Infections After Shoulder Surgery

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• No disclosures
Goals

• Review of P. acnes
• Diagnosis and Challenges
• Prevention
• Management of Infection
• Treatment
Infected?

CRP 47.4
ESR 13
WBC 14.5
Infected?

- Routine TSA
- 3 months post-op
- Moderate pain, 4/10
- AROM 130 FE
- No fevers, chills
- Wound healing well
- Feels like he is making progress in PT
Is the shoulder the same as other joints?

- Traditional approach: Extrapolate hip/knee infection literature to shoulder
- Recent data shows significant differences in microbiology of shoulder infections
- Risk factors for infection are different
- Clinical presentation of shoulder infection is different
What is P. acnes?

- *Propionibacterium acnes*
  - Anaerobic
  - Gram positive bacillus
  - Fastidious – difficult to grow in culture
  - Requires 7-13 days extended incubation for detection – no consensus
  - The most common pathogen in post-operative shoulder infections
Why P. acnes in the shoulder?

- Originates from dermis, which is not sterilized
- Especially prevalent in the axilla - lots of sebaceous glands and hair follicles permit growth of bacterial flora

Deep cultures from primary surgery are also positive for P. acnes, suggesting mechanism for infection.
Is positive culture an infection?

- Mook JBJS 2015
  - 13% positive cultures from sterile gauze in shoulder arthroscopy
- Matsen JSES 2014
  - 14% positive deep cultures at primary shoulder replacement
- Levy JSES 2013
  - 42% positive cultures at primary arthroscopy, no prior surgery
Infection After Arthroscopy

- Still rare – most studies <1%
- No large series
Infection After Open Cuff Repair

- Rates from 0.43 to 1.7%
- Mirzayan: 11/13 cases with humeral osteomyelitis
- Athwal: 3.3 debridements per case, 8 weeks abx, 100% infection eradication
Infection After Shoulder Arthroplasty

- 0-3% for TSA
- 3-15% for RSA
  (5.1% in large series – 4x rate of TSA)
Diagnosis
Diagnosis

• Risk factors
  – Male sex, younger age, arthroplasty for trauma, post-op hematoma

• History
  – Persisting pain after surgery, constant pain out of proportion, lack of alternative explanation

• Radiographs
  – Pottinger JBJS 2012: progressive humeral osteolysis = 10-fold increased risk of p. acnes
  – Radionuclide scans not useful in isolation
Diagnosis

• Serologic Tests:
  – Sensitivity and Specificity of ESR and CRP are low in the shoulder
  – Topolski: 75 patients with positive intra-op cultures: 25% high CRP, 14% high ESR
  – Millett: 10% had elevation of both ESR & CRP
Diagnosis

• Aspiration:
  – No guidelines are available for when to aspirate shoulder (unlike hip and knee)
  – P. acnes often does not grow even when there is fluid (Kelly CORR 2009, Dilisio JSES 2014)
  – Synovial leukocyte count is unhelpful because p. acnes taps are often dry
  – IL-6 and alpha-definsin may have better sensitivity and specificity than serologic ESR/CRP
Diagnosis

- Biopsy
  - Dilisio JBJS 2014
    - All patients with + p acnes in scope biopsy also had p. acnes at time of revision surgery
    - All patients with no growth on scope biopsy had no growth at revision surgery

| TABLE IV Arthroscopic Biopsy, Aspiration, and Revision Surgery Biopsy Cultures |
|---------------------------------|------------------|----------------------|
| No. of patients                 | 14               | 19                   | 17                   |
| No. (%) with positive culture*  | 1 (7)            | 9 (47)               | 7 (41)               |
| P. acnes                        | 1                | 9                    | 7                    |
| Staphylococcus capitis ssp. ureolyticus | 1              |                      |                      |
| Enterococcus faecalis           | 1                |                      |                      |

*The mean time to a positive culture was 10.1 ± 3.79 days (range, 5 to 18 days).
Diagnosis

• Intra-operative:
  – No correlation between frozen sections and positive cultures unless purulence is seen for p. acnes
    • Topolski: 75 shoulders, 8% of those with positive cultures had acute inflammation on frozen section
  – Traditional higher virulence organisms follow the rules for hip and knee infections

• Implant Sonication
  – Piper et al 2009: soincate more sensitive than periprosthetic tissue culture (67% vs 54%)
Definition of Infection: MSIS (Hip and Knee)

1. Presence of sinus tract communicating with prosthesis
2. A Pathogen isolated by culture from at least two separate tissue or fluid samples
3. Three of the following minor criteria
   - Elevated ESR and CRP
   - Elevated synovial leukocyte count
   - Elevated synovial neutrophil percentage
   - Isolation of microorganism in one culture
   - Greater than 5 neutrophils per HPF in 5 HPF’s at 400x magnification
Definition of Shoulder Infection?

- Still lacking – vital need for more explicit criteria for diagnostic algorithm
- ASES committee tasked with this question
- My practice:
  - **Unlikely infection**: normal labs, female patient, appropriate pain level for pathology, no loose components within 5 years, negative aspirate, no red flags on history
  - **Undetermined**: constant pain, male patient, pain out of proportion to pathology, loose components after 5 years, concerning history, elevated labs with no growth on aspirate
    - Biopsy
  - **Likely infection**: elevated labs, growth on aspirate, high cell count, constant pain out of proportion, loose components less than 5 years, osteolysis, drainage, erythema, concerning history
Prevention
Home Prep

- Sabetta et al JSES 2015: 48 hours of BID topical benzoyl peroxide (BPO) gel applied to shoulder and axilla prior to surgery
  - Control (exposed to air only)
    - 4% positive p. acnes
  - Before Skin Prep:
    - 16% positive p. acnes on BPO treated side
    - 32% p acnes on untreated side
    - 48% positive in men, 19% in women

- Murray et al JSES 2011: showers followed by 2% chlorhexidine cloths applied to shoulder prior to surgery
  - P acnes 24% in treatment group, 30% in control group
  - All bacteria 66% in treatment group, 90% in control group
Shave Axilla?

- Marecek et al JSES 2015:
  - Clipped one randomly selected armpit in 85 male volunteers with surgical clippers
  - Cultured both armpits
  - Median total bacterial burden was 48 in clipped axilla and 5 in the unclipped

<table>
<thead>
<tr>
<th>Table III Microbiologic flora before surgical preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria</td>
</tr>
<tr>
<td>All species</td>
</tr>
<tr>
<td>Propionibacterium acnes</td>
</tr>
<tr>
<td>Coagulase-negative staphylococcus</td>
</tr>
<tr>
<td>Corynebacterium spp.</td>
</tr>
<tr>
<td>Gram-negative bacillus</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
</tr>
<tr>
<td>Micrococcus spp.</td>
</tr>
<tr>
<td>Peptostreptococcus spp.</td>
</tr>
<tr>
<td>Enterococcus spp.</td>
</tr>
<tr>
<td>Staphylococcus haemolyticus</td>
</tr>
<tr>
<td>Streptococcus viridans</td>
</tr>
<tr>
<td>Citrobacter spp.</td>
</tr>
</tbody>
</table>

Values expressed as number (percentage) or median [25th quartile, 75th quartile].
Surgical Prep

- Saltzman et al JBJS 2009: 150 patients
  - Chloraprep:
    - 7% positive cultures overall, 7% p. acnes
  - Duraprep:
    - 19% positive cultures overall, 12% p. acnes
  - Povidone-iodine scrub and paint:
    - 31% positive overall, 15% p. acnes
  - **Chloraprep was the best overall, but did not change p. acnes positivity**

- Lee et al JBJS 2014: Chloraprep followed by punch biopsy of dermis: 70% still had positive p. acnes culture
Antibiotic Prophylaxis

• Cefazolin – the standard
• Ceftriaxone – more effective against p. acnes than cefazolin, less likely than clinda to cause c.difficile
• Vancomycin – to cover second most common organism, coag-negative staph
• Matsen – Ceftriaxone and Vanco for shoulder arthroplasty
Antibiotics In Cement

• Nowinski JSES 2012
  – 501 Reverse TSA procedures
  – Tobra, Gent, Vanco-tobra
  – 265 antibiotic in cement: 0% infection rate
  – 236 no antibiotics in cement: 3% infection rate
Treatment
Treatment

• Suppression
• I&D
• Resection
• One stage exchange
• Two stage exchange
• Poor quality data, less than 20 studies, very heterogeneous
Treatment

- Suppression: Coste JBJS 2004
  - 3/5 persistent symptomatic infection
- I&D with prosthesis retention:
  - Coste: 12% recurrence (63% more surgery)
  - Sperling et al CORR 2001: 50% recurrence
- Resection arthroplasty
  - Armstrong JSES 2015: 71% satisfied and functional with ADLs
  - With permanent spacer as definitive implant
  - Without spacer
Treatment

• One Stage Exchange
  – High success rate for occult infections
  – Variable success rate of higher virulence organisms
  – Ince et al JBJS 2005
    • Used antibiotic cement
    • 9 patients, no recurrent infections
  – Klatte et al 2013
    • 16 patients, 6% recurrence at 5 years
Treatment

• Two Stage Exchange
  – High morbidity
  – Reasonably good success rates, 60-90%
  – Generally better success than single stage, but not for occult infections
Post-op

• What to do with “Surprise intra-operative cultures?"
  – Grosso et al JSES 2012: 17 patients with low clinical suspicion but positive cultures at single stage revision without antibiotic treatment - One recurrence (5.9%)
  – Foruria et al JSES 2013: 107 patients with unexpected positive cultures, 10% recurrence rate
  – Organisms in both studies were p. acnes and Coagulase-negative staph

• Manage these as if a one stage exchange was done.
# Antibiotics

## TABLE E-5 Antibiotic Treatment Recommendations for Common Microorganisms Identified in Periprosthetic Shoulder Infections*

<table>
<thead>
<tr>
<th>Microorganism</th>
<th>Antibiotic of Choice</th>
<th>Alternative(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Staphylococcus aureus</em> or coagulase-negative staphylococci</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methicillin susceptible</td>
<td>Nafcillin or cefazolin ± rifampin</td>
<td>(1) Clindamycin, (2) trimethoprim-sulfamethoxazole, and (3) vancomycin</td>
</tr>
<tr>
<td>Methicillin resistant</td>
<td>Vancomycin ± rifampin</td>
<td>(1) Linezolid, (2) daptomycin, and (3) rifampin and ciprofloxacin, or levofloxacin, or trimethoprim-sulfamethoxazole, or minocycline</td>
</tr>
<tr>
<td><em>Propionibacterium acnes</em> and corynebacterium species</td>
<td>Penicillin G</td>
<td>(1) Third-generation cephalosporin, (2) vancomycin, and (3) clindamycin</td>
</tr>
<tr>
<td><em>Streptococcus</em> species</td>
<td>Penicillin G</td>
<td>(1) Third-generation cephalosporin and (2) vancomycin</td>
</tr>
<tr>
<td><em>Enterococcus species</em> (penicillin susceptible)</td>
<td>Penicillin G</td>
<td>(1) Ampicillin or amoxicillin and aminoglycoside and (2) vancomycin</td>
</tr>
<tr>
<td><em>Enterococcus species</em> (penicillin resistant)</td>
<td>Vancomycin</td>
<td>Linezolid</td>
</tr>
<tr>
<td><em>Enterobacter</em> species</td>
<td>Meropenem, ertapenem, or imipenem</td>
<td>(1) Ciprofloxacin and (2) cefepime</td>
</tr>
<tr>
<td><em>Pseudomonas aeruginosa</em></td>
<td>Cefepime or ceftazidime</td>
<td>(1) Meropenem or imipenem, (2) aminoglycoside, and (3) ciprofloxacin</td>
</tr>
</tbody>
</table>

*The recommendations are based on the reviews provided by Zimmerli et al.30, Kowalski et al.49, Sankar and Esterhaj123, and Peel et al.124. The antibiotics listed should be used as general guidelines. Antibiotic type, route, dose, and duration should be discussed with a medical infectious disease consultant, and final determination should be guided by the final culture sensitivities of the pathogen(s) isolated in culture.*
Cases
Conclusion

• Lots of work to do:
  – Need consensus definition of infection
  – Need to figure out how to use new tests
    • Biopsy, IL-6, alpha defensin, sonication
  – Need to find a way to be cost-effective with diagnosis and treatment
  – Need to understand and detect when p. acnes is a real pathogen and how to prevent it