Propionibacterium acnes Infection in Shoulder Surgery

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Microbiology

- P. acnes
  - Anaerobic, Gram-positive Bacillus
  - Found in sebaceous follicles of the axilla
    - Greater concentration exist in the axilla compared with the hip or knee
    - Can also be found in deep layers of skin, conjunctiva, external auditory canal, respiratory tract, and intestinal tract
  - Colonization is more common in men than women
  - Common pathogen in infections after shoulder surgery along with Staphylococcus species

Propionibacterium acnes colonization of the human shoulder

Amar Patel, MD*, Ryan P. Coffeen, MD†, Matthew Planko, MD*, Staci A. Fischer, MD*, Andrew Green, MD*†
Propionibacterium acnes: an underestimated etiology in the pathogenesis of osteoarthritis?

- May play a role in development of arthritis
- High incidence of *P. acnes* in shoulders prior to arthroplasty suggesting a correlation with arthropathy [Levy et al., JSES 2013]
- However, a recent study saw a low rate of positive cultures (3.125%) of *P. acnes* using the Oxford protocol to collect tissue specimens [Macioni et al., JSES 2015]
- Different results reflect different rates of contamination rather than infection
- Emphasizes the need for strictly controlled specimen collection

Incidence of Infection

- **Arthroplasty**
  - Anatomic TSA – 0.4-2.9%
  - Reverse TSA – 1-10%
  - Revision shoulder arthroplasty – as high as 15.4%
- **Arthroscopic RCR** - 1.9%

Risk Factors

- Male patients
- More hair in the upper body harbors more of the bacterium
- Increased duration of surgery
- Preoperative anemia
- Age less than 65
- Posttraumatic shoulder arthroplasty
  - 3 times higher risk of infection than elective surgery [Richards et al., CORR 2014]
- Prior shoulder surgery
- Workman’s compensation
Prevention

• Axillary hair removal
  - Maracek et al. (JSES, 2015)
  - 85 healthy male volunteers
  - Cultured clipped vs. unclipped axillae
  - Clipped axillae had a higher total bacterial burden
  - After preparation with chloraprep however there was no difference in bacterial load
  - Based on this study, the authors no longer routinely remove axillary hair

Efficacy of preoperative home use of 2% chlorhexidine gluconate cloth before shoulder surgery

Michael R. Murray, MD**, Matthew D. Saltzman, MD, Stephen M. Gryde, MD, Michael A. Terry, MD, Chase C. Woodward, BS, Gordon W. Nuber, MD

• JSES 2011
• Home use of 2% chlorhexidine wipes before shoulder surgery decreases overall bacterial culture rates, especially for coagulase-negative Staphylococcus

Efficacy of Surgical Preparation Solutions in Shoulder Surgery

By Matthew D Saltzman, MD, Gordon W. Nuber, MD, Stephen M. Gryde, MD, Geoffrey S. Maracek, MD, and Jason L. Koch, MD

• JBJS 2009
• Surgical preparation
  - Chloraprep (2% chlorhexidine gluconate and 70% isopropyl alcohol) vs. DuraPrep (0.7% iodophor and 74% isopropyl alcohol) vs. povidone-iodine scrub vs. paint (0.75% iodine scrub and 1.0% iodine paint)
  - No difference in eliminating P. acnes
  - However, Chloraprep was most effective in eliminating coagulase negative Staphylococcus when used for preoperative preparation
Frequent isolation of *Propionibacterium acnes* from the shoulder dermis despite skin preparation and prophylactic antibiotics

Joieep Phadnis, FRCS (Tr&Orth)*, David Gordon, FRACP, FRCPA†, Jeganath Krishnan, FRACS, PhD‡, Gregory Ian Bain, FRACS, PhD§

*Department of Trauma & Orthopaedics, Brighton and Sussex University Hospitals, UK
†Department of Orthopaedics and Trauma, Flinders University, Adelaide, SA, Australia
‡Department of Microbiology and Infection Medicine, Flinders University, Adelaide, SA, Australia
§International Musculoskeletal Research Institute, Adelaide, SA, Australia

- 50 consecutive patients
- 70% chlorhexidine alcohol
- 42% pre-preparation positive for *P. acnes*
- 14% post-preparation positive
- 52% positive dermal swabs
- 40% positive dermal biopsies
- Higher rate in patients <50 years old and revision surgeries

Efficacy of topical benzoyl peroxide on the reduction of *Propionibacterium acnes* during shoulder surgery

James R. Sabetta, MD*, Vishal P. Rana, BS*, Katherine B. Veduseli, MD*, R. Timothy Greene, MD*, James G. Cunningham, MD*, Seth R. Wilber, MD*, Paul M. Sethi, MD**

- Residual bacteria can still be found on the skin up to 29-40% of the time after skin preparation.
- Incising the skin/sebaceous glands can introduce *P. acnes* into the surgical wound.
- Sabetta et. al. (JSES, 2015)
  - Benzoyl peroxide (BPO) as a good adjunct preoperatively to chlorhexidine preparation
  - Use of 5% topical BPO cream for 2 days prior to surgery substantially reduced the rate of *P. acnes* identified in cultures to 6%
  - This was only done in arthroscopic cases
  - Future study to include open shoulder cases

Nottage, et al., ASES 2016, unpublished

- He has been using BPO clindamycin compound preoperatively
- Showed almost no *P. acnes* growth
Complications in Total Shoulder Arthroplasty

John W Spurling, MD, MHA, Richard L Hamilton, MD, Caller Wald, MD, and Joseph D. Tuchman, MD

An International Course Leader, American Academy of Orthopaedic Surgeons

- Type 1 = positive cultures at the time of revision surgery when preoperative workup is negative.
- Type 2 = are identified within 30 days after surgery and are considered acute.
- Type 3 = infections are acute hematogenous infections identified more than 30 days after surgery.
- Type 4 = infections are chronic infections

Diagnosis

- P. acnes is a commensal organism considered to be low virulence
- Makes clinical diagnosis difficult
- Patients usually only present with shoulder pain and may have no fever or local inflammation and may have normal inflammatory markers
- Inflammatory markers also may be poor indicators. Sensitivities of CRP and ESR in shoulder infections were found to be 42% and 16%, respectively (contrast to lower limb 88% and 75%, respectively)
Diagnosis

- Gold standard is intraoperative cultures
- 7-21 days of incubation are often necessary for detection

Interleukin-6 as a predictor of infection

Villacis et al. (JBJS, 2014) prospectively evaluated serum IL-6 in shoulder arthroplasty patients
- Sensitivity = 14%
- Specificity = 95%

Fragniome et al. (JBJS, 2015) prospectively evaluated synovial fluid IL-6 of patients undergoing revision surgery
- Sensitivity = 87%
- Specificity = 90%

Cost associated
Organism and Culture Times

<table>
<thead>
<tr>
<th>Organism</th>
<th>Number of Infections</th>
<th>Days to Growth of All Culture Specimens (avg)</th>
<th>Days to Growth of 1st Positive Specimen (avg)</th>
<th>Range (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. acnes</td>
<td>26(54%)</td>
<td>12.2</td>
<td>12.2</td>
<td>6-21</td>
</tr>
<tr>
<td>Coag Negative Staph</td>
<td>16(33%)</td>
<td>5.9</td>
<td>5.9</td>
<td>2-10</td>
</tr>
<tr>
<td>Corynebacterium</td>
<td>4 (8%)</td>
<td>8.8</td>
<td>8.8</td>
<td>8-10</td>
</tr>
<tr>
<td>Staph</td>
<td>2 (4%)</td>
<td>4.1</td>
<td>4.1</td>
<td>2-5</td>
</tr>
<tr>
<td>MSSA</td>
<td>3 (6%)</td>
<td>3.2</td>
<td>3.2</td>
<td>1-6</td>
</tr>
<tr>
<td>Candida</td>
<td>3 (6%)</td>
<td>11.0</td>
<td>9.3</td>
<td>4-20</td>
</tr>
<tr>
<td>MRSA</td>
<td>2 (4%)</td>
<td>2</td>
<td>2</td>
<td>1-3</td>
</tr>
<tr>
<td>Acid Fast Bacilli</td>
<td>2 (4%)</td>
<td>11</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Aspergillus</td>
<td>1 (2%)</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>E. coli</td>
<td>1 (2%)</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

Late Cultures

<table>
<thead>
<tr>
<th>Organism</th>
<th>Number of Infections</th>
<th>Number of Cultures that became positive after 10 days</th>
<th>Number of Cultures that became positive after 14 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propionibacterium</td>
<td>26</td>
<td>57%</td>
<td>28%</td>
</tr>
<tr>
<td>Coagulase Negative Staph</td>
<td>16</td>
<td>8%</td>
<td>2.7%</td>
</tr>
<tr>
<td>Corynebacterium</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>enterococcus</td>
<td>4</td>
<td>0.1%</td>
<td>0</td>
</tr>
<tr>
<td>MSSA</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>MRSA</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Frozen Section Correlation

<table>
<thead>
<tr>
<th>Organism</th>
<th>P value</th>
<th>F value</th>
<th>Φ correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. acnes</td>
<td>.71</td>
<td>.15</td>
<td></td>
</tr>
<tr>
<td>Coag Negative Staph</td>
<td>.05</td>
<td>.14</td>
<td></td>
</tr>
<tr>
<td>Corynebacterium</td>
<td>.01</td>
<td>.16</td>
<td></td>
</tr>
<tr>
<td>MRSA</td>
<td>.95</td>
<td>.00</td>
<td></td>
</tr>
<tr>
<td>enterococcus</td>
<td>.1</td>
<td>.9</td>
<td></td>
</tr>
<tr>
<td>MSSA</td>
<td>.23</td>
<td>.37</td>
<td></td>
</tr>
<tr>
<td>Candida</td>
<td>.46</td>
<td>.48</td>
<td></td>
</tr>
<tr>
<td>Acid Fast Bacilli</td>
<td>.1</td>
<td>.13</td>
<td></td>
</tr>
<tr>
<td>E. coli</td>
<td>.1</td>
<td>.09</td>
<td></td>
</tr>
</tbody>
</table>
Discussion

- Organisms and rates similar to the literature
- Average incubation time 12.2 days
  - Slightly longer than only other study in literature holding cultures 21 days
- Frozen sections cannot reliably be used

Diagnosis

- Different Strains of *P. acnes*
  - Nodzo et. al. (Am J Orthop, 2014)
    - Took samples from patients who have undergone arthroplasty or nonarthroplasty shoulder procedures
    - An orthopedic surgeon classified these infections as definite, likely, or unlikely.
    - Overall 22 *P. acnes* samples, 13 were hemolytic, 9 were nonhemolytic
      - 10/13 hemolytic strains were definite infections
      - 3/9 nonhemolytic strains were definite infections
    - Hemolytic strain is the pathologic strain

Early Versus Late Culture Growth of *Propionibacterium acnes* in Revision Shoulder Arthroplasty

Salamone J. Frangiamore, MD, Aya Saleh, MD, Matthew J. Zimmo, BS, Rakesh Mulak, MD, Thomas W. Isaac, MD (1963)

- Contaminant vs. true positive???
- Frangiamore et. al. (JBJS, 2015)
  - Evaluated the timing of growth of *P. acnes* after intraoperative cultures taken
  - Probable true-positive cultures grew at a significantly shorter time (4-7 days) compared to probable contaminants (6-12 days)
Treatment

- Treatment can be further complicated with unexpected intraoperative positive cultures
  - Grosso et al. (JSES, 2012)
  - Treated patients with unexpected positive intraoperative cultures with a one-stage revision and no postoperative antibiotics and found low reinfection rates (5.9%)
  - Foruria et al. (JSES, 2013)
  - Supported ignoring or monitoring unexpected intraoperative positive cultures of low virulence and negative preoperative workup in healthy patients
  - Pottinger et al. (JBJS, 2012)
  - Found preoperative and intraoperative risk factors that correlate with positive cultures during revision surgery.
  - They included male sex, osteolysis, membrane formation, and cloudy fluid

Prevention

- Guidelines for treatment of P. acnes infections are few and are based mostly on anecdotal experience.
  - Vancomycin and clindamycin typically are first-line for deep P. acnes infections of the shoulder
  - Crane et al., 2013
  - Antibiotics with the lowest minimum inhibitory concentration (MIC) values against P. acnes (MIC50 and MIC90) included penicillin (0.006, 0.125), cephalexin (0.047 and 0.094), and ceftriaxone (0.016, 0.045).
  - First-generation cephalosporins and penicillins may have a greater role in prevention. They did note strains resistant to clindamycin

Summary

- P. acnes is a commensal bacteria found in sebaceous glands of hair follicles around the shoulder
- Diagnosis is difficult due to its indolent course and normal clinical findings
- Gold standard for diagnosis is intraoperative cultures
- Can take up to 3 weeks for P. acnes to grow
- Surgical skin preparation can decrease the bacterial burden and plays a large role in prevention along with antibiotic prophylaxis
Thank you!