection in Orthopaedic Surgery.

- Retrospective study of fractures in NON diabetic patients
- Hyperglycemia (BS>200 x 2) was an independent risk factor for thirty-day surgical-site infection
**Diabetes and Hyperglycemia**

What’s a good minimum preoperative cutoff?

- A1c <8.0 (Average BS of 180 last 2-3 months)

- 90% of qid BS <180 for one week
Diabetes and Hyperglycemia

What’s a good minimum preoperative cutoff?

- A1c <8.0 (Average BS of 180 last 2-3 months)
- 90% of qid BS <180 for one week
- Fructosamine (Average BS last 1-2 weeks)

Diabetes and Hyperglycemia

Who should be screened?

ADA Standards of Medicare Care in DM - 2017

- Suggest that all patients with a prior diagnosis of diabetes or hyperglycemia have A1c if not performed in the prior 3 months.
Diabetes and Hyperglycemia

Who should be screened?

ADA Standards of Medicare Care in DM - 2017
- Suggest that all patients with a prior diagnosis of diabetes or hyperglycemia have A1c if not performed in the prior 3 months.


- 33.6% of pts. had previously undiagnosed dysglycemic patients

Diabetes and Hyperglycemia

Who should be screened?

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- Suggest that all patients with a prior diagnosis of diabetes or hyperglycemia have A1c if not performed in the prior 3 months.


- 33.6% of pts. had previously undiagnosed dysglycemic patients

Diabetes and Hyperglycemia

Who should be screened?

ADA: BMI > 25kg/m2 AND one risk factor (45, 1st degree relative, sedentary, HTN, high risk group, GDM, dyslipidemia, PCO, vascular disease)

USPTF: 40 to 70 AND overweight

CDC: 45 OR 1st degree relative, sedentary, GDM, high risk ethnic group, risk factors
Topics

- What is a Orthopedic Perioperative Specialist?
- Diabetes Screening
- Inpatient Diabetes Management
- Nutrition Screening

Diabetes and Hyperglycemia

Postoperative Inpatient Management:
ADA Standards of Medicare Care in DM - 2017

- Withhold oral medications starting the morning of surgery
Diabetes and Hyperglycemia

Postoperative Inpatient Management:
ADA Standards of Medicare Care in DM - 2017
- Withhold oral medications starting the morning of surgery
- Insulin with basal, correctional, and carb coverage

- CPOE recommended
- Sliding scales strongly discouraged
Diabetes and Hyperglycemia

Postoperative Inpatient Management:
ADA Standards of Medicare Care in DM - 2017
- Withhold oral medications starting the morning of surgery
- Insulin with basal, correctional, and carb coverage
  - CPOE recommended
  - Sliding scales strongly discouraged
  - Could resume orals when stable
- CPOE recommended
- Sliding scales strongly discouraged
- Could resume orals when stable
- Reduce chronic meds at d/c if needed
- Target glucose range for the perioperative period should be 80–180 mg/dL (4.4–10.0 mmol/L).
Diabetes and Hyperglycemia

Postoperative Inpatient Management:

- ADA Standards of Medicare Care in DM - 2017
  - Strong emphasis on avoiding hypoglycemia but using long acting basal insulin when needed
  - ADA now defines clinically significant hypoglycemia as glucose values <54mg/dL (70 trigger for adjustment)
  - Severe hypoglycemia is defined as that associated with severe cognitive impairment regardless of blood glucose level
Diabetes and Hyperglycemia

Postoperative Inpatient Management:
ADA Standards of Medicare Care in DM - 2017
- Strong emphasis on avoiding hypoglycemia but using long acting basal insulin when needed
- ADA now defines clinically significant hypoglycemia as glucose values <54mg/dL (70 trigger for adjustment)
- Severe hypoglycemia is defined as that associated with severe cognitive impairment regardless of blood glucose level
- The ADA does not endorse any single meal plan or specified percentages of macronutrients, and the term “ADA diet” should no longer be used.

Topics
- What is a Orthopedic Perioperative Specialist?
- Diabetes Screening
- Inpatient Diabetes Management
- Nutrition Screening

Nutrition

The Questions:
Nutrition

The Questions:

- How is malnutrition defined?

- How much malnutrition increases postop complications?

- Does correcting malnutrition decrease complications?
Nutrition
How is malnourishment diagnosed?

- Academy of Nutrition/ASPEN recommend 2 or more for diagnosis:
  - Insufficient energy intake
  - Weight loss
  - Localized or generalized fluid that may mask weight loss
  - Loss of subcutaneous fat
  - Loss of muscle mass
  - Decreased hand strength
Nutrition

How is malnourishment diagnosed?

- Academy of Nutrition/ASPEN recommend 2 or more for diagnosis:
- Screening tools
  - Mini Nutrition Assessment Short Form (MNA-SF)
  - The Malnutrition Universal Screening Tool (MUST)
  - The Subjective Global Assessment of Nutritional Status
  - The Nutritional Risk Screening Tool
  - Rainey-MacDonald nutritional index

Nutrition

Screening Tools

Comparing the adequacy of the MNA-SF, NRS-2002 and MUST nutritional tools in assessing malnutrition in hip fracture operated elderly patients

- All screening tools were adequate in assessing malnutrition parameters in hip fracture operated elderly patients
- Only the MNA-SF could also predict readmissions and mortality
Nutrition

How is malnourishment diagnosed?

- Academy of Nutrition/ASPEN recommend 2 or more for diagnosis:
- Screening tools
- LABS (albumin, transferrin, pre-albumin, lymphocytes)

There are many recent studies showing low albumin (<3.5 g/dl) have worse outcomes:

- Hypoalbuminaemia-a marker of malnutrition and predictor of postoperative complications and mortality after hip fractures - Injury 2017 Feb
- Hypoalbuminemia independently Predicts Surgical Site Infection, pneumonia, LOS, and readmission after Total joint arthroplasty - J. of Arthroplasty 8-2016
- Malnutrition and Total Joint Arthroplasty- J Nat Sci 6-2016
- Malnutrition Increases With Obesity and Is a Stronger Independent Risk Factor for Postoperative Complications A Propensity- J. Oil Arthroplasty 4-2016
- Malnutrition a marker for increased complications, mortality, and length of stay after total shoulder arthroplasty- J Shoulder Elbow Surgery 5-2016
Nutrition

How is malnourishment diagnosed?

- Academy of Nutrition/ASPEN recommend 2 or more for diagnosis:
  - Screening tools
  - LABS (albumin, transferrin, pre-albumin, lymphocytes)
- Nutrition labs falsely abnormal
  - Associated with inflammatory processes
  - Negative acute phase reactants
  - Can be low for other non-diagnosed illnesses

Nutrition

Does routine supplementation or correcting “malnutrition” decrease complications?
Nutrition

Does routine supplementation or correcting "malnutrition" decrease complications?

- There are studies showing benefit with immunonutrition supplementation with GI surgery
- Methodological flaws
  - Variance of supplementations
  - Surgical patients with highest risks were excluded

Nutrition

Does routine supplementation or correcting "malnutrition" decrease complications?

- There are studies showing benefit with immunonutrition supplementation with GI surgery
- Methodological flaws
  - Variance of supplementations
  - Surgical patients with highest risks were excluded
  - Minimal/no studies showing correction of the malnutrition parameter improves outcomes with TJA
Nutrition

Conclusions?

- Variability of defining “malnutrition”
- Minimal supportive studies showing correction lead to improve outcomes with TJA
- Supplements choice? Cost?
Nutrition

Conclusions?

- Variability of defining “malnutrition”
- Minimal supportive studies showing correction lead to improve outcomes with TJA
- Supplements choice? Cost?
- Until higher quality data demonstrating unequivocal benefit are available, nutritional supplementation cannot be recommended as a routine addition to surgical patients.

Thank you.
ppcaccav@yahoo.com
What Is the Role of 1 vs 2 Stage in Periprosthetic Infection?

Thomas K. Fehring, MD
2017
OrthoCarolina Hip and Knee Center
Charlotte, NC

I (and/or my co-authors) have something to disclose.

Detailed disclosure information is available via:

“My Academy” app;

PERIPROSTHETIC INFECTION
Scope Of The Problem
2020
• 49,000 PI Projected
• Projected Costs - $1.6 Billion

Kurtz, JBJS 2007
**PREVENTION STRATEGIES-CRITICAL**

- Perioperative Antibiotics
- OR Traffic Reduction
- Pre Op Decolonization Protocols
- Chlorhexidine Wipes
- Laminar Flow
- Occlusive Post Op Dressings

**PATIENT OPTIMIZATION**

**Modifiable Risk Factors**

- HgB A1C < 8
- BMI <40
- Albumin > 3.5
- Smoking Cessation

**MSIS INFECTION CRITERIA**

- Sinus tract communicating with the prosthesis or Positive Culture on 2 separate tissues or fluid samples or

- Three of the following 5 criteria exist
  - Sedrate > 30 + CRP>10
  - Synovial WBC > 2000
  - Synovial PMN's >75%
  - One positive culture
  - > 5 Neutrophils in 5 high power histologic fields
SYNOVIAL BIOMARKERS

- Alpha Defensin
- Leukocyte Esterase
- Synovial CRP
- IL-6
- Next Generation Sequencing

TREATMENT OPTIONS

- I & D & Poly Exchange
- 2 Stage Re-implantation
- 1 Stage Re-implantation

Periprosthetic Knee Sepsis
The Role of Irrigation and Debridement

61% Reinfection Rate

64% Reinfection rate
Clin Orthop Rel Res 471, 2013
**Irrigation and Debridement for Periprosthetic Infections**

*Does the Organism Matter?*

- Susan M. Odema, MD,^5^ Thomas K. Pelening, MD,^9^ Adolph V. Lombardi, MD,^5^ Ben M. Zmuidzinas, BS,^5^ Nicholas M. Hansen, BS,^5^ Jeffrey T. Luvs, MD,^2^
  - Keith A. Pelening, MD,^5^ and Erin N. Myers, MD,^5^
  - and The Periprosthetic Infection Consortium^1^

**Step 7** Failure all other organisms 67%

**The Fate of Acute Methicillin-Resistant Staphylococcus aureus Periprosthetic Knee Infections Treated by Open Debridement and Retention of Components**

*Estes et al., CORR 2010*

- 2 stage debridement with beads between stages
- 2 perioperative
- 18 acute hematogenous
- 18/20 successful

*Mont et al., J Arthroplasty 1997*

- 10 acute perioperative infections
  - 7/10 - 2 or 3 debridements
  - All successful

**The Problem: BIOFILM**

- Dooms I & D Poly Exchange Results
- Bacterial colonies attach to the implant
- Secret a protective matrix that protects the bacteria from external threats such as antibiotics or the immune system
- Once mature they shed free planktonic bacteria which start new colonies on the implant
- Antibiotics can only kill the free planktonic bacteria
2 Stage Re-implanation

- 30% reinfection rate
- 86% success rate

Two Stage Reimplantation for Periprosthetic Knee Infection Involving Resistant Organisms


1 Stage Re-implanation

- One Stage vs. Two Stage: Controversial
  - Implant extraction only removes implant related biofilm
  - Soft tissue biofilm must also be removed through meticulous debridement

- Question: Can local biofilm attach to a newly implanted prosthesis?

European One Stage Studies

- 70 patients minimum 9 year f/u
- Radical resection of bone
- Hinged implant removal: 93% infection free
- 16% lost to f/u
- 16% loose implant

**EUROPEAN ONE STAGE STUDIES**

- 100% Success rate
- 11 Periprosthetic Hip Infections
- 28 Periprosthetic Knee infections
- 5 year f/u
- Exclusion criteria
  - Significant comorbidities
  - Resistant organisms
  - Presence of sinus tract
  - Peripheral Vascular disease

**ONE STAGE VS. 2 STAGE WHICH IS BEST?**

- One Stage data encouraging but difficult to interpret due to limited numbers, organism exclusion & comorbid patient exclusion
- Two Stage is the gold standard in U.S. but the reinfection rate is closer to 80% than the 90% often quoted
- Patient convenience & Economic ramifications of 2 Stage
  - Demand reevaluation

**Economic Burden of Periprosthetic Joint Infection in the United States**

- Nationwide inpatient sample study
- Annual cost in 2009 - 566 million
- Projected to exceed 1.62 Billion by 2020
- Gold standard in U.S- 2 Stage

Do health economics mandate an investigation concerning 1 Stage?
OREF SPONSORED STUDY

• Prospective randomized multicenter study One stage vs. Two stage treatment for Periprosthetic hip & knee infections

Initial Sites
- OrthoCarolina
- Rush
- Rothman
- Cleveland Clinic
- HSS

Additional Sites
- USC
- UC SF
- Emory
- Ochsner Clinic
- UT Chattanooga
- Univ. of Michigan
- Univ. of Iowa

---

ONE STAGE vs. 2 STAGE STUDY

**Inclusion Criteria**

- Primary surgery
- Infection/MSIS criteria
- Known organism
- Resistant organisms
- Previous I & D
- Reprep/Re-drape Protocol
- All host classified/ MSIS criteria
- 350 patients

**Exclusion Criteria**

- Fungal infection
- Immunosuppressed patients
- Extensive soft tissue defect
- Revision surgery

---

ONE STAGE VS. TWO STAGE

Go with the status quo or an unknown quantity with significant risk but a possible upside

It's time to settle this controversy
WHAT DO WE NEED?
A prospective randomized multicenter study excluding only fungal organisms and immunosuppressed patients

ONE STAGE VS. TWO STAGE
WE’LL LET YOU KNOW

AUDIENCE RESPONSE QUESTION
I would consider doing a One Stage Preimplantation for a Periprosthetic Hip or Knee Infection.

1. If the organism was a sensitive staph or strep in a healthy patient.
2. In an elderly infirmed patient with multiple medical problems regardless of organism.
3. In any patient even one with a resistant organism if not immunosuppressed.
4. #1 & #2 only
5. Never I would prefer a 2 Stage Approach.
Fixation of Periprosthetic TKR
Fx’s: What to look for, What to consider, What to do…

Frank A. Liporace, MD
Chairman – Dept. Of Orthopaedics
Chief Orthopedic Trauma & Adult Reconstruction
Jersey City Medical Ctr / RWJ Barnabas Health
Associate Professor – New York University

Disclosure

• Design Team
  • Depuy / Synthes
  • Biomet

• Educational Consultant
  • Depuy
  • Biomet

Etiology

• 0.3 to 2.5% TKR’s

• Risk Factors
  • Osteopenia
  • Osteolysis
  • Having a TKR
  • Decreased BMD 6-12 mo post-TKR
  • Notching (0.5-52% TKR’s)
  • 1.5% of notched femurs (Gujarat N, et al: Acta Orthop 2009)

• Low vs High Energy Mechanisms
Considerations

- Fracture location
- Implant stability
- Bone quality

Anatomy

Trapezoid cross section

Deforming Forces
Radiographic Evaluation

- Good Quality AP and Lateral
- CT scan
- Angiography
  - Asymmetric pulses
  - ABI <0.9

Fractures of the Distal Third of the Femur

A Comparison of Methods of Treatment
By Marcus J. Stewart, David Sisk, Sidney L. Wallace
JBJS June 1966

- 20 year review of 442 fractures
- 213 with at least 1 year of follow-up
- 144 treated closed and 69 treated with ORIF
- 67% good or excellent with closed treatment
- 54% good or excellent with ORIF

Conservatism should be taught and practiced more universally.

Supracondylar Fractures of the Adult Femur

A study of 110 cases
By Charles Neer, Ashby Grantham, and Marvin Shelton
JBJS 1967

- 90% satisfactory with closed treatment
- 52% satisfactory with ORIF

"Most patients were satisfied as long as they had strong extensor power and could flex the knee to 70 degrees."
In 2017…

- WE SHOULD OPERATE unless:
  - Patient too medically unfit
  - Completely undisplaced fracture?

Goals of Treatment

- **Stable fixation** of the meta-diaphyseal fracture
- **Avoid complications**: malunion, nonunion, infection, arthrofibrosis
- **Allow early movement** and rehabilitation
  - Minimize disability and maximize return to function

Achieving goals
Achieving goals

TKA Classification
Rothman Institute 2006

Type I: Good Bone Stock, Well Fixed Component
IA non-displaced-potential nonoperative (Rorabeck I)
IB Displaced fx- operative (Rorabeck II)

Type II: Good Bone stock but loose or poorly positioned component
Revision with long stem components

Type III: Good or Poor bone stock with loose component
Revision TKA (Rorabeck III)

Kim, et al. CORR, 446. 2006
Decision Matrix

<table>
<thead>
<tr>
<th>Bone Stock Implant</th>
<th>Good</th>
<th>Bed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>Nell vs. Plate</td>
<td>Revise vs. ORIF/Augment</td>
</tr>
<tr>
<td>Bed*</td>
<td>Revise</td>
<td>Revise with long stem</td>
</tr>
</tbody>
</table>

Options

- IMN
- ORIF
- Supplements
  - CaPhos
  - Allograft
  - BG substitutes
- Revision TKR

Options

- What’s best to decrease r.r. nonunion?
  - IMN
  - Locked implants
  - Conventional plating / struts
  - Non-op

415 case meta-analysis

- IMN
- Locked implants
LISS vs Blade Plate

Higgins TF et al (JOT 2007)

• LISS
  • Less subsidence
  • Greater resistance to failure
  • Findings regardless of BMD

• LISS w/ multiple fixed angle devices that are multiplanar

Uni vs Bicortical screws…
Locking implants…

Osteoporotic Bone

*Simulation of osteoporotic bone performed with 15 BMD strain
**Options**

- Can we increase pull-out strength with ORIF and osteopenia?
  - PMMA or TCP with locking screws
  - 5x increased pull-out strength to conventional plating

Collinge et al.: JOT 2007

**Patient NC**

[Images of medical scans or X-rays of a knee joint with a implant or plate]
Should 90-90 strut-plate be standard?

Biomechanical Evaluation of Periprosthetic Femoral Fracture Fixation

• 90-90 strut / plate stronger than
• Conventional plate
• Locked plate + cables
• Biomechanical study with THR’s

WHAT ABOUT THE BLOOD SUPPLY???
Double-Plating of Comminuted, Unstable Fractures of the Distal Part of the Femur

• Sanders et al. J. Bone and Joint Surg. 1991
  • 9 patients
  • Functional outcomes
    • 5 good results
    • 4 fair results
    • 1 patient with > 100° knee flexion
    • Neurovascular concerns medially

• WHAT ABOUT THE BLOOD SUPPLY???

Saving the Blood Supply

• 10 cadaveric femurs
• CPO vs MIPPO
• 16 hole LC-DCP
• Dye injection
• ALL MIPPO specimens with intact nutrient and perforating arteries

(M & Kreshak, JOT, 1999; Injury 1997)
**Indirect Reduction of Metaphyseal Component**

**Effect of Keeping Periosteum**
- Maintenance of b.s.
- Higher union rates
- Lower complications
- Less bone grafting


**Indirect Reduction Techniques**

Bolhofner: JOT 1996

- 57 fractures treated by MIPPO with single plate
- Union and FWB at 10.7 wks.
- 100% union (2 delayed)
- 84% good or excellent with > 100 degrees motion
- 5% < 90 degrees motion
Clinical Results

- MIPPO w/ DCS in distal femur
  - 14 cases all MIPPO with DCS
    - 1 died 6wks post-op
  - Limited exposure
    - Indirect reduction techniques
    - No bone graft used
  - 12/13 healed w/o 2nd procedure
    - 1 plate / screw failure

(Krettek, Injury, 1997)

Clinical Results

- 59 patients (~74yo)
  - Lateral plating
    - MIPPO techniques
    - NO allograft struts
  - 58 healed w/o 2nd procedure
  - 49 returned to pre-injury status
  - IMMEDIATE post-op motion

(Ricci WM and Borrelli J: Injury 2007)

DF Implants

- Multiple 'little blade plates'
- Difficult to get around implants

Issues with unicortical shaft screws
Locked Screws & Osteoporosis

- Cortical thickness
- Canal dilatation
- Working Length
  - Screw
- Bi-cortical Lock
  (Gautier, Injury, 2003)

Fixed angle device with angular options???

Is polyaxial locking strong enough???

Results of Polyaxial Locked-Plate Fixation of Periarticular Fractures of the Knee

- 56 peri-articular knee fractures
- 12 open
- All treated w/ POLY-AX plate

- 94% union
- No varus progression
- No screw or plate failures
What about the tibia?

Tibia TKR fx’s

- Intra-op
  - Metaphyseal
  - Tubercle osteotomy

- Post-op
  - Non-displaced
  - Displaced

<table>
<thead>
<tr>
<th>Major Anatomical Pattern</th>
<th>Subcategory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total plateau</td>
<td>A. waiter's prosthesis</td>
</tr>
<tr>
<td>Adjacent to vein</td>
<td>B. loose prosthesis</td>
</tr>
<tr>
<td>Distal to tibia</td>
<td>C. intraoperative</td>
</tr>
</tbody>
</table>

TABLE 3: Classification of Postoperative Periprosthetic Tibial Fractures
Inter-prosthetic Fx

• Between TKR and THR
• Between TKR and Hip Fixation

Span Femur with LONG PLATE !!!
IMN

- Retrograde
- Antegrade

Retrograde Nailing

- Less invasive?
- Technically difficult
  - Purchase
  - Stability

Retrograde Nailing

- BUT...
  - Ineffective or complicated w/ "boxed" TKR
  - Limited distal fixation (osteoporosis)
  - Increase risk prosthetic infection
  - Increase risk of polyethylene damage / 3rd body
Intramedullary Nails

• Are they more stable than plates?
  • Traditionally suggested to be biomechanically more advantageous to plates → SHAFT FX’s
  • Immediate WB’ing?

Comparison of the LISS and a retrograde inserted supracondylar intramedullary nail for fixation of a periprosthetic distal femur fracture proximal to a total knee arthroplasty
Bong M et al J Arthroplasty 2002

• Laboratory biomechanical model
  • Nail
    • Greater resistance to varus load and torsional load
  • LISS
    • Greater resistance to valgus load w/ bone loss

• BUT…
  • Did not address osteoporotic model
  • Did not address all types TKR or LOW peri-prosthetic fracture
  • Did not address model w/ varus bone loss
Biomechanical Evaluation of the Less Invasive Stabilization System, Angled Blade Plate, and Retrograde Intramedullary Nail for the Internal Fixation of Distal Femur Fractures

Michael Zorodoulis, MD, Scott Wilfavan, BS, Peter A. Cole, MD, Lyle D. Zardnickas, PhD, and Philip J. Kregor, MD

Hospital for Joint Diseases - Department of Orthopaedic Surgery

LISS > IMN

DEFORMATION W/ CYCLICAL LOADING

ELASTIC

IMN & LISS

SIMILAR

PERMANENT DEFORMATION

PLASTIC
Biomechanical Evaluation of the Less Invasive Stabilization System, Angled Blade Plate, and Retrograde Intramedullary Nail for the Internal Fixation of Distal Femur Fractures

AXIAL LOADING:
- IMN < LISS
- LOAD-TO-FAILURE
- LOW BMD
- IMN > LISS
- LOAD-TO-FAILURE
- HIGH BMD

Retrograde IMN
- Require accurate reduction
- May require supplemental fixation
- High union rates
- Risk valgus and extension deformity

Antegrade IMN
Extreme Nailing

Nailed Cementoplasty

Distal Femoral Plating Technique
GOALS

• Biologic preserving !!!
  • Respect soft tissues

• Restoration of:
  • Mechanical axis
  • Length
  • Alignment / Rotation

Non-articular or Simple Split

• Lateral approach
  • ***Limited surgical dissection
  • Percutaneous plate insertion

  • Metaphysis Indirect Reduction
    • Ramps
    • Femoral Distractor
    • Percutaneous Pins
    • External fixator
Results of polyaxial locked-plate fixation of periarticular fractures of the knee.

Haidukewych G, Sems SA, Huebner D, Horwitz D, Levy R.

Plate Placement Problems

- Prior to complete plate fixation, must confirm appropriate location
  distally and proximally!!!
Plate Placement Problems

• Prior to complete plate fixation, must confirm appropriate location **distally and proximally!!!**
NONUNION
LOSS OF FIXATION

Diagram Courtesy of George Haidukewych, MD

- CHALLENGES

- SITUATIONS FOR SPECIAL CONSIDERATION

- SALVAGES

RetroIMN for PP FEMUR FXs

• Distal 1/3 Fx's around Primary TKR
  • No "box" (CR)
  • If "box" (PS) with:
    • Removable polyethylene plug
    • Pre-existing hole
    • Try to avoid "making a hole" with a metal cutting burr

• Less Invasive?

• More biologically friendly?
**CHALLENGES**

- Lack of access
- "Box" (PS) without ability to pass
- Revision TKR
- THR above
- Iatrogenic damage
  - Patella or tibia polyethylene
- Limited Distal Fixation
- Limited offerings that actually "Dial-in-Deformity"
- Worse with CR or PS ???

**DEFORMITY**

Due to entry access
APEX-POSTERIOR
Lack of purchase in distal fragment
VALGUS

**PS**
DIFFERENT ANATOMY PER PERSON

DISTAL ANGULATION

Nails CAN BE VERY FORGIVING at times…
Patient has full extension and >90 degree flexion!

LOL – Seriously?

10 months from IMN
Limited ROM
"Why am I in PAIN !!!"

INADEQUATE
STABILITY W/ CURRENT IMN ALONE

Nails CAN BE very FORGIVING at times... but NOT ALWAYS !!!
SOME ANSWERS FOR DENSITY OF FIXATION

- Multi-lock screws
  - Multi-directional support with fixed angle screw within a screw
    - LISS vs Blade idea

- Screw configuration
  - Additional screws
  - Take advantage of PM and Pl condyles

- Plate attachment to Nail
  - ALL OF THE ABOVE !!!

SCREW CONFIGURATION
WHERE COULD WE GO WITH THIS?

• Plate – Nail combo’s
  • Fix "needing" a nail with a THR above or rev TKR below
  • Metaphyseal Nonunions requiring better fixation
  • Osteoporosis
  • Avoid deformity (Distal Femur, Proximal & Distal Tibia)
  • "Dial-in" stability

Distal femoral nonunion: treatment with a retrograde inserted locked intramedullary nail
• 25% union rate of nonunions with retrograde IMN alone
Patient BP
Periprosthetic tibia
Subtroch fx above stemmed tkr
REMEMBER ???

Reasonable operation choice done wrong…
77 yo male periprosthetic fracture

Hospital for Joint Diseases • Department of Orthopaedic Surgery
77 yo male periprosthetic fracture

Locked screws in Fx Zone
Excessively Rigid Fixation
Short segment proximal fixation
NOT Balanced Fixation
Multiple cerclage
Dissection to get “Chicken Claw”

EV – vacation in Mexico gone wrong
EV

JV – 77 yo male
3 time failed distal femoral nonunion
ALL surgeries with lateral plate
Previous Hip Fx short hip IMN above
SOLUTION ???
STEP 1 – BIOPSY (significant history)

NOTE ALLOGRAFT FIBULA INTRAMEDULLARY STRUT ??!
NEGATIVE FOR INFECTION

B.S. sign
Bone Stimulator
JZ

Distal Femoral Fx 10 yrs ago w/ 4 time nonunion s/p platings above TKR

THR above that had previous fx at stem tip

Non-ambulator x 2.5 years

***INFECTED***
2.5 months post-definitive op
Uses walker – 1st time in 2.5 yrs
Proximal and Distal N/P Linkage

CALLUS

PLATE-NAIL SUMMARY

• Improve “reliability” and “feasibility” of current retrograde IMN usage
  • Improve stability – DISTAL FRAGMENT
  • Decrease late deformity

• Allow for improvement with ease of REDUCTION

• PREVENTATIVE Tx of potential Interprosthetic fx

• Allow for expanded IMN nailing indications

• Can “dial-in” desired amount of STABILITY
Future directions

- Implants to accommodate tibia IM fixation
- Modular implants
  - Modular Plate
    - Modular Nail / Plate or Locking washer
- Mating Implants
  - TKR with THR above

Top 5 DO’s

- Complete radiographs
- Implant or bone incompetence
- Distal Femur Fx’s if implant stable
  - INDIRECT reduction techniques
- Distal Femur Fx’s retrograde IMN
  - Check box status
  - “Healthy” incision
  - Don’t ream polyethylene
  - Don’t leave reamings in joint
- Consider polyaxial implants and bone substitute augmentation
  - Above, span both implants

Top 5 DON’Ts

- Don’t accept axis deviations → implant wear
- Don’t leave loose implants
- Don’t use incompetent fixation
  - Allograft with cables ONLY
  - Wires only
  - Screws only or NON-Balanced plate fixation
- Don’t delay post-op ROM
- Don’t delay surgery in elderly
  - Systemic manifestations similar to hip fx’s
PERIPROSTHETIC FEMUR FRACTURES AFTER THA: Treatment with Revision

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Presenter Disclosure Information

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• The author’s institution receives research support from: DePuy, Zimmer, Stryker, Biomet, Smith-Nephew

PERIPROSTHETIC FX: THA
Introduction

• The infrequency and complexity of these problems often leads to suboptimal management
PERIPROSTHETIC FX: THA
Introduction

Fortunately…
• We don’t see much of this anymore:

PERIPROSTHETIC FX: THA
Introduction

• But we still see this…

PERIPROSTHETIC FX: THA
Introduction

• And we still see this…

Nonunion

Loose
PERIPROSTHETIC FX: THA

Current Management?

Vancouver Classification

Fracture Location Guides Treatment:
• Peritrochanteric
• Around stem
• Well distal to stem

Fractures Around Stem

Fractures Around Stem:
• Little role for nonoperative Rx
• Prolonged recovery
• Just delays--and makes more difficult--the inevitable operation
• Risk of malunion, nonunion
PERIPROSTHETIC FX: THA
Non Operative Treatment: Problems

Malunion
Non union

Fractures Around Stem

Fracture Around Stem

Stem Fixed
Stem Loose
Stem Loose
Bone Poor

ORIF
Revise
Revise

Loose Stem

Fracture Around Stem

Stem Fixed
Stem Loose
Stem Loose
Bone Poor

ORIF
Revise
Revise
PERIPROSTHETIC FX: THA Loose Stem

Revision Principles:
- Use fracture for access to remove implant
- Bypass fracture, usually with long stem
- Stabilize fracture
- Get stable implant fixation
- Respect biology: Avoid stripping muscle

PERIPROSTHETIC FEMUR FRACTURES: Vancouver B₂/B₃

Fractures Around Loose Stems:
- With modular tapered fluted, modular stems we can treat B₂ and B₃ fractures the same!
PERIPROSTHETIC FEMUR FRACTURES: Vancouver B₂/B₃

- Bypass fracture with fluted tapered stem → get distal axial and rotational stability
- Reassemble fracture around proximal stem as scaffold

Key points:
- Access failed implant and joint through fracture or osteotomy
- Keep all fracture fragments vascular
- Goal: Reasonable but not anatomic reduction

Keys to Success:
- Absolute axial and rotational stability distal to fracture
- Ream distal femur aggressively
- Prophylactic cerclage below fracture
PERIPROSTHETIC FEMUR FRACTURES: Vancouver B₂

PERIPROSTHETIC FEMUR FRACTURES: Vancouver B₂

PERIPROSTHETIC FEMUR FRACTURES: Vancouver B₃
PERIPROSTHETIC FEMUR FRACTURES: Results

Mayo Experience:
• 44 B₂/B₃ fxs
• Healing 43/44
• Stable stem 43/44

Vancouver Experience:
• Similar!

Abdel, Lewallen, Berry, CORR 2014;472:599

PERIPROSTHETIC FX: THA Pitfalls

Fracture

Immediate postop

Loose

Avoid Undersizing Stem

Migration of Proximal Bone Fragments
PERIPROSTHETIC FEMUR FRACTURES: Conclusions

Modern Techniques:

• Simplified treatment

• Higher level of success

PERIPROSTHETIC FX: THA Conclusions

Modern Techniques:

• Emphasis on simultaneously creating strong durable mechanical constructs and

• Optimizing biologic environment for fracture healing

EARLY POSTOP FRACTURES
PERIPROSTHETIC FX: THA
Early Postop Femur Fracture

Incidence Has Increased in Recent Years:
• More wedge shaped uncemented stems
• Smaller exposures → missed intraop fxs
• Quicker rehab, earlier weight bearing, more falls

PERIPROSTHETIC FX: THA
Etiology of Early Postop Fractures

Etiology:
• Unrecognized intraop fracture that displaces under load
• Fall or stumble that creates new fracture before stem is bone ingrown

PERIPROSTHETIC FX: THA
Early Postop Femur Fracture

• Most are associated with *uncemented proximally coated wedge shaped stems*
PERIPROSTHETIC FX: THA
Fracture Patterns

Stereotypical Pattern: triangle of posterior medial cortex with lesser trochanter

PERIPROSTHETIC FX: THA
Fracture Patterns

Typical Pattern:
- Loose
- Subsided
- Retroverted

PERIPROSTHETIC FX: THA
Fracture Patterns: Fracture-Dislocation
PERIPROSTHETIC FX: THA
Treatment

- Remove implant, fix fracture, revise stem
- Results mostly good

PERIPROSTHETIC FX: THA
Early Fracture Prevention

- Identify and treat intraop fractures
- Prophylactic cerclage in selected patients
- Warn patients on rapid rehab protocols to avoid falls
Adductor Canal Block vs. Femoral Nerve Block

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Disclosure

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• Consultant for Edan Medical
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Overview

• Adductor Canal blocks: the rationale
• Precautions
• Conclusions
First the Femoral Nerve block

- Femoral nerve block was the gold standard


Less pain at rest and during PT
Less analgesic drug
Better ROM
Shorter LON
Less nausea
Less sedation
Less pruritus
Higher satisfaction

Case series of 5 patients with a combined spinal/FNB for TKA
- 4 Wound disruption
- 1 peri-prosthetetic fracture

Kandasami M et al. Knee 2009,16(2):98-100

Femoral Nerve Block for Total Knee Replacement — a Word of Caution — (Surgeon Perspective)

Case study of 1190 patients with a continuous CFNB for TKA
- First 469 patients received a 2-3 days infusion
- The next 721 patients had their infusion stopped 12 hrs after surgery
- 9 Femoral nerve palsies
  (2 in group 1 and 7 in group 2)
- 8 major falls,
  no differences between groups


Major Complications Associated with Femoral nerve Catheters for Knee Arthroplasty — a Word of Caution (Surgeon Perspective)

Case study of 1190 patients with a continuous CFNB for TKA
- First 469 patients received a 2-3 days infusion
- The next 721 patients had their infusion stopped 12 hrs after surgery
- 9 Femoral nerve palsies
  (2 in group 1 and 7 in group 2)
- 8 major falls,
  no differences between groups

The Association Between Lower Extremity Continuous Peripheral Nerve Blocks and Patient Falls after Knee and Hip Arthroplasty

Pooled data from 3 previous randomized, placebo-controlled, blinded studies of CPNB after knee and hip surgery

- 0/86 fall in saline group
- 7 falls in 6 patients/85 in ropivacaine group
- Although only 1 patient is attributing the fall to weakness
- No patient sustained an injury

Ilfeld BM. et al. JBJS 2007;120(3);551-563

Inpatient Falls after Total Knee Arthroplasty: The Role of Anesthesia Type and Peripheral Nerve Blocks

Review 190,000 TKA.
1.6% had in-hospital fall

- Risks:
  • Advanced age
  • Male sex
  • Increased co-morbidity
  • Use of GA without neuraxial
- Non-factors
  • Neuraxial with/without GA
  • Peripheral nerve block use

Memtsoudis, S. et al. Anesthesiology. 2014;120(3);551-563

Then in 2014 Anesthesiology

- Femoral nerve block
  and concern for fall
Volunteer Study

- Jaeger et al – 2012, compared with contra-lateral placebo
  - Volunteer study
  - AC block produces quadriceps strength reduction of 8%
  - Femoral nerve block produces quadriceps strength reduction of 49%
  - Significant difference
  - No surgery or tourniquet effect

ACB vs Placebo

- Jensgtrup MT et al – Effects of adductor-canal-blockade on pain and ambulation after TKA: a randomized study
  - Ropi vs. placebo
  - Less opioid
  - Less pain during flexion
  - No diff for pain at rest
  - Better rehab

- Acta Anaesth Scan 2012;56(3):357-64
The Effects of Ultrasound-Guided Adductor Canal Block Versus Femoral Nerve Block on Quadriceps Strength and Fall Risk

- Femoral nerve block reduces the quadriceps strength more than AC block 91% vs 11%, no difference in adductor strength
- Balance scores reduced from 56 to 37 with FNB. No reduction with ACB

AC vs Fem

- Jaeger P et al – Adductor Canal Block versus Femoral Nerve Block for Analgesia after TKA: a Randomized, Double-blind Study
  - Spinal anesthesia (n=48)
  - Continuous AC vs Fem catheter
  - 30 ml ropi 0.5% initial dose
  - 8ml/hr ropi 0.2%
  - Strength from baseline 52% vs. 18%
  - No difference for pain or opioid for the first 24 hrs
- RAPM 2013;38(6),526-32
AC vs Fem

- Jaeger P et al – Adductor Canal Block versus Femoral Nerve Block for Analgesia after TKA: a Randomized, Double-blind Study
  - Spinal anesthesia (n=48)
  - Continuous Fem vs AC catheter
  - 30 ml ropi 0.5% initial dose
  - 8ml/hr ropi 0.25%
  - Strength from baseline 52% vs. 18%
  - No difference for pain or opioid for the first 24 hrs
- RAPM 2013;38(6),526-32

Adductor Canal Block Versus Femoral Nerve Block for Total Knee Arthroplasty: A Prospective, Randomized, Controlled Trial

- Kim DH et al – Adductor Canal Block versus Femoral Nerve Block for TKA
  - CSE anesthesia (n=93)
  - Single injection Fem vs AC (randomized, DB)
  - 30 ml bupi 0.25% for Fem and 15 ml for AC
  - At 6-8hrs: Fem vs. AC
    - strength: significant decrease
    - pain or opioids: no difference
  - At 24-48hrs: no more strength difference
- Anesthesiology 2014;120,540-50

Effect of Adductor Canal Block Versus Femoral Nerve Block on Quadriceps Strength, Mobilization, and Pain After Total Knee Arthroplasty A Randomized, Blinded Study

Ulrik Grevstad, MD, et al.

50 TKA pt with severe movement-related pain
DB RDMZ 0.2% ropi ACC vs fem

1 strength
2 ambu
3 pain

Adductor canal block provides a clinically relevant and statistically significant increase in quadriceps muscle strength for patients in severe pain after TKA
Overview

- Adductor Canal blocks: the rationale
- Precautions
- Conclusions

Delayed Motor Block

- AC block can easily spread proximal to affect motor branches of the femoral nerve


Day of surgery: ambulation without assistance
20 hr after an 8ml/hr ropi 0.2% produced profound quad weakness
2 ml dye spread to the fem nerve
Immediate Motor Block

- AC block can easily spread proximal to affect motor branches of the femoral nerve


Rescue single injection AC with 20 ml of ropi 0.5%
Motor block last for 20 hrs and the sensory for 48 hrs

Impairment of Sciatic Nerve Function During Adductor Canal Block

AC block can spread distal to affect motor branches of the sciatic nerve


Conclusions

- ACB vs FNB with post knee injection
  - Less motor blockade with better rehab condition
  - Similar analgesia after major knee surgery
- Possible delayed quadriceps weakness
- Add multimodal analgesia
- Potential problems:
  - Femoral artery injury?
  - Saphenous neuropathy?
  - No block asleep or under spinal !!!
KEY CHOICES AND TECHNIQUES IN REVISION THA AND TKA
Step-by-Step Decisions

Moderator: Daniel J Berry, Mayo Clinic
Panelists: John J Callaghan
William L Griffin
Thomas P Vail
Michael P Bolognesi

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• Board of Governors, Mayo Clinic; Board of Directors, AJRR; Presidential line, Hip Society

TOUGH REVISION THA AND TKA

REVISION THA
Old Skin Incisions:
• Which ones do you use?

In revision THA, how often do you perform an extended greater trochanteric osteotomy?
• Under what circumstances?
TOUGH REVISION THA AND TKA
THAR: Exposure

- What type of ETO do you prefer?
  - lateral 1/3 of femur (Paprosky)
  - anterior 1/3 of femur (Wagner)

TOUGH REVISION THA AND TKA
THAR: Implant Removal

- Well-fixed uncemented cup removal
  “Technical Tips”
TOUGH REVISION THA AND TKA
THAR: Implant Removal

• Well fixed uncemented stem removal?

TOUGH REVISION THA AND TKA
THAR: Implant Removal

• Well fixed broken stem removal?

TOUGH REVISION THA AND TKA
Implant Removal

• Well-fixed fluted tapered stem removal?
THAR: Acetabular Bone Loss

Mild-Moderate Bone Loss:
- What is your “go to” technique?

- Do you always use an “enhanced” ingrowth surface in revisions?
TOUGH REVISION THA AND TKA
Acetabular Bone Loss

• When you have major medial segmental loss, what is your preferred reconstruction method?
  - cancellous graft
  - bulk graft
  - metal augments

TOUGH REVISION THA AND TKA
THAR: Acetabular Bone Loss

• When you have major lateral segmental acetabular bone loss, what are your indications for:
  - highly porous metal augments?
  - bulk bone allograft?

TOUGH REVISION THA AND TKA
Acetabular Bone Loss

• When do you need more than a hemisphere?
• Any indications for custom triflange cup?
TOUGH REVISION THA AND TKA
THAR: Acetabular Bone Loss

Pelvic Discontinuity:
• Go to method?

TOUGH REVISION THA AND TKA
THAR: Femoral Bone Loss

Mild-Moderate Bone Loss:
• What is your “go to” method in mild femoral bone loss?

• What is your “go to” category of stem when there is notable femoral bone loss?
  - fluted tapered modular
  - extensively coated
  - cemented long stem
  - impaction grafting
**TOUGH REVISION THA AND TKA**

**Femoral Bone Loss**

- Is there a role for impacting grafting?
- For bulk proximal femoral allograft?

**HIP STABILITY**

**TOUGH REVISION THA AND TKA**

**Joint Stability**

- In revisions, when do you use:
  - large fixed head?
  - dual mobility?
  - constrained?
TOUGH REVISION THA AND TKA
Joint Stability

- Revision for recurrent dislocation:
  - large head?
  - dual mobility?
  - constraint?

TOUGH REVISION THA AND TKA
HISTORY OF INFECTION

Question:
- Do you typically use a one stage or a two stage protocol for infected THA?
Question:
• During two stage treatment, do you prefer articulated or non articulated spacers?

Articulated  Non-articulated

Question:
• During two stage treatment, what is your typical resection interval?

Question:
• Femoral fixation at reimplantation - cemented? - uncemented?
POSTOP MANAGEMENT

Postop:
• Hip guide brace?
• Weight bearing
  - cup revision with bone loss
  - femoral revision with bone loss

REVISION TKA
EXPOSURE

Your “go to” exposure when things are tight?

- Quad snip
- Tibial tubercle osteotomy

IMPLANT REMOVAL
Implant Removal in Revision TKA:

- Multiply Revised Knee:
  - technical tips to:
    - speed removal
    - avoid complications

Do you ever need to do something exotic like "osteotomy" to get out well-fixed stemmed implants?

IMPLANT FIXATION
BONE LOSS
TOUGH REVISION THA AND TKA
TKAR: Bone Loss/Fixation

Options to Improve Fixation/Manage Bone Loss:
• Cemented stems
• Uncemented stems
• Metaphyseal cones/sleeves
• Bone graft

TOUGH REVISION THA AND TKA
TKAR: Bone Loss - Fixation

Cemented Versus Uncemented Stems?
• Balance of fixation versus
• Removability

TOUGH REVISION THA AND TKA
TKAR: Bone Loss - Fixation

• How do you get fixation in sclerotic canal damaged by previous stem?
TOUGH REVISION THA AND TKA
TKAR: Bone Loss - Fixation

One Good Method:
• Metaphyseal cone
• Impacting grafting

• When do you use metaphyseal sleeves or porous metal cones?

• When do you use particulate bone graft?
• When do you use small-medium size bulk bone allograft?

• When do you use massive bulk bone allograft?

• When do you go to distal femoral replacement?
STABILITY/CONSTRAINT

What % of implants for multiply revised knees?
- PS
- Constrained condylar
- Hinge

• Indications for hinge?
TOUGH REVISION THA AND TKA

TKAR: Implant Constraint

- Role of ligament augmentation/ligament allograft?

EXTENSOR MECHANISM

What do you do with the very deficient patella?
- Leave unresurfaced?
- Bone graft with pouch?
- Gull wing osteotomy?
Extensor Mechanism Deficiency:

- Role of allograft?
- Role of marlex mesh reconstruction?
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