Management Update:
I&D and One Stage Exchange
Is it time to Rethink the Gold standard?

Nader A. Nassif, MD
Hoag Orthopedic Institute
Disclosure

• Depuy Education Panel
• Institutional Education and Research Support
  – OREF Omega Grant
  – Depuy-Synthes
  – Zimmer-Biomet
  – Corin
  – The Hoag Foundation
Two-stage revision

- **Gold** standard in U.S.
- Varying treatment protocols
  - Articulating or static spacers
  - IV antibiotics (6 weeks)
- Excellent infectious outcomes
  - Durable success >85%
  - Functional outcomes lacking
- Timing of re-implantation/drug holiday
  - Lack of guiding evidence
• Retrospective
  • 120 patients underwent 2-stage revision protocol with static spacer
  • Infectious and ROM data collected
• Results
  • 94% success rate
  • Mean final ROM 100 deg flexion, 67 with full extension
  • Mean final KSS 88
• Modern two stage protocol has a high success rate
Prospective
- 107 patients at interim analysis and publication
- Randomized to 3 months of tailored oral antibiotics or usual treatment

Results
- 5% failure versus 19% in control group
- Large % infected with new organism
- At 2 years post-op, oral antibiotics effective
Two Stage Revisions...They work!

Table 2. Success of two-stage revision for periprosthetic knee infection

<table>
<thead>
<tr>
<th>Study</th>
<th>Success (number of patients)</th>
<th>Definition of failure</th>
<th>Resistant organism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wilson et al. [37]</td>
<td>16/20 (80%)</td>
<td>ROI</td>
<td>NR</td>
</tr>
<tr>
<td>Insall et al. [18]</td>
<td>10/11 (91%)</td>
<td>ROI</td>
<td>NR</td>
</tr>
<tr>
<td>Haleem et al. [12]</td>
<td>87/96 (91%)</td>
<td>ROI</td>
<td>NR</td>
</tr>
<tr>
<td>Booth and Lotke [1]</td>
<td>24/25 (96%)</td>
<td>ROI</td>
<td>NR</td>
</tr>
<tr>
<td>Goldman et al. [11]</td>
<td>58/64 (91%)</td>
<td>ROI</td>
<td>NR</td>
</tr>
<tr>
<td>Fehring et al. [9]</td>
<td>51/55 (93%)</td>
<td>ROI</td>
<td>NR</td>
</tr>
<tr>
<td>Masri et al. [25]</td>
<td>22/24 (92%)</td>
<td>ROI</td>
<td>NR</td>
</tr>
<tr>
<td>Hofmann et al. [17]</td>
<td>44/50 (88%)</td>
<td>ROI</td>
<td>4%</td>
</tr>
<tr>
<td>Teeny et al. [35]</td>
<td>8/8 (100%)</td>
<td>ROI</td>
<td>NR</td>
</tr>
<tr>
<td>Hart and Jones [13]</td>
<td>42/48 (88%)</td>
<td>ROI</td>
<td>2%</td>
</tr>
<tr>
<td>Hirakawa et al. [16]</td>
<td>41/55 (75%)</td>
<td>ROI</td>
<td>11%</td>
</tr>
<tr>
<td>Wilde and Ruth [36]</td>
<td>9/10 (90%)</td>
<td>ROI</td>
<td>NR</td>
</tr>
<tr>
<td>Durbakhula et al. [8]</td>
<td>22/24 (92%)</td>
<td>ROI</td>
<td>20%</td>
</tr>
<tr>
<td>Cuckler [6]</td>
<td>43/44 (98%)</td>
<td>ROI</td>
<td>11%</td>
</tr>
<tr>
<td>Total</td>
<td>477/534 (89%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ROI = recurrence of infection; NR = not reported.
When all you have is a hammer...
PJI is like a Malignancy

- Can be indolent
- May metastasize (sepsis)
- If not treated properly can locally recur (re-infection)
- Different pathogens treated differently and some respond better to treatment
- Can result in significant morbidity and Mortality
Tailoring Treatment = Precision Medicine

Time + Host + Pathogen = Treatment
Two-stage revision

Infection Irradiation Rate

Cost Increased Morbidity

Alternative:

Debridement, Antibiotics, Implant Retention (DAIR)

One-Stage Exchange
Debridement, Abx & Implant Retention (DAIR)

• Contra-indications:
  • Chronic periprosthetic infections
  • Sinus Tracts

• Classic Indications
  • Late acute hematogenous PJI (<3 weeks of symptoms)
  • Postoperative PJI (<3wks sx w/in 4 weeks of surgery)

• Classic Outcomes
  • Failure rate >50% (Sherrell et al. 2011)
  • ?? High secondary failure rate of two stage
93 articles (hip, knee and shoulder data) – 75% infection control rate

Debridement, antibiotics and implant retention for periprosthetic joint infections: A systematic review and meta-analysis of treatment outcomes

Setor K. Kunutsor, Andrew D. Beswick, Michael R. Whitehouse, Vikki Wylde, Ashley W. Blom

Journal of Infection 2018 (77: 479-488)
• Location Bias:

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>Infections Controlled</th>
<th>Total</th>
<th>Infection control (95% CI)</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>917</td>
<td>1,839</td>
<td>52.00 (46.00, 58.10)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Europe</td>
<td>1,724</td>
<td>2,515</td>
<td>69.50 (64.30, 74.50)</td>
<td></td>
</tr>
<tr>
<td>Asia</td>
<td>200</td>
<td>367</td>
<td>56.70 (45.70, 67.30)</td>
<td></td>
</tr>
<tr>
<td>Pacific</td>
<td>123</td>
<td>164</td>
<td>78.20 (66.00, 88.50)</td>
<td></td>
</tr>
<tr>
<td>South America</td>
<td>9</td>
<td>12</td>
<td>75.00 (46.80, 91.10)</td>
<td></td>
</tr>
</tbody>
</table>
Timing of DAIR

• The sooner the better
• Improved eradication with shorter time to surgery
  – 91% if less than 1 weeks
  – 75% > 1 week
  – Each Day decrease effectiveness of DAIR

Grammatopoulous et al BJJ 2016
DAIR in Acute infections

• Shohat et al (JBJS Am 2019)
  – 199 pts.
    • Acute SSI (n = 147)
    • Hematogenous infections (n = 52, >3 mo with < 3 weeks of symptoms.

• Results:
  – 56% failure rate in hematogeneous infections
  – 31% failure in acute SSI
DAIR in Acute infections

• Predictors of failure:
  – Higher Charleston Co-morbidity index
  – Prior revision (OR 2.55)
  – Patient factors:
    • COPD, Malignancy, Diabetes, Polymicrobial infection
  – Clinical factors:
    • intraoperative purulence, high CRP, elevated SBP and tachycardia
DAIR in acute Infections

Positive Blood Cultures Decrease the Treatment Success in Acute Hematogenous Periprosthetic Joint Infection Treated With Debridement, Antibiotics, and Implant Retention

Feng-Chih Kuo, MD \textsuperscript{a,b}, Karan Goswami, MD \textsuperscript{a}, Mitchell R. Klement, MD \textsuperscript{a}, Noam Shohat, MD \textsuperscript{a,c}, Javad Parvizi, MD, FRCS \textsuperscript{a,*}

\textsuperscript{a} Rothman Orthopaedic Institute, Philadelphia, PA
\textsuperscript{b} Kaohsiung Chang Gung Memorial Hospital, Kaohsiung, Taiwan
\textsuperscript{c} Sackler Faculty of Medicine, Tel Aviv University, Ramat Aviv, Israel

• 49 patients – acute hematogenous infection
• Results:
  – 45% + blood cultures
  – Infection free survival (@ 1 yr):
    • Negative blood Cultures: 67%
    • Positive blood cultures: 36%

JOA 2019
DAIR in acute infections

58 patients, minimum 2 year F/U.

- Acute post-operative infections
- No Tourniquets or drains for primary or DAIR
- Placed gentamicin eluting collagen substrate
- 2 weeks IV + 4 weeks targeted oral Abx
DAIR in acute infections

Acceptable Success Rate in Patients With Periprosthetic Knee Joint Infection Treated With Debridement, Antibiotics, and Implant Retention

Casper S. Ottesen, MD *, Anders Troelsen, MD, DMSc, PhD, Håkon Sandholdt, Steffen Jacobsen, MD, DMSc, PhD, Henrik Husted, MD, DMSc, PhD, Kirill Gromov, MD, PhD
Department of Orthopedic Surgery, Copenhagen University Hospital, Copenhagen, Denmark

• Results:
  – Avg Time to DAIR 21 days, no difference noted in success until >90 days
  – 7 patient had sinus tract.
  – No MRSA

Table 2
Microbiological Findings (N = 58).

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>No</th>
<th>Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphylococcus aureus</td>
<td>29</td>
<td>89% (26/29)</td>
</tr>
<tr>
<td>Coagulase-negative Staphylococcus</td>
<td>8</td>
<td>87% (7/8)</td>
</tr>
<tr>
<td>Streptococcus</td>
<td>16</td>
<td>No re-revision</td>
</tr>
<tr>
<td>Enterococcus</td>
<td>3</td>
<td>No re-revision</td>
</tr>
<tr>
<td>Enterobacter cloacae</td>
<td>1</td>
<td>Re-revised</td>
</tr>
<tr>
<td>Parvimonas micra</td>
<td>1</td>
<td>No re-revision</td>
</tr>
<tr>
<td>Klebsiella pneumoniae</td>
<td>1</td>
<td>No re-revision</td>
</tr>
<tr>
<td>Pseudomonas</td>
<td>1</td>
<td>No re-revision</td>
</tr>
<tr>
<td>Escherichia coli</td>
<td>1</td>
<td>No re-revision</td>
</tr>
<tr>
<td>Corynebacterium species</td>
<td>1</td>
<td>No re-revision</td>
</tr>
<tr>
<td>Citrobacter freundii</td>
<td>1</td>
<td>No re-revision</td>
</tr>
<tr>
<td>S capitis</td>
<td>1</td>
<td>No re-revision</td>
</tr>
</tbody>
</table>
Adjuvants to the Debridement

• Multiple Type of Intraoperative adjuvants:
  – Povidone-Iodine or Chlorhexidine Lavage
  – Vancomycin Powder
  – Dissolvable Calcium Sulfate Beats with antibiotics
Adjuvant Lavage

- **Riesgo et al** *(JOA 2018)*
  - 36 patients treated with vanco+ Povidone-Iodine I lavage
  - 16% failure following DAIR vs 37% in control group

- **Smith et al** *(JOA 2015)*
  - Chlorhexidine gluconate effective in eradication of MRSA biofilm in vitro at concentrations as low as 2%
Calcium Sulfate Abx Eluting beads

– Not enough data available
– 2 studies in the peer reviewed literature
– Knecht (JOR 2018):
  • *in vitro* study compared pulse lavage +/- Calcium Sulfate beads for biofilm eradication
  • Conclusion: combination of the two more affective than 1 alone
– Flierl et al (JOA 2017)
  • Small series 32 patients (DAIR)
  • 48% failure rate
  • Beads did not seem to improve outcomes of DAIR
Chronic suppression

• Not a substitute for a poorly performed surgery

• Extending antibiotic treatment only delays rather than prevents re-infections

(Byren 2009 antimicro chemotherapy)
Host Factors
Predicting Failure in Early Acute Prosthetic Joint Infection Treated With Debridement, Antibiotics, and Implant Retention: External Validation of the KLIC Score

Claudia A.M. Löwik, MD a,*, Paul C. Jutte, MD, PhD a,1, Eduard Tornero, MD b, Joris J.W. Ploegmakers, MD a,1, Bas A.S. Knobben, MD, PhD c,1, Astrid J. de Vries, PhD c,1, Wierd P. Zijlstra, MD, PhD d,1, Baukje Dijkstra, MSc d,1, Alex Soriano, MD, PhD e, Marjan Wouthuyzen-Bakker, MD, PhD f, on behalf of the Northern Infection Network Joint Arthroplasty (NINJA)

a Department of Orthopaedic Surgery, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands
b Department of Orthopaedic Surgery, Parc Sanitari Sant Joan de Deu, Sant Boi de Llobregat, Spain
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e Department of Infectious Diseases, University of Barcelona, Hospital Clinic of Barcelona, Barcelona, Spain
f Department of Medical Microbiology and Infection Prevention, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

• KLIC score:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>K Chronic renal failure (kidney)</td>
<td>2</td>
</tr>
<tr>
<td>L Liver cirrhosis</td>
<td>1.5</td>
</tr>
<tr>
<td>I Index procedure (revision surgery or prosthesis indicated for a fracture)</td>
<td>1.5</td>
</tr>
<tr>
<td>C Cemented prosthesis</td>
<td>2</td>
</tr>
<tr>
<td>C C-reactive protein &gt;115 mg/L</td>
<td>2.5</td>
</tr>
</tbody>
</table>

KLIC, chronic renal failure (K), liver cirrhosis (L), index surgery (I), cemented prosthesis (C), and C-reactive protein >115 mg/L

1. JOA 2018
2. International Orthopedics 2018 (42:33-38)
KLIC score

- Acute PJI
- Primary Outcome:
  - Failure: EARLY (within 60 days)
- Cut off value of 3.5:
  - Sensitivity 77%
  - Specificity 57%
Other Risk Factors

- Rheumatoid Arthritis
- COPD (for acute hematogenous infections only)
Does performing a DAIR affect subsequent 2 stage Revision?

Hell Yes

NO WAY JOSE
NO WAY
83 Knees (1994-2008), minimum 2 year f/u

– All failed initial DAIR and had a subsequent Two stage revision

Results:

– 34% failure rate
– 53/83 were staph species (15 MRSA)
– No association between length of time between index procedure and DAIR (> or < 4 weeks).
Does Prior Failed Debridement Compromise the Outcome of Subsequent Two-Stage Revision Done for Periprosthetic Joint Infection Following Total Knee Arthroplasty?

Ashok Rajgopal, MS, MCh, FRCS (Ortho) a, *, Inayat Panda, MS, DNB (Ortho) a, Arun Rao, BPT b, Vivek Dahiya, DNB (Ortho) a, Himanshu Gupta, MS (Ortho) a

a Department of Orthopaedics, Fortis Bone and Joint Institute, New Delhi, India
b Department of Physiotherapy, Fortis Bone and Joint Institute, New Delhi, India

- 184 knees (88 Failed DAIR, 96 direct 2-stage)
  - 5 year follow up
  - Failed DAIR 24% failure
  - Direct 2 stage 16% failure
  - Worse outcomes with MRSA, Pseudomonas
  - If MRSA, MRSE, Pseudomonas excluded similar rates of failure (12% vs 14%)
• Retrospective state database study (California and New York)
  • 2005-2011, 4 yr follow up
  • 750 patients (2-stage revisions), 57/750 had a prior DAIR.
  • Overall failure rate: 16.8% (126/750)

• Results
  • No increased risk of failure after I&D (actually risk was lower!) 8.7% DAIR vs 17.5% control
  • Female sex protective
  • No antimicrobial data available
• 45 Failed DAIR vs 132 2-stage exchange
  – Single institution, 2009-2015
  – >4 year follow-up
  – Similar eradication rate of 82%
  – No organism dependent trends (including drug resistant organisms).
Pathogen

- Evidence is not consistent
- Some studies demonstrate higher failure rate for Staph Species, others do not
- Higher failure rate also noted for Enterococcus
- Drug Resistant (MRSA & MRSE) also showed mixed data in the literature.
Factors for Successful DAIR

• Minimizing the time to surgery (ideally less than 7 days but less than 21 days)
• Exchange of Modular Components
• Thorough Synovectomy and Debridement
• Scrub Implants
• Addition of Rifampin for Staph Infections

Methylene Blue–Guided Debridement as an Intraoperative Adjunct for the Surgical Treatment of Periprosthetic Joint Infection. Shaw Et al JOA 2017
Keys to Success of an I&D

**HOST**
- Healthier Host
- RA
- COPD
- Kidney Disease
- Liver Disease
- +Blood Cultures
- Prior Surgery

**PATHOGEN**
- ??
- Staph Aureus?
- Drug Resistant?
- Pseudomonas
- Enterococcus
- Polymicrobial

**TIME**
- Acute SSI (less than 3 weeks of symptoms)
- Acute Hematogenous (< 3 weeks)
- Chronic Infection
After all that....

I DON’ WANNA
One Stage Revision. Why?

• **Potential Advantages:**
  – Decreased Surgical Morbidity
  – Earlier functional return
  – Decrease in healthcare spending and economic burden (maybe)
  – Increase in Health related quality of life years

• **Potential Disadvantages:**
  – Resource and technique intensive
One-stage revision

• Not widespread U.S. use
  • Relatively newer
  • Gaining traction in Europe
• Varying protocol
  • Strict versus wide indications
  • Adjuvant IV antibiotics
  • Re-prepping and draping prior to final implantation
1-stage exchange

**Indications**
- Non-immunocompromized Host
- No Sepsis
- Minimal Bone loss or soft tissue defects
- Isolated organism
- Known sensitivities

**Contra-indications**
- Severe damage to the soft tissue preventing direct closure
- Culture negative infection
- Drug Resistant Organism
- Poor bone stock
Surgical Technique

• Requires infrastructure and well-versed surgical team
• One stage = Two stage done at the same setting
  – Thorough, aggressive soft tissue debridement
  – New Drapes, New Instruments
  – +/- full closure
Outcomes

• Excellent infectious outcomes

• Comparable Outcomes between 1-stage and 2-stage exchanges
  • Durable success >85%
  • Possibly improved functional outcome
Is Single-stage Revision According to a Strict Protocol Effective in Treatment of Chronic Knee Arthroplasty Infections?

Fares Sami Haddad FRCS (Tr&O), Mohamed Sukeik MRCSEd, Sulaiman Alazzawi MRCSEd

- Retrospective
  - 100 patients, 30% single stage
  - **Strict protocol:** No bone loss, no immunocomp, known bug without resistance
  - Antibiotics min 6 weeks

- Results
  - No single stage re-infections,
  - 93% success 2 stage
  - KSS 88 vs 76 (p<0.05)

- Single stage revision can be very effective
• Meta-analysis
  • ~400 single stage, ~5000 2-stage patients

• Results
  • 7% re-infection single, 8.8% 2-stage
  • No difference in limited functional data
  • No microorganism data

• Unable to identify a significant benefit to two stage revision
98 articles reviewed

Results
- 2500 1-stage: 8% reinfection rate
- 3200 2-stage: 9% reinfection rate
- Same issues as with prior study
• 2008-2017: Reinfection rate: 13%
• 1:1 matched cohort
• Risks for re-infection
  – Prior 1-stage or 2-stage
  – Enterococci or strep.
Complications - Infection

One-Stage Periprosthetic Joint Infection Reimbursement—Is It Worth The Effort?

Keith A. Fehring, MD *, Brian M. Curtin, MD, Bryan D. Springer, MD, Thomas K. Fehring, MD

OrthoCarolina Hip and Knee Center, Charlotte, NC

Results: The average reimbursement for a one-stage knee procedure was $2,597.08, with an average intraoperative service time of 259 minutes ($601.60/h). The average reimbursement for a primary total knee was $2,435.00, with an average intraoperative service time of 100 minutes ($1,461/h). The average reimbursement for a one-stage hip procedure was $2,826.17, with an average intraoperative service time of 311 minutes ($545.24/h). The average reimbursement for a primary total hip was $2,754.71 with an average intraoperative service time of 104 minutes ($1,589.26/h).

Conclusion: One-stage procedures for PJIs are reimbursed at approximately 1/3 the hourly rate of a primary procedure, which may discourage surgeons from selecting this treatment alternative even if recent studies confirm efficacy. Payers should be encouraged to reimburse physicians commensurate with the intraoperative service time needed to perform a one-stage procedure as adoption will decrease morbidity and save the healthcare system financially.

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DRG Reimbursement to the hospital similarly affected
Reconsidering Strategies for Managing Chronic Periprosthetic Joint Infection in Total Knee Arthroplasty

Using Decision Analytics to Find the Optimal Strategy Between One-Stage and Two-Stage Total Knee Revision

Karan Srivastava, MD, MBA, Kevin J. Bozic, MD, MBA, Craig Silverton, DO, Andrew J. Nelson, MD, Eric C. Makhni, MD, MBA, and Jason J. Davis, MD

Investigation performed at Henry Ford Hospital, Detroit, Michigan

• Decision Analytics and Montecarlo simulation
• Looked at all pathogens and difficult to treat pathogens
• 1-stage cost savings $19,000-$27,000/infection

JBJS 2019
Summary

• **Two stage exchange** remains the gold standard

• **One stage exchange** is a good alternative with similar results in select group of patients with both morbidity and economic advantages (maybe!)

• **DAIR** has a lower success rate than 1-stage and 2-stage exchange but is a viable option for acute surgical site and hematogeneous infections without + blood cultures
Megaprostheses in non-oncologic Applications

Nader A. Nassif, MD
Medical Director, Sarcoma Program
Hoag Orthopedic Institute
Hoag Family Cancer Center
Goals

• Give quick fire Pearls for use
Indications

• Significant Bone Loss
• Non supportive bone
• Necrotic bone.
• Multiply revised
• Periprosthetic Fracture in the elderly
Complications

- 25-30% skin necrosis
- 15% Nerve injury
- 5% fracture
Wound Complications

• Multifactorial:
  – Poor Host
  – Malnutrition
  – Large Dissection
  – Marginal Soft tissue Coverage
Fixation

Compress

Cemented

Uncemented
Proximal Femur replacements

- Approach: Lateral
- Removes the proximal Portion of the femur and detaches it from
  - Hip Flexors
  - Abductors
  - Adductors
  - Hip Extensors
- Capsule is repaired
- Muscles are Tied to each other
- Need Global Hip Precautions
Pearls

• Larger Head or Dual Mobility maybe a good option to insure stability
• Purse string suture around the capsule also helps with stability.
• Preserve the bigrastric attachment to the greater trochanter
• Attempt at a re-attaching the abductors will improve function
• Version is placed in neutral
Distal Femur Replacements

• Approach: Midline, Medial or Lateral
• Distal End of the femur is removed along with capsule and all collaterals
• Be aware of the posterior neurovascular bundle (stay on bone)
• Extensor Mechanism is PRESERVED
Pearls

- **Length, joint-line and rotation are key**

- **Length:**
  - Intraoperative measurements/exam
  - Compare to contralateral limb (ASIS ot ankle)

- **Joint line:**
  - Meniscal scar
  - Patellar position

- **Rotation:**
  - Linea aspera
  - Patellar position in flexion
• 14 studies, 3.8 yr follow up

• 356 patients
  – 23.8% re-operations
  – 15.7% dislocation rate
  – 7.6% infections

• Uses:
  – Infection: 78.9% clearance rate
  – Periprosthetic fractures: 15% dislocation, 10% infection
Proximal Femur replacement

• De Martino et al (Int Orthop 2018)
  – 41 patients single institution
  – 22% reoperation rate
  – 7% infection rate
  – 95% survival at 5 years
Open Reduction vs Distal Femoral Replacement Arthroplasty for Comminuted Distal Femur Fractures in the Patients 70 Years and Older


- 38 pts 10DFR vs 28 ORIF
- Avg age 82
- Reoperation rates
  - DFR 10%
  - ORIF 11%
- Ambulation:
  - DFR: 100%
  - ORIF: 25%

JOA 2016
30 DFRs, mean age 74
43% complication rate
62% 3-year survival
Mean ROM 82 deg
KSS 61 vs 88 for Primary TKA
Proximal Tibia Replacements

- Removal of Proximal Tibia and all attachments and capsule
- Extensor Mechanism is sacrificed and reconstructed
- Commonly requires a gastroc rotation flap
17 yo F  proximal Tibia chondroblastic OGS, ROM at 1 year Post op 0-90.
Pearls

• Extensor function is the key to success
• Redundant repair of the extensor mechanism
  – Save the tubercle if possible and repair to implant
  – Figure of 8 with braided non-absorbable suture tape
  – Gastroc flap
Proximal Tibia Replacement

• NO DATA!
Downsides

• Higher Infection rate

• Higher Failure Rate

• More bone loss than would be necessary
Take Home Points

• Megaprostheses are a LAST resort for limb salvage in a multiply operated on joint

• Patients are fragile and surgery are significant.

• Complications rates are high.

• Advantage: earlier return of function