Antibiotic prophylaxis before invasive dental procedures in patients with arthroplasties of the hip and knee


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More than a million hip replacements are carried out each year worldwide, and the number of other artificial joints inserted is also rising, so that infections associated with arthroplasties have become more common. However, there is a paucity of literature on infections due to haematogenous seeding following dental procedures. We reviewed the published literature to establish the current knowledge on this problem and to determine the evidence for routine antibiotic prophylaxis prior to a dental procedure.

We found that antimicrobial prophylaxis before dental interventions in patients with artificial joints lacks evidence-based information and thus cannot be universally recommended.

Joint prostheses are one of the remarkable advances of modern medicine. In 1936, the first joint replacement, a total hip replacement, was performed. Over 70 years later, more than a million hip replacements are carried out annually worldwide. Apart from loosening of the components or dislocation, infection is the most common complication. Although the overall risk has been reduced to < 1% for hip and < 2% for knee replacements, infection is observed quite often owing to the sheer volume of patients who undergo joint replacement. In the United States, at least 400 000 total hip and knee replacements are carried out each year, and approximately 70 000 in the United Kingdom. However, in managing infection of the prosthesis, the costs of treatment are five to seven times higher than the initial operation and the morbidity is considerable.

Orthopaedic surgeons have considered prophylactic antibiotics to be necessary for patients with joint replacements who undergo any dental procedures, so as to avoid bacteraemia and consequent haematogenous seeding of the implant. We reviewed the scientific literature on the epidemiology, microbiology, pathogenesis and prophylaxis of infections of total hip and knee replacements following dental treatment to ascertain whether this opinion is justified on the basis of the evidence available.

Materials and Methods
We conducted a PubMed search of the literature to identify English-, French- and German-language publications before 1 July 2007 using the following terms ‘dental’, ‘joint replacement’, ‘bacteraemia’, ‘infection’, ‘prosthesis’, ‘arthroplasty’, ‘dentist’ and ‘prophylaxis’, and paired in a second step with the terms ‘recommendations’ and ‘guidelines’. Bibliographies of relevant articles were hand searched to retrieve further papers. Case reports and references to abstracts of conference presentations were also included. Animal studies and in vitro experiments were excluded.

Results
Of 144 articles retrieved, 24 were case reports, seven described series involving at least three cases, 34 were review articles, and 48 were retrieved from publications concerning dentistry or maxillofacial surgery, 20 from orthopaedic journals and 11 from literature concerning infectious diseases; 123 were published before 2002 and 21 within the last five years. Of these articles, 23 prospectively investigated the rate of asymptomatic bacteraemia after dental work. No publication concerning the risk of infection was based on randomised or comparative trials. There were 27 publications (18.8%) in favour of systemic antibiotic prophylaxis before dental procedures for special circumstances, but 11 (7.6%) did not perceive any benefit. The remaining 106 papers (73.6%) took no clear position on the subject. The delay between intra-oral intervention and symptomatic infection ranged between 24 hours and nine months. The delay between implantation of the arthroplasty and dental work ranged between 11 and 95 months.
Most patients were immunocompetent, and only a few were immunocompromised.13-15

Discussion and review of the literature
Prosthetic joint infections can be classified according to the time of onset as early (less than three months after surgery), delayed (3 to 24 months), or late (more than 24 months after operation).16 Most early and delayed infections are presumed to be acquired in the operating theatre,17,18 whereas late infections,16 are often attributed to hematogenous seeding. Transient bacteremia of oral origin may harbour risks for infection of implants, but this occurs rarely as anaerobic bacteria or streptococci of the oral cavity are seldom encountered in infections of arthroplasties where cutaneous Gram-positive organisms such as staphylococci predominate.2,16,19,20

A computer simulation model indicated a low incidence of late-stage artificial joint infections associated with dental treatment with 29 to 68 cases per 106 dental visits (0.04%),21 whereas retrospective studies showed an incidence of 0.2% for total knee13 and 0.1% for total hip replacements.8 Some clinicians have attributed up to 6%,22 or 11%13 of all late infections to a dental source.

In most reports, infection developed within two weeks of a dental procedure.9,12,14,15,22-35 However, opinion about an oral origin is often an assumption underlined by microbiological results compatible with oral flora because of the lack of a valid alternative explanation. Occasional cases of pre-existing dental or periodontal infections have been described that may have been the source of joint infection rather than a direct dental procedure.12 Some papers indicated skin commensals, such as Staphylococcus epidermidis, as causative pathogens,25 thereby casting doubt on an oral origin.

Asymptomatic bacteremia after dental procedures. Dental work that may provoke bacteremia does not need to be invasive or surgical. It can be caused by periodontal probing,36 ultrasonic scaling,37,39 tooth brushings,37,39 orthodontic appliances,40 or occur spontaneously due to simple gingivitis.5,41,42 Whether chewing, debanding (removal of fixed orthodontic appliances) or gold chain adjustments (fitting a gold orthodontic appliance) may also cause bacteremia remains a subject of debate. Some reports are affirmative,39,43 while others deny such a link.44,45 Upper alginate impression or adjustment of arch wires were not found to increase the rates of bacteremia.46 Routine dental operations can produce ten to 240 colony-forming units of pathogens per millilitre of blood.47-49 Durack50 estimated the incidence of asymptomatic transient bacteremia to be 60% after tooth extraction, 88% after periodontal surgery, 40% after tooth brushing and 35% after tonsillectomy. The cumulative risk of ‘spontaneous’ bacteremia from periodontitis, oral hygiene and chewing can be considerably higher than from dental interventions.51,52 Transient bacteremia might occur spontaneously up to 12 times each day.53 After tooth extraction, 90% of positive blood cultures are identified within 30 seconds.42,54-57 Most episodes last less than 30 minutes,13,42,49,56,58,59 with a mean duration of approximately 11 minutes49 and up to 180 minutes at most.50 Under normal conditions, the bacteria are rapidly eliminated from the reticuloendothelial system.42

The duration of the dental intervention plays a role. In a prospective trial, the incidence of positive blood cultures was significantly higher when the procedure lasted less than three minutes, compared with more than six minutes.61 In other studies with orally-induced artificial joint infections, the mean duration of dental procedures was 115 minutes (7.5 to 205)13 or 65 minutes (45 to 90).8

Microbiology and regimes for prophylaxis. Among 578 patients with infected joint replacements seen at the Mayo Clinic, Rochester, Illinois, 53% were due to staphylococci, 9% to streptococci, 6% to Gram-negative pathogens and 4% to anaerobes.62 In contrast to this variety of bacteria isolated from infected arthroplasties, those found in blood cultures after dental work were streptococci, mostly of the viridans group,8,13,32,42,49,56,57 Neisseria,42,56 Actinomycetes,31,39,40,49,56 Prevotella,17,22,36,39,42,57,63 and other anaerobic bacteria,24,7,49,56 or Gram-negative organisms.13,23,30,37,49,56 In up to a quarter of the patients the bacteremia was polymicrobial.13,37,42,61

In the 1980s and early 1990s penicillins,64 cephalexins,21,25,53 and erythromycin,9,65 were advocated as the antibiotics of choice, despite reports of infection by erythromycin-resistant pathogens.14 Currently, amoxicillin/amoxicillin (2 g), a first- or second-generation cephalosporin, or clindamycin in a dose of 600 mg in cases of intolerance to β-lactam antibiotics, are considered adequate.5,6,20,66 The effectiveness of clindamycin has been questioned,5,6,20 partly because of the increasing resistance of streptococci to linezolid. Prophylactic antibiotics are preferably given orally one hour before the dental procedure.5,6,8 A second dose is seldom recommended.49

Analogy to infective endocarditis. Although endocarditis and an infected joint replacement are different clinical entities,5,6,9,70 their management as regards to dental care have similarities. The measures used in endocarditis have been established in experimental data and animal studies.71 No randomised trial has ever shown that antibiotic prophylaxis for endocarditis would be effective.50 The majority of episodes do not occur after dental procedures. Asymptomatic bacteremia is much more likely to occur during daily activities than after a dental procedure, and a high percentage of patients develop endocarditis despite correctly administered antibiotic prophylaxis. As a consequence, in April 2007 the recommendations of the American Heart Association were modified in light of the current evidence.72 Now, for a procedure that involves the manipulation of gingival tissue, teeth in the periapical region, perforation of the oral mucosa, procedures on the respiratory tract or in infected skin and musculoskeletal tissues, antibiotic prophylaxis is restricted to patients with prosthetic cardiac valves, a history of prior
endocarditis, congenital heart disease, and cardiac transplant recipients who develop valvulopathy. Some European societies do not yet follow these recommendations and prefer to revise existing guidelines in cooperation with others.

**Human studies with infection as an outcome.** In contrast to antibiotic prophylaxis for surgical site infection in general, few studies have assessed the epidemiology of infections of artificial joints in a large patient database (Table I). Ainscow and Denham followed 1000 patients with 1112 total joint replacements for a mean of six years. Patients were not advised to take antibiotics during dental procedures. Invasive dental or surgical treatment was carried out on 224 patients. Only three developed infection in their implants, all of which were associated with skin infections. Jacobson et al investigated 2693 joint replacements where only one patient acquired an infection thought to be associated with dental treatment. Ching et al attributed four episodes of infection in joint replacements from among 110 patients to dental infection, but none to dental manipulation in the absence of pre-existing infection. In another retrospective analysis of 24 late infections in joint replacements, only three were related to dental treatment. Of these, two had a pre-existing dental or periodontal infection. Jacobson et al investigated 2693 joint replacements where only one patient acquired an infection thought to be associated with dental treatment. Ching et al attributed four episodes of infection in joint replacements from among 110 patients to dental infection, but none to dental manipulation in the absence of pre-existing infection. In another retrospective analysis of 24 late infections in joint replacements, only three were related to dental treatment. Of these, two had a pre-existing dental or periodontal infection.

**Asymptomatic bacteraemia.** Brennan et al, in a placebo-controlled trial, demonstrated that amoxicillin given before non-surgical dental procedures reduced the incidence of asymptomatic bacteraemia from 20% in the placebo group to 6% in those given amoxicillin, indicating that even correct prophylaxis did not guarantee the absence of bacteraemia. Coulter et al found a reduction in the incidence of bacteraemia from 63% to 35% with antibiotic prophylaxis. Lockhart et al noted an incidence of bacteraemia of 89% following invasive dental care in a placebo group, compared with 33% in those given amoxicillin (p < 0.0001). Similar observations have been published by others.

In a double-blind, randomised placebo-controlled study of 70 adults undergoing single-tooth extraction, the use of a chlorhexidine mouthwash reduced the rate of asymptomatic bacteraemia at one and three minutes after the start of extraction. Similar findings have been observed using an antibiotic mouthwash or a povidone-iodine solution.

**Existing guidelines, expert opinion and cost-effectiveness analyses.** In 1992, the Working Party of the British Society for Antimicrobial Chemotherapy emphasised that there was no evidence to support the use of antibiotic prophylaxis before dental work in patients with joint replacements. Despite this, 78% of British orthopaedic surgeons admitted to using antibiotics for prophylaxis before dental procedures. The Australian Orthopaedic Association Arthroplasty Group emphasised that the risk of a joint replacement becoming infected by a bacteraemia of oral origin is exceedingly low, whereas the risk of an adverse reaction to the antibiotic prophylaxis is higher. If all patients with joint replacements were to receive antibiotic prophylaxis when having dental treatment, more would die from anaphylactic shock than from infection. This assessment was supported by computer simulation models that did not confirm the cost-effectiveness of routine prophylaxis. Only one group has concluded that antibiotic prophylaxis may be marginally cost-effective for patients with joint replacements. An analysis from The Netherlands concluded that for some patients with joint disease, but not with joint replacements, antibiotic prophylaxis before dental work was likely to be cost-effective.
Table II. Summary of national guidelines/recommendations concerning antibiotic prophylaxis before invasive dental procedures in patients with joint replacements

<table>
<thead>
<tr>
<th>Author</th>
<th>Association</th>
<th>Prophylaxis</th>
<th>Indications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scott et al84</td>
<td>Australian Orthopaedics</td>
<td>Yes</td>
<td>High-risk dental procedures in immunocompromised patients (immunosuppressive treatment including systemic steroids, insulin-dependent diabetes mellitus, rheumatoid arthritis)</td>
</tr>
<tr>
<td></td>
<td>American Dental Association; American Academy of Orthopedic Surgeons</td>
<td>Yes</td>
<td>For the first two years after joint replacement: all patients for all high-risk dental procedures</td>
</tr>
<tr>
<td>Simmons et al82</td>
<td>Working Party of British Society for Antimicrobial Chemotherapy</td>
<td>No</td>
<td>No specific mention of higher-risk groups</td>
</tr>
<tr>
<td>Seymour et al86</td>
<td>British Orthopaedic Association; British Dental Association</td>
<td>Yes</td>
<td>Prophylaxis may be considered only in patients with diabetes mellitus, rheumatoid arthritis, haemophilia, malignancy, overt oral sepsis, or when dental treatment is invasive, complex and of long duration (&gt;45 minutes)</td>
</tr>
<tr>
<td>Rossi et al89</td>
<td>Swiss Society for Infectious Diseases</td>
<td>Yes</td>
<td>Implantation of prosthesis in the last 12 months No general recommendation, even for immunocompromised patients Individual decision</td>
</tr>
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In 1997, the American Dental Association and the American Academy of Orthopedic Surgeons issued an advisory statement5,86 which was updated in 2003, together with the provision of an information leaflet for patients.68 They stated that antibiotic prophylaxis is not mandatory for routine dental procedures in most patients with joint replacements, but should be considered in those with an increased risk, including joint replacement within the past two years, previous infection of a joint replacement, inflammatory arthritis, type-1 diabetes mellitus, haemophilia, immunosuppression, a history of previous or current malignancy, dental extractions, periodontal procedures, dental implantation, root canal work, descaling if bleeding was anticipated, specialised injections of local anaesthetic, or placement of orthodontic bands.68 Arguments for the inclusion of inflammatory arthritis or immunocompromised patients are based on other trials which demonstrated an increased risk of per-operatively acquired infection,87 whereas the other recommendations originate from case reports and/or common sense.5 Apart from the two-year limit, the recommendations of the American Dental Association were shared by most authors,13,23,34,32,65,76,88,94 but sometimes with many restrictions.6 The recommendations of the Swiss Society of Infectious Diseases are very similar, except for the use of prophylaxis during dental procedures within one year of joint replacement and the individuals’ decision even for immunocompromised patients.69 The rationale behind the recommendations of antibiotic prophylaxis in the early period after joint replacement relies mainly on common sense. Local hyperaemia following surgery and the processes of active healing may make the replacement more vulnerable, but after two years the joint is fully embedded in inactive soft tissue. However, documented clinical evidence for this assumption is lacking. Table II summarises some of the most frequently used guidelines and recommendations.

Conclusions
Infections of total hip or knee replacements due to haematogenous seeding following dental intervention are very rare. The scientific rationale for systemic or local antimicrobial prophylaxis is very weak at best.70 No occurrence of genetically identical strains of Streptococcus in the mouth and joint has been recorded.84 According to the criteria of evidence-based medicine, no supportive data in favour of antimicrobial prophylaxis could be found in our review of the literature, and there was no proof that antibiotic prophylaxis could prevent infection.84

However, there have been many cases which have suggested that infection of a joint replacement has had an oral origin.11-14 Because of the heavy financial, medical and social burden associated with infection of a joint replacement, most authors agree that prevention should be recommended for selected individuals. However, this attitude is based more on fear than on science, and the relationship between the individual orthopaedic surgeon and the patient will greatly influence the decision. To avoid this pitfall, Seymour et al86 proposed leaving the decision to the dental surgeon. However, the dentists and their patients may seek advice from the orthopaedic surgeon or physician in charge.

Recommendations and future perspectives
Prophylactic antibiotics are not required before a dental intervention in patients with artificial joints and without...
cardiac risk factors. However, a pre-existing dental infection requires antibiotic treatment and prophylaxis. The guidelines listed in Table II may be helpful. A one-year delay between surgery and the dental procedure should be sufficient. With a surgical site infection, a single peroperative dose of antibiotic is as effective as prolonged therapy and a one- to two-hour ‘window’ before the initial incision has the lowest rate of infection. We consider that similar timing should be used if it is decided to use prophylactic cover for dental work.

Three important aspects should be borne in mind. First, according to experimental trials, systemic antibiotics could theoretically be replaced by topical antibiotic or oral anti-septic agents. However, further controlled trials, including careful monitoring of adverse events and cost-effective evaluation, are needed before any definitive conclusion can be reached. Second, infected foci elsewhere in the body must be treated first. Finally, all patients should be advised to establish and maintain good oral health.

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