Propionibacterium acnes Postoperative Shoulder Arthritis: An Emerging Clinical Entity

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The purpose of this study, which involved 276 patients, was to report the importance of Propionibacterium acnes in shoulder infections. The proportion of patients with shoulder infection who had infection due to P. acnes was significantly greater than the proportion of patients with lower limb infection who had infection due to P. acnes (9 of 16 patients vs. 1 of 233 patients; P < .001). This bacterium requires a prolonged incubation period and should not be considered to be a contaminant.

Propionibacterium acnes, which is a gram-positive anerobic bacillus, is generally considered to be a commensal organism and is usually found in skin sites with high numbers of sebum-excreting sebaceous follicles, including the face, the chest, and the thorax [1]. P. acnes is a common contaminant of cultures, and interpretation is difficult when it is isolated from a single specimen. P. acnes is a fastidious organism, at least 6 days are required for growth on culture, and anerobic conditions are also necessary. It has been identified at various sites, particularly in the presence of foreign bodies, such as in cases of endocarditis, or bone infection [2].

A recent study showed that P. acnes was implicated in arthroplastic and osteosynthetic infections [3] and in 2.8%-12% of bone infections. The first P. acnes osteomyelitis review was published in 1987 [4] and analyzed 10 cases reported in 6 publications. Reports of prosthetic joint infection due to P. acnes are rare and have recorded few detailed characteristics [5]; however, cases of spondylodiscitis are more frequently reported after spinal surgery or neurosurgery [6]. An association between sciatica and P. acnes has been hypothesized [7], but this still remains controversial.

Shoulder infections due to P. acnes have become an emerging problem, as documented in recent reports of 52 cases of prosthetic infection due to P. acnes [3], cases of P. acnes infection after rotator cuff repair (RCR) [8, 9], an outbreak of postoperative shoulder infections linked to the ventilation system [10], and a recent deep infection review involving 4886 patients who underwent RCR [11].

The purpose of this study was to evaluate, through a combined approach of clinical retrospective analysis and prospective systematic bacterial analysis, the prevalence of P. acnes in shoulder infections, compared with its prevalence in lower limb infections, and to define this new clinical entity.

Patients and methods. From January 1999 through December 2006, a group of 197 patients with postoperative orthopedic infection seen in consultation at the Department of Clinical Microbiology of the Hôpital Conception (Marseille, France) were enrolled in a retrospective study. From January 2005 through July 2007, 79 patients hospitalized in the Department of Orthopedic Surgery with a diagnosis of osteoarthritis infection underwent a diagnostic kit procedure that included systematic analysis by culture and molecular amplification. This study was validated by the local ethical committee.

Infected patients without prosthetic devices or ligamento-plasty were excluded from the study. Specimens were collected by needle aspiration or surgical biopsy only. Patients with superficial wound infections involving the skin and subcutaneous tissues were excluded from the study. Only patients with at least 2 cultures of different intraoperative samples that grew P. acnes exclusively were considered. Direct microscopic examination, inoculation, and identification with commercially available biochemical assays—and when needed, with molecular identification methods—were performed as described elsewhere [12].

Statistical analysis was performed using the χ² test and Fisher’s exact test. P < .05 was considered to be statistically significant.

Results. Over the course of the 6-year study, 197 consecutive patients were seen in consultation for infections involving orthopedic devices. Final diagnoses were categorized as either shoulder infection or hip or knee infection. The proportion of patients who received a diagnosis of P. acnes infection was significantly higher among patients with a shoulder infection.

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than among patients with a lower limb infection (5 [41.7%] of 12 patients vs. 0 [0%] of 185 patients; \(P<.001\)). With the use of systematic microbiologic analysis of specimens, 79 patients with suspected osteoarticular infection were included in the study; 27 patients had cultures that showed no growth. The proportion of patients who received a diagnosis of \(P.\) acnes infection was significantly higher among patients with a shoulder infection than it was among patients with a lower limb infection (4 [100%] of 4 patients vs. 1 [2.1%] of 48; \(P<.001\)).

When both patient groups are conglomerated, a statistically significant difference in the proportion of \(P.\) acnes infection is still noted (9 [56.3%] of 16 patients with shoulder infection vs. 1 [0.4%] of 233 patients with lower limb infection; \(P<.001\)) (table 1). Data for patients with shoulder infection due to \(P.\) acnes are summarized in table 2. Seven of 9 patients were men; 5 of 9 had infection associated with a shoulder prosthetic (1 of whom had the prosthetic removed in a 1-step exchange). Four patients had deep infection associated with RCR; of these patients, 3 received a diagnosis during surgical debridement. The symptom-free interval was 1–4 months for patients with RCR-associated infection and 1–36 months for patients with arthroplasty-associated infection, but no statistically significant differences were noted between patients for whom the delay before symptom onset was long and those for whom the delay was short. In each case, the findings of a microscopic examination of samples were suggestive of infection. Testing for susceptibility to major antibiotics was systematically performed before treatment.

**Discussion.** In our 276-patient series, \(P.\) acnes was found significantly more often among patients with shoulder infection than among patients with lower limb infection. In all of our cases, \(P.\) acnes was identified as the true pathogen, because only patients with 2 cultures of intraoperative samples recovered from different joint sites that grew \(P.\) acnes exclusively were considered. Careful analysis of the literature shows that this predominance is never specifically recorded but is often implied. In the largest study, which involved 52 cases of osteosynthetic infection due to \(P.\) acnes [3], one-third of the patients had shoulder infection (11 associated with arthroplasty, 4 associated with prosthetic implants, and 2 associated with osteosynthesis of the clavicle or upper extremity of the humerus). In a second recent study, this bacterium was involved in 12% of the cases [2]. Infection due to \(P.\) acnes after RCR was first described in 1999, in a study that reported infection due to \(P.\) acnes in 6 of 16 patients with RCR-related infection [8], and was then reported in a review involving 360 patients [9]; in the latter study, 7 (1.9%) of the patients developed postoperative infection, and 6 of these 7 patients had infection due to \(P.\) acnes. This trend is confirmed by a recent study of 4886 patients [11], in which \(P.\) acnes was the most common organism isolated, involved in 20 (51.3%) of 39 cases of infection. In our study, the predominance of male patients evidenced and confirmed what had previously been substantiated [11]. \(P.\) acnes infection of the shoulder is, therefore, a new clinical entity, recently established for patients with RCR but also frequently found in patients with arthroplasty. In our experience, although *Staphylococcus* species are the main etiological agents of infections associated with hip or knee prostheses [12], \(P.\) acnes is the most frequent bacteria found in postoperative infections of the shoulder. Cases typically involved either a male patient who underwent RCR and complained (after a short symptom-free interval) of pain, mild fever, and inflammation of the scar or a male patient who underwent a prosthetic implant, complained of symptoms indicative of chronic infection, such as chronic pain and mild local signs, and had previously had negative culture results.

The shoulder seems to have a propensity for developing \(P.\) acnes infection. The pathophysiology is difficult to understand; this bacterium was detected in an outbreak involving a ventilation disturbance [10], and patients undergoing any type of orthopedic surgery could be susceptible to this pathogen. Shoulder surgery, such as RCR or arthroplasty, is considered to be clean surgery, and skin decontamination is easy to perform. The incision in these surgical procedures is small, and the chief danger of infection is from bacteria capable of growing inside the derma, such as *P. acnes*. It is generally acknowledged that postoperative shoulder infections are less common than postoperative hip or knee infections. Acknowledging that *P. acnes* is a major infection etiology in the shoulder, however, could increase the number of shoulder infections that are diagnosed (e.g., by reducing the number of false-negative culture results).

There are many explanations for why the diagnosis of shoulder infection due to *P. acnes* is difficult. Clinical signs are generally associated with late-stage infection, which can result in a delayed diagnosis. Microbiological diagnosis is difficult, because anaerobic conditions and prolonged duration are necessary for culture. False-negative results are frequent when samples are cultured for only 5 days, which is the usual standard duration for culture of other pathogens. On the other hand, it is sometimes impossible to decide whether the presence of *P. acnes* is clinically significant, because it is frequently a contam-

### Table 1. Clinical investigation and systematic microbiological analysis of *Propionibacterium acnes* infection.

<table>
<thead>
<tr>
<th>Site of infection</th>
<th>No. of patients ((n = 276))</th>
<th>No. of patients with positive culture ((n = 247))</th>
<th>No. of patients with infection due to <em>P. acnes</em>&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoulder</td>
<td>19</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Lower limb</td>
<td>257</td>
<td>233</td>
<td>1</td>
</tr>
</tbody>
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<sup>a</sup> *P* value for comparison of shoulder infection versus lower limb infection was <.001.
infectant derived from the patient’s skin or from the skin of the medical staff obtaining the sample or performing the laboratory processing of the culture. PCR amplification and sequencing of 16S rDNA has been described as an interesting tool for the diagnosis of bone and joint infections [12]. In our group of 525 samples, the systematic use of PCR allowed us to correct 16 diagnoses that had been initially considered to be negative. Unfortunately, this was of little help in diagnosing infection due to P. acnes. PCR of 16S rDNA has poor sensitivity, because the cell wall of this gram-positive bacterium limits the extraction of DNA. Because P. acnes is a commensal skin bacterium, improving the extraction effectiveness increases the risk of contamination by the operator during laboratory processing.

Case management is not clearly defined. In the 2 most recent series [2, 3], patients were treated with a combination of ceftaxin and rifampin or clindamycin and rifampin. High susceptibility of P. acnes to antimicrobial drugs, better restoration of joint function, and simplification of surgical treatment led the authors to prefer a 1-stage exchange for management of P. acnes infection. In our study, the combination of amoxicillin and rifampin, administered orally for 3–6 months, was efficient, with a long-term follow-up evaluation after 1 year of therapy for 3 patients. The choice of this antibiotic regimen was corroborated in a recent study regarding the use of penicillin or linezolid plus rifampicin for the eradication of P. acnes biofilms [13]. In our patient group, surgical debridement performed during the exploration of RCR was necessary when the symptom-free interval was <2 months.

In conclusion, physicians should be aware of the high incidence of P. acnes infection during shoulder surgery. This bacterium should no longer be considered to be a contaminant, and cultures should be systematically observed for at least 10 days. In addition, isolation of axilla with adhesive antimicrobial drape has been recently advised [11] to decrease the risk of infection.

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### References