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ORIGINAL PAPER

What is the significance of a positive *Propionibacterium acnes* culture around a joint replacement?

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Abstract The purpose of this study was to show the significance of a positive *Propionibacterium acnes* sample around a joint replacement. Records from the microbiology laboratory data over a 3-year period were reviewed to identify patients with prosthetic joints from whom *Propionibacterium acnes* was isolated at least once. The medical records of all those patients were retrieved and the demographic, clinical, microbiological and haematological data were collected and examined. The preoperative values of erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) were recorded. Fifty patients underwent a routine revision of a joint arthroplasty; six patients had a joint aspiration. Only one patient had further revision surgery for infection. The preoperative values of ESR and CRP were very variable. The presence of a positive sample around a joint arthroplasty is of uncertain significance. Further studies are needed in order to establish uniform criteria for the diagnosis of infection caused by *Propionibacterium acnes*.

Résumé Le propos de cette étude était de montrer l'importance de la présence autour d'une prothèse articulaire de propionibactério acnes. L'étude des données d'un laboratoire de microbiologie sur une période de trois ans a permis d'identifier les patients porteurs de prothèses articulaires et pour lesquels la propionibactério acnes a été isolée au moins une fois. Les données médicales de ces patients mais aussi les données cliniques, microbiologiques, hématologiques ont été collectées et examinées de même que les valeurs pré-opératoires de la CRP et de l'ESR. 50 patients ont été revus, six avaient nécessité une aspiration articulaire et un une révision chirurgicale pour infection. Les valeurs préopératoires de l'ESR et de la CRP sont variables. La présence autour d'une articulation de propionibactério acnes a une signification très incertaine. Il sera nécessaire de pratiquer des études ultérieures de façon à établir les critères du diagnostic d'une infection secondaire à propionibactério acnes.

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Introduction

Propionibacterium acnes (*P. acnes*) is an anaerobic diphtheroid which is well known to inhabit the sebaceous glands and is the most abundant organism isolated on routine skin cultures, far outnumbering aerobic bacteria [7]. It is traditionally considered non-pathogenic [6]. The true incidence of anaerobic skeletal infections remains in some dispute. In a combined study from the Mayo Clinic and the Hospital for Special Surgery on periprosthetic hip infections, the incidence of anaerobic bacteria was 12% whereas the most common organisms isolated were *Staphylococcus epidermidis* and *Staphylococcus aureus* with an incidence of 54% [4]. A review of 34 papers on infected hip

arthroplasty from 1977 to 1999 showed that propionibacteria accounted for 1.7% of the infections [3].

Our aim was to investigate the significance of a positive *P. acnes* culture around a joint arthroplasty and their correlation to the inflammatory markers erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP).

Materials and methods

Records from the clinical microbiology laboratory data between May 2001 and May 2004 were reviewed to identify patients with prosthetic joints from whom *P. acnes* was isolated at least once. The following criteria were required for inclusion of a patient in the study: a presence of a joint arthroplasty, at least one isolation of *P. acnes* in a culture of a surgical specimen (joint fluid, para-articular fluid, perioperative irrigation-drainage fluid) or joint fluid obtained from a transcutaneous puncture.

We then retrieved the medical records of all those patients and the demographic, clinical, microbiological and haematological data were collected together with the therapeutic options chosen. There was no history of previous periprosthetic infection. The preoperative values of the ESR and CRP were recorded. For the purposes of this study, an ESR rate of 30 mm/h or higher and a CRP level of 10 mg/l or higher were considered to be suggestive of infection and were deemed a positive result.

Results

Between May 2001 and May 2004, 56 patients with prosthetic joint replacements had a positive sample of *P. acnes*. Fifty patients underwent a routine revision of a joint arthroplasty and six patients had a joint aspiration only. There were 35 males and 21 females. The average age was 66.9 years (range: 18–91). There were 30 hip joint replacements, 21 knee joint replacements, 4 endoprosthetic replacements of the femur and 1 shoulder joint replacement (Table 1).

Pain and/or loosening of the prosthesis were the main reasons for revision arthroplasty in all 50 patients. The treatment methods included surgical intervention and antibiotic treatment. Thirty-five patients did not receive any antibiotics, 12 patients received antibiotics (either through the enteral or parenteral route or a combination of both) for a total time of 6 weeks and in 9 patients the records were inadequate regarding antibiotic treatment. The number of total culture samples taken and sent off for microbiological analysis varied markedly (from one to eight samples). In 40 patients *P. acnes* bacteria were isolated only whereas in the rest of the 16 patients a mixture of both *P. acnes* and other organisms were isolated. These included 12 coagulase-negative staphylococci, 2 bacilli, 1 *Staphylococcus aureus* and 1 enterococcus pathogens. Only one patient underwent further revision for infection. The average follow-up period was 20.5 months (1–48).

In the group where only *P. acnes* were isolated there was a variable CRP and ESR result (Table 2). In 19 patients both ESR and CRP were normal, in 7 patients they were both elevated, whereas for the rest of the patients either ESR or CRP was elevated.

In the group where there was a mixture of *P. acnes* and other isolates there was also a variable result (Table 2). In nine patients both CRP and ESR were normal, in only one patient they were both elevated, whereas in the rest of the patients either ESR or CRP was elevated.

Discussion

P. acnes is a low-virulence organism, part of normal skin and dental microbiota, often causing delayed clinical infections with a long interval between the inoculation of the bacteria and the onset of symptoms. Tunney et al. [13] in their paper have shown that *P. acnes* was isolated as the single infecting organism in 46% of their samples taken from hip replacements and a further 16% of the samples were infected by a combination of *P. acnes* and an aerobic Gram-positive organism. They then concluded that infection of retrieved hip prostheses is currently underestimated. It is likely that patients who had routine revision surgery for 'aseptic' loosening of prostheses probably harboured a low-grade infection. The purpose of our study was to evaluate the significance of joint arthroplasties colonised with *P. acnes*. Only one patient in our study underwent further revision for periprosthetic infection. *P. acnes* was the sole causative organism and the patient was also given a 6-week course of antibiotics following the routine revision.

It is interesting to note from our study that all the *P. acnes* isolates were sensitive to penicillin. None of the rest of the patients underwent revision surgery despite the positive *P. acnes* samples. We could also argue that in patients where a mixture of organisms was isolated, *P. acnes* could be regarded as a contaminant but it is very difficult to justify it.

Intraoperative cultures are considered the 'gold standard' for the diagnosis of infected arthroplasties. The area that appears to be most inflamed should be sampled and at least three tissue samples should be sent for culture to improve the yield and to decrease the likelihood of a false-negative culture. Atkins et al. [1] in their prospective study of infections in arthroplasty showed that at least three positive samples were necessary to predict infections, regardless of the pathogen involved. In our series only two patients had

Table 1 Demographic factors, clinical and microbiological characteristics, and outcome of patients with positive samples for *P. acnes* around a joint replacement

Age	Sex	ESR (mm/h)	CRP (mg/l)	Operation	Positive *P. acnes* samples	Antibiotics	When found	Other organisms	Follow-up	Months
58	f	23	8	BHR	1 of 2	No	Aspirate	None	No further infection	12
62	f	39	12	THR	1 of 1	n.a.	Aspirate	CNS	No further infection	24
64	m	40	10	THR	1 of 1	Yes	Aspirate	CNS	No further infection	23
66	f	29	12	THR	1 of 1	No	Aspirate	None	No further infection	19
66	m	71	3	THR	1 of 1	No	Aspirate	None	No further infection	18
73	f	7	2	THR	1 of 1	No	Aspirate	None	No further infection	360
18	m	18	6	EPR femur	1 of 2	No	Routine revision	None	No further infection	32
18	m	39	78	EPR femur	1 of 1	No	Routine revision	None	No further infection	48
18	m	32	7	EPR femur	1 of 3	Yes	Routine revision	None	No further infection	360
48	f	5	1	EPR femur	1 of 2	No	Routine revision	None	No further infection	10
48	m	11	21	TKR	1 of 2	No	Routine revision	None	No further infection	3
50	f	7	12	TKR	1 of 4	No	Routine revision	CNS	No further infection	7
53	f	23	11	THR	1 of 3	n.a.	Routine revision	None	No further infection	24
57	m	18	15	THR	3 of 3	No	Routine revision	None	No further infection	32
57	m	2	3	THR	1 of 3	No	Routine revision	None	No further infection	25
57	f	68	73	THR	1 of 2	No	Routine revision	None	Further infection	13
58	m	27	9	THR	1 of 4	Yes	Routine revision	*Staph. aureus*	No further infection	15
58	m	10	5	TKR	1 of 1	n.a.	Routine revision	None	No further infection	42
60	m	10	14	TKR	4 of 8	Yes	Routine revision	CNS	No further infection	28
60	m	11	12	THR	2 of 3	No	Routine revision	CNS	No further infection	12
61	f	31	14	THR	1 of 2	Yes	Routine revision	None	No further infection	21
63	m	5	97	TSR	1 of 4	n.a.	Routine revision	CNS	No further infection	8
64	m	5	3	TKR	2 of 3	No	Routine revision	Bacillus	No further infection	15
67	m	32	8	TKR	1 of 3	Yes	Routine revision	None	No further infection	18
67	m	5	4	TKR	2 of 4	No	Routine revision	None	No further infection	35
69	m	29	12	THR	1 of 2	n.a.	Routine revision	None	No further infection	34
70	m	5	1	TKR	1 of 4	No	Routine revision	None	No further infection	23
70	m	40	3	TKR	1 of 5	Yes	Routine revision	CNS	No further infection	6
70	m	14	2	THR	1 of 3	n.a.	Routine revision	None	No further infection	36
71	m	57	13	THR	1 of 3	Yes	Routine revision	None	No further infection	14
71	m	15	5	THR	2 of 2	Yes	Routine revision	None	No further infection	12
71	f	5	3	TKR	1 of 2	No	Routine revision	None	No further infection	1
72	f	11	3	TKR	1 of 4	Yes	Routine revision	None	No further infection	11
72	m	5	3	TKR	1 of 3	n.a.	Routine revision	None	No further infection	36
73	f	29	6	THR	1 of 3	No	Routine revision	Bacillus	No further infection	18
73	m	43	5	THR	1 of 3	n.a.	Routine revision	None	No further infection	24
73	m	15	3	TKR	1 of 4	n.a.	Routine revision	CNS	No further infection	4
73	f	31	13	TKR	1 of 4	Yes	Routine revision	None	No further infection	29
73	m	31	3	THR	1 of 3	No	Routine revision	None	No further infection	23
74	m	19	10	TKR	1 of 2	No	Routine revision	None	No further infection	33
74	m	16	3	THR	1 of 3	No	Routine revision	CNS	No further infection	5
74	f	25	25	TKR	1 of 4	No	Routine revision	None	No further infection	35
74	m	12	3	THR	1 of 3	No	Routine revision	CNS	No further infection	26
75	m	10	5	TKR	1 of 3	No	Routine revision	CNS	No further infection	10
79	f	45	8	THR	1 of 1	No	Routine revision	None	No further infection	23
80	f	29	4	TKR	1 of 2	No	Routine revision	CNS	No further infection	8
80	m	9	5	THR	1 of 2	No	Routine revision	None	No further infection	15
81	m	10	3	THR	1 of 4	No	Routine revision	None	No further infection	25
81	m	45	34	THR	1 of 1	No	Routine revision	None	No further infection	41
82	m	13	7	TKR	1 of 2	No	Routine revision	None	No further infection	4
82	f	2	3	THR	1 of 1	Yes	Routine revision	None	No further infection	19
84	f	26	20	THR	1 of 3	No	Routine revision	None	No further infection	25
85	f	45	5	THR	1 of 3	Yes	Routine revision	CNS	No further infection	40
88	m	7	3	THR	2 of 3	No	Routine revision	None	No further infection	8

Table 1 (continued)

Age	Sex	ESR (mm/h)	CRP (mg/l)	Operation	Positive *P. acnes* samples	Antibiotics	When found	Other organisms	Follow-up	Months
91	f	41	20	THR	1 of 1	No	Routine revision	None	No further infection	8
91	f	13	3	TKR	2 of 3	No	Routine revision	Enterococcus	No further infection	8

m male, *f* female, *BHR* Birmingham hip resurfacing, *THR* total hip replacement, *TKR* total knee replacement, *EPR* endoprosthetic replacement, *TSR* total shoulder replacement, *CNS* coagulase-negative *Staphylococcus aureus*, *n.a.* not applicable

three or more positive samples. In one of the patients *P. acnes* was the sole organism whereas in the other patient coagulase-negative staphylococcus was also isolated. None of these patients underwent further revision surgery. Lutz et al. [8] in their study included a group of patients with joint arthroplasty infected with *P. acnes*. In that group the patients had signs of either prosthetic dysfunction or pseudoarthrosis without the signs of sepsis. The average number of positive samples in this group was one. Of their 17 patients, 12 were treated exclusively by surgery and without antibiotic treatment; only 1 patient failed treatment. They concluded that making a suitable decision in this group of patients is particularly difficult, as the lack of signs of sepsis does not exclude infection. In our series none of the patients had signs of sepsis preoperatively and whether they had a low-grade infection is difficult to say.

In another study by Marculescu et al. [9] two patients who underwent revision arthroplasty and had at least two positive samples for *P. acnes* obtained at the time of revision surgery received no antimicrobial treatment; both had a favourable outcome without a second removal of the prosthesis. In our study three patients had at least two positive intraoperative samples for *P. acnes* solely and they all had a favourable outcome.

The significance of positive intraoperative cultures taken during revision surgery in a case that was not thought to be infected following preoperative investigation remains controversial. Tsukuyama et al. [12] reported their experience of 31 of 275 patients who underwent revision arthroplasties in whom intraoperative cultures were positive but infection was not suspected preoperatively. All were treated with a 6-week course of intravenous antibiotics. During their study period 5 of those 31 patients had recurrent infections. It would seem that in at least some cases, positive cultures represent previously undiagnosed infection and require treatment.

On the contrary, in another study by Byrne et al. [2], the authors examined 80 patients who underwent hip and knee cemented arthroplasty in order to determine the incidence of perioperative contamination in these patients. Contaminated samples were identified in 18 patients (22.5%) with *Staphylococcus epidermidis* being the most common contaminating organism involved. Despite the high incidence of intraoperative contamination, this was not reflected by a similar rate of post-operative infection as none of the patients developed clinical evidence of deep prosthetic infection at follow-up.

Although it has been recommended that all cases of positive intraoperative cultures should be treated with antibiotics [5, 12], no prospective study has looked at the results of treatment with antibiotics as compared with no additional antibiotic treatment in addition to the revision surgery and perioperative antibiotics.

The most commonly used preoperative investigations for a suspected infected joint arthroplasty are laboratory screening tests, such as measurements of the ESR and the level of CRP.

An elevated CRP may be more indicative of infection than a rise in the ESR, but is still non-specific. The measurement of both CRP levels and ESR is marginally more accurate [10].

A prospective analysis of Spangehl et al. [11] has shown that when both the measurement of ESR and CRP values reveal negative findings, the probability of infection is 0.00 (0 of 95; 95% confidence interval: 0.00–0.04); when both tests are positive, the probability of infection is 0.83 (20 of 24; 95% confidence interval: 0.62–0.95). They did not define though the causative organism in their infected cases. CRP concentration seems to be normal in some infections with bacteria of low virulence such as propionibacteria, whereas high values are generally seen in infections with *Staphylococcus aureus* and β-streptococci [10]. In the study by Lutz et al. [8] in their group of patients

Table 2 Preoperative values of ESR and CRP

Organisms	Both normal ESR + CRP	Both elevated ESR + CRP	Normal CRP, elevated ESR	Elevated CRP, normal ESR	Total
P. acnes isolates only	19	7	6	7	39
P. acnes and other organism isolates	9	1	3	4	17

who had signs of sepsis and at least one positive intra-operative sample for *P. acnes*, the ESR was elevated in 96% and the CRP was elevated in 93% of the patients. Unfortunately, in the rest of the patients with no signs of sepsis they did not perform a preoperative measurement of the inflammatory markers. In our study the preoperative values of ESR and CRP were very variable and difficult to interpret. For example, of seven patients colonised with *P. acnes* and both ESR and CRP elevated, only one patient underwent further revision surgery whereas the rest of the patients did not have further revision surgery.

There are no studies in the medical literature to show the preoperative ESR and CRP values in colonised or infected joint arthroplasties with *P. acnes*.

From our study we have drawn some messages. The presence of a positive *P. acnes* sample around a prosthetic joint is of uncertain significance. We can confidently say that a positive sample of *P. acnes* is not an indication of severe infection. We were unable to explain the elevated preoperative values of ESR and CRP. All *P. acnes* isolates were sensitive to penicillin and whether these patients should have a course of antibiotics is questionable. We do support the value of multiple samples, which could lead to less false-positive results. It is important to follow up the patients at the long term as a low-grade infection can declare itself in the future. Uniform criteria have not been established for the diagnosis of infection of prosthetic joints caused by *P. acnes* and further studies are needed.

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