

# Infection following orthopaedic implants and bone surgery

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## العدوى التالية للغرّائس التقويمية وجراحة العظام

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**الخلاصة:** تم استقصاء سبعة وأربعين مريضاً للبحث عن العدوى المبكرة أو المتأخرة التالية للعمليات الجراحية الخاصة بالغرّائس التقويمية أو جراحة العظام أو كليهما. وتبين أن أكثر العوامل المسببة لهذه العدوى شيوعاً هي الرائفة الزنجارية والمعتودية البشرية. وتم استفراد جرثوم لاهوائية من 16 مريضاً (34%)، 50% من المرضى بالعدوى المتأخرة، و10.5% من المرضى بالعدوى المبكرة. وتبين أن 6 من المرضى (12.8%) كانوا مصابين بالجرثوم اللاهوائية وحدها. وقد احتفظ جميع هؤلاء المرضى بجهاز للتثبيت الداخلي خارج النقي. ويبدو أن الجرثوم اللاهوائية تقوم بدور هام في إحداث الإصابة بالعدوى المتأخرة التالية للعمليات الجراحية، لاسيّما في حالة وجود جهاز للتثبيت الداخلي خارج النقي.

**ABSTRACT** Forty-seven patients were investigated for early or late postoperative infections of orthopaedic implants and/or bone. A total of 88 isolates were recovered (64 aerobes and 24 anaerobes). *Pseudomonas aeruginosa* and *Staphylococcus epidermidis* were the most common causative agents. Anaerobic bacteria were isolated from 16 (34%) patients; 50% of patients with late-onset infection and 10.5% with early-onset infection. In 6 (12.8%) patients, infection was with anaerobic organisms alone. All these patients had retained an extramedullary internal fixation device. Anaerobic microorganisms appear to play a significant role in the pathogenesis of late-onset postoperative infection, especially where there is an extramedullary internal fixation device.

### Infection consécutive à des implants orthopédiques et une chirurgie osseuse

**RESUME** Quarante-sept patients ont été examinés à la recherche d'infections postopératoires à début précoce ou tardif touchant les implants orthopédiques et/ou les os. Au total, 88 isolats (64 aérobies et 24 anaérobies) ont été obtenus. *Pseudomonas aeruginosa* et *Staphylococcus epidermidis* étaient les agents pathogènes les plus courants. Des bactéries anaérobies ont été isolées chez 16 patients (34 %), 50 % des patients ayant une infection à début tardif et 10,5 % à début précoce. Chez 6 patients (12,8 %), l'infection ne concernait que des organismes anaérobies. Tous ces patients avaient conservé un fixateur interne extramédullaire. Les micro-organismes anaérobies semblent jouer un rôle significatif dans la pathogenèse de l'infection postopératoire à début tardif, notamment lorsqu'il y a un fixateur interne extramédullaire.

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## Introduction

Bone infection may be acquired by three routes: haematogenously, by direct inoculation or from an adjacent non-bony focus. In studies of infections associated with orthopaedic implants, *Staphylococcus aureus* appears to dominate the early-onset infections, whereas aerobic and anaerobic bacteria of the normal skin flora, such as *S. epidermidis*, *Propionibacterium acnes* and peptostreptococci, are commonly found in delayed infections [1-3].

In contrast to acute haematogenous osteomyelitis, which is a general disease with organic manifestations, post-traumatic osteomyelitis is a primary local infection that can produce general symptoms of disease, but does not do so in every case. Following bacterial colonization of the affected tissue, acute haematogenous osteomyelitis is accompanied by hyperaemia and increased cell density, while post-traumatic osteomyelitis is characterized by avascularity [4]. However, postoperative orthopaedic infections may involve infection of soft tissues and the adjacent orthopaedic implant alone and are not necessarily associated with osteomyelitis.

This study was carried out to investigate the causative agents and the predisposing factors of postoperative orthopaedic infections, with particular attention to anaerobic microorganisms.

## Methods

This prospective study comprised 47 patients (37 males and 10 females). The study was conducted in Basra University Teaching Hospital, Iraq. The period of study ran from September 1994 to October 1997. The cases included presented with an infection of an orthopaedic implant and/or bone. The operative procedures that had

been performed included extramedullary and intramedullary internal fixations that were indicated for management of fractures; total hip replacements for fractures of the femoral neck in elderly patients; osteotomies for bone deformities; excisions of tumorous bone in cases of malignancy; and the application of bone cement for treatment of a pathological fracture.

Only patients with clinical, bacteriological and/or radiological evidence of infection were included in the study. In all, 19 patients presented with early-onset postoperative infection (infection appeared within 5-15 days of the operative procedure). All these patients were given prophylactic antibiotics after surgery. Another 28 patients presented with late-onset postoperative infection [infection appeared from 3 months to 9 years (mean = 2 years) after the operation].

Material for bacteriological culture was obtained from the infected bone, or deep soft tissue or prosthesis removed during surgical exploration under general anaesthesia. The specimens were collected by syringe avoiding contamination from the sinus track. The aspirate was freed of visible air bubbles and the sample for anaerobic culture inoculated immediately onto pre-reduced selective and non-selective culture media (bedside inoculation). Samples were incubated under anaerobic conditions immediately after inoculation (also at the bedside) in a GasPak jar (BBL), and then the jar was transferred to the incubator. No anaerobic transport media were used. The following media were employed for anaerobic culture: blood agar, phenyl ethyl alcohol blood agar, and Bacteroides bile esculin (BBE) agar. Samples grown on chocolate agar were cultured under 5%-10% carbon dioxide. The following media were employed for aerobic culture: blood agar, MacConkey agar, phenyl ethyl alcohol

blood agar, and mannitol salt agar. Anaerobic cultures were examined daily after 48 hours of incubation. Aerobic cultures were examined after 24 and 48 hours of incubation. Aerobes and anaerobes were identified using conventional methods.

## Results

In this study, 47 patients with postoperative infection were investigated. The operative procedures leading to infection are shown in Table 1. Extramedullary internal fixations were the most commonly occurring procedures (28 cases).

The cultures were monomicrobial in 26 patients and polymicrobial in 21 patients. A total of 88 isolates were recovered (64 aerobes and 24 anaerobes). The predominant aerobic organisms isolated, in descending order of frequency, were: *Pseudomonas aeruginosa*, *S. epidermidis*, *S. aureus* and *Klebsiella* sp. (Table 2). The predominant anaerobes isolated were: pigmented

Table 1 The operative procedures according to time of onset of infection

Procedure	Early onset	Late onset	Total
Extramedullary internal fixation	5	23	28
Total hip replacement	7	1	8
Intramedullary internal fixation	2	4	6
Osteotomy	3	0	3
Excision of bone tumour	1	0	1
Application of bone cement	1	0	1
Total	19	28	47

Table 2 Organisms isolated from patients with postoperative infection by time of onset of infection

Organism	Early onset	Late onset	Total
<b>Aerobes</b>			
<i>Pseudomonas aeruginosa</i>	6	11	17
<i>Staphylococcus epidermidis</i>	2	9	11
<i>S. aureus</i>	6	4	10
<i>Klebsiella</i> sp.	5	2	7
<i>Proteus</i> sp.	6	0	6
<i>Escherichia coli</i>	2	0	2
<i>Enterobacter</i> sp.	1	1	2
<b>Other</b>			
<i>Enterobacteriaceae</i>	0	7	7
<i>Streptococcus</i> sp.	0	2	2
<b>Anaerobes</b>			
Pigmented bacteroides	0	9	9
<i>Bacteroides fragilis</i>	1	4	5
<i>Peptostreptococcus anaerobius</i>	0	4	4
<i>Peptostreptococcus micros</i>	0	4	4
<i>Propionibacterium acnes</i>	0	2	2
Total	29	59	88

bacteroides, *Bacteroides fragilis* and *Peptostreptococcus* sp.

Anaerobic organisms were recovered from 16 (34%) patients; 6 (12.8%) patients were infected with anaerobic bacteria alone. All 6 patients had late-onset infection and all had extramedullary internal fixation devices (Table 3). The anaerobes were isolated from 14 (50%) of the 28 patients with late-onset infection and from only 2 (10.5%) of the 19 patients with early-onset

Table 3 Data for six patients with purely anaerobic infections

Age (years)	Sex	Time between operation and development of infection (years)	Operation	Organism
29	M	2.5	Extramedullary	Pigmented bacteroides
70	F	9	Extramedullary	Pigmented bacteroides
32	M	4	Extramedullary	Pigmented bacteroides <i>Peptostreptococcus micros</i> <i>Peptostreptococcus anaerobius</i>
40	M	3	Extramedullary	Pigmented bacteroides
43	M	6	Extramedullary	<i>Peptostreptococcus micros</i> <i>Peptostreptococcus anaerobius</i>
62	F	5	Extramedullary	Pigmented bacteroides

M = male, F = female.

infection. The difference was statistically significant ( $\chi^2 = 7.85, P < 0.01$ ). Extramedullary internal fixation had been performed in 14 (87.5%) of the 16 patients with anaerobic infection.

The predominant organism found in the 26 patients with monomicrobial cultures was *S. aureus* (8 cases) as shown in Table 4. The other 21 patients had mixed infections in which the predominant organism was *P. aeruginosa* (13 cases).

## Discussion

The study revealed that *P. aeruginosa* and *S. epidermidis* were the most common causative agents of postoperative orthopaedic infection. These organisms are often found as part of the normal cutaneous flora [5] and can be transmitted from improperly decontaminated skin into trauma-

Table 4 Organisms isolated from 26 patients with monomicrobial infection by onset of infection

Organism	Early onset	Late onset	Total
<i>Staphylococcus aureus</i>	5	3	8
<i>Pseudomonas aeruginosa</i>	1	3	4
<i>S. epidermidis</i>	0	4	4
Pigmented bacteroides	0	4	4
<i>Klebsiella</i> sp.	2	1	3
<i>Enterobacteriaceae</i>	0	2	2
<i>Enterobacter</i> sp.	0	1	1
Total	8	18	26

tized bone or soft tissue during the operative manipulation. Therefore, meticulous preoperative skin decontamination and perfect sterilization of operative and dressing instruments are mandatory. *P. aeruginosa* is usually resistant to commonly used antibiotics and thus might be transmitted from one patient to another by imperfectly sterilized instruments, or could be introduced into the surgical wound through faulty dressing technique.

The most frequently recovered anaerobic organisms were pigmented bacteroides, *B. fragilis* and *Peptostreptococcus* sp. By contrast, Templeton et al. [3] found that *Peptostreptococcus* sp. and *Propionibacterium acnes* were the most common anaerobic bacteria recovered from patients with postoperative osteomyelitis.

Anaerobic microorganisms were isolated from 34% of patients in the study, while Hall et al. [6] found a lower prevalence (22%) of anaerobic infection in patients with infected total hip arthroplasties. The high rate of recovery of anaerobes was related to the methodology of careful collection, inoculation and anaerobic culture of the operative specimens. Specimens were collected by syringe and inoculated and cultured immediately at the bedside, without the use of transport media. Anaerobic transport media were not used as they might have led to overgrowth of facultative

anaerobic bacteria over strict anaerobes, a situation that could lead to anaerobic organisms being missed. In addition, collection of specimens by syringe, the method used in this study, has been found to be more efficient than collection by cotton swab for the isolation of anaerobes on culture [7,8].

The findings of this study give a higher incidence of anaerobic infection in delayed-onset (50.0%) than in early-onset (10.5%) postoperative infections. Moreover, the isolation of anaerobes alone from 6 patients with delayed-onset infection indicates the significant role of these bacteria in the pathogenesis of this infection. All of these 6 patients also had extramedullary internal fixation devices. This association needs to be further investigated to explore the relationship between anaerobic infection and extramedullary internal fixation. Late-onset anaerobic infection might be acquired from the blood by transfer of anaerobes on an internal fixation device, where a metallic foreign body with low oxygen tension could predispose towards anaerobic infection. Therefore, retaining an internal fixation device for a prolonged period may increase the risk of anaerobic infection. It is therefore recommended that any internal fixation device be removed as soon as possible after bone healing. Anaerobic cultures should also be made in all cases presenting with delayed-onset postoperative infection.

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### **Surgical care at the district hospital**

*Surgical care at the district hospital* provides a practical guide to surgical procedures that are commonly performed by non-specialist clinicians working in district hospitals (1st level referral hospitals) with limited resources. In many developing countries, essential emergency surgical and anaesthetic care at such referral hospitals is provided by inadequately trained non-specialist medical, nursing and paramedical personnel, with limited facilities, equipment and supplies. The objective of this manual is to improve the quality of clinical care at the district hospital particularly in essential procedures in surgery, obstetrics, gynaecology, orthopaedics, anaesthesia and trauma. The manual includes a comprehensive guide to the organization of the district surgical service, management of equipment and infection control. It has been written by an international team of specialists and reviewed by clinical specialists from all parts of the world.

*Surgical care at the district hospital* is currently in production and is due out in early 2003. Further information is available from the Department of Blood Safety & Clinical Technology, World Health Organization, 20 Avenue Appia, CH 1211, Geneva 27, Switzerland.