Prosthetic joint infection, dental treatment and antibiotic prophylaxis

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Abstract

Current international and national prophylactic antibiotic regimens have been analyzed in respect of the prevention of bacteremia after dental and surgical procedures and, therefore, of joint prosthesis infection. This information was used to formulate guidelines for the Department of Maxillofacial and Oral Surgery. Publications since 2003 were used in this research. In addition, recommendations of accredited institutions and associations were examined. These included the guidelines of the American Dental Association in association with the American Academy of Orthopaedic Surgeons (2003), the American Heart Association (2007), the Working Party of the British Society for Antimicrobial Chemotherapy (2006) and the Australian Dental Guidelines (2005). No guidelines published by any institution in South Africa were found. The general rationale for the use of antibiotic prophylaxis for surgical (including dental) interventions is that those procedures may result in a bacteremia that may cause infection in joint prostheses. Antibiotics, however, should therefore be administered to susceptible patients, e.g. immunocompromised patients, prior to the development of bacteremia. The guidelines recommended for use in South Africa are based solely on those used outside South Africa. South Africa is regarded as a developing country with its own population and demographic characteristics. Eleven percent of our population is infected with HIV, and a specific guideline for prophylactic antibiotic treatment is, therefore, essential.

Introduction

There are many controversies in the dental literature regarding the use of prophylactic antibiotics in patients with joint prostheses. Antibiotics are prescribed in dentistry to treat and prevent infections.[1]

For the purpose of this article, the main indications and controversies relating to prophylactic use of antibiotics in dentistry will be reviewed, notably the prevention of bacteremia and infections in patients with joint prostheses.

In the early 1950s, the first hip prosthesis was used and from these small beginnings, joint replacement has expanded to include the knee, ankle, shoulder, elbow and finger joints. Generally these joint replacements are successful with an over 90% success rate over a 10-year period.[2] In the United States in 1995, 243,919 total knee replacements were performed[2] and in 2003, approximately 450,000 total joint arthroplasties were performed.[3,4] In Australia, in the financial year 2002-2003, a total of 55,836 total hip and knee replacements were performed.[5] In Norway 73,000 arthroplasties were performed between 1994 and 1999, i.e. in 11 years.[6]

Currently no register exists in South Africa on the total of any arthroplasties performed locally although many joint replacements were performed in government and private hospitals. The provision of joint prostheses is thus a common orthopedic procedure.

In the late 1950s and early 1960s, there was a high prevalence (15-25%) of post-operative infections associated with such surgery.[1] Infections that occurred within three months of surgery were categorized as early and were related to the surgical procedure either sourced from the patient or the surgical staff.[1] Many advances have been made across the world to minimize infection. Theatre design incorporating laminar flow, improved surgical technique, wearing of exhaust suits and prophylactic antibiotics have all been shown to be successful at limiting infection rates. Many countries in the world, such as France and Malaysia, have devised strict national guidelines to minimize discrepancies between hospitals and improve prophylactic antibiotic administration.[7] Infections after three months of surgery were considered as late and we believed these to be caused by hematogenous spread of bacteria from another site of infection elsewhere in the body.[1] The incidence of this is low and in the order of 0.97%.[8] Antibiotic prophylaxis at the time of surgery reduced the prevalence of post-operative infection to approximately 1%.[1]

Can orthopedic implants be infected by blood-borne bacteria? Historically it was believed that one of the key sources of focal infection was the teeth.[9] The basis of this theory was the process of anachoresis which is the preferential deposit of bacteria that have localized out of the bloodstream into areas of inflammation.[10] Today we know oral bacteria clearly do enter the bloodstream during chewing, teeth clenching and tooth brushing, although the amounts are small and transient. The greatest amount of bacteremia occurs following extraction of erupted, periodontally involved teeth.[9]

The prevalent bacteria causing late infection are *Staphylococcus aureus* (35%) and *Staphylococcus epidermis* (15%). These have a skin origin.[11,12] Both infective endocarditis and hematogenous total joint infection have been documented to occur secondary to cutaneous infections, which may account for approximately one half of all late-onset hematogenous total joint infections.[13] Group A Streptococci, which are mainly from oropharyngeal origin, occurred in about 8% of cases. Thus bacteremia-related joint infections of oral origin may occur but generally at a low incidence. Skin organisms are the predominant group. The risk of oral-related infections is very low (0.04-0.07%).[11,12] There is extensive soundly-based scientific literature on this.[2,5,14-16] It is important that all papers which set out to document joint infections have meticulous methodology as it is easy for the source of the infection to be based on anecdote. Ideally, to confirm that an implant has been infected from an oral treatment, one requires a coincident history and an accurate and simultaneous typing of the oral flora bacteremia and joint organisms.[14] These steps have not usually been taken in most investigations in the literature and some papers are based solely on history[9] of dental treatment received before the arthroplasty procedure. There is scant evidence to suggest that dental-induced bacteremia can cause hematogenous infection around a prosthetic joint.[15] By contrast, there are several studies that show the opposite. Studies were reported where late hematogenous joint infections in prosthetic joints occurred after dental treatment. The organisms cultured from the sites of infection were the same in both the prosthetic joint and the oral cavity.[17-19] Other articles were unable to demonstrate any case of secondary joint infection after dental treatment in a patient who was not medically compromised. Even in a healthy patient with joint infection there was not enough evidence to link the infection to dental treatment.[20-23]

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Infections of total hip or knee replacements because of hematogenous seeding following dental intervention are very rare. The scientific rationale for the use of systemic or local antimicrobial prophylaxis to prevent bacteremia, is very weak at best.[24] The statement that there is no evidence to link prosthetic joint infections to dental procedures and none to prove that antibiotic is effective to prevent bacteremia was also supported by Gould in 2008.[25] The National institute of Health and Clinical Excellence (NICE) made new recommendations available. Antibiotic prophylaxis does not eliminate bacteremia following dental procedures but some studies show that it does reduce the frequency of detection of bacteremia post procedure. Therefore, they recommend that no prophylaxis is necessary for prevention of infective endocarditis for dental procedures. It is also not possible to determine the effect of antibiotic prophylaxis on the duration of bacteremia.[26] The whole issue of chemoprophylaxis in dental practice is surrounded by a distinct lack of evidence based information. For a variety of justifiable reasons, there is a lack of randomized placebo-controlled trials to determine the efficacy of chemoprophylaxis in the various at-risk categories of patients. In many instances, the need for antibiotic cover is driven by the medical profession and is overstated.[27]

All surfaces of the body are colonized by a unique micro flora. Any bacteremia may be caused by incision of the skin, gastroenteral mucosa, airway mucosa, genitourinary mucosa or oral mucosa. Bacteria from these sources frequently enter the blood on a physiological basis as a transient bacteremia and are dealt with by the host defences.[28]

Oral bacteria clearly do enter the bloodstream during chewing, teeth clenching and tooth brushing although the amounts are small and transient.[29] Transient bacteremia that follow normal activities such as chewing are usually cleared by the host defences within ten minutes.[30] Oral interventions including dental treatment will produce a greater bacteremia than physiological function but is of a low grade and duration. Even a simple dental extraction in a patient with chronic periodontitis will result in a greater bacterial load than in a patient with optimal oral hygiene (Table 1).[31] Dental procedures can be classified into high- and low-risk, based on the levels of bacteremia (Table 2).[3,32]

Traditionally, 'significant bleeding' associated with a dental procedure has being equated with a bacteremia. A recent study measuring pre- and post-procedure bacteremia showed that bleeding was a poor predictor of odontogenic bacteremia above usual physiological levels.[33]

The rationale for the use of antibiotic prophylaxis for surgical, including dental, interventions is that the procedure causes bacteremia and the bacteremia may cause infection. Therefore it is reasoned that the antibiotics should be given to susceptible patients before the bacteremia is induced.[28] Antibiotics may prevent infection either by killing bacteria or by damaging them to an extent in which the host defences can then destroy them,[28] but no randomized, placebo-controlled study has established whether any of the antibiotic regimens recommended are efficacious.[27] General preventive measures (good dental care and skin hygiene, avoidance of unnecessary procedures and instrumentation) remain essential.[28]

Any dose of oral penicillin can cause an allergic reaction rate similar to that of intramuscular penicillin.[34] Hypersensitive patients receiving penicillin prophylaxis to prevent bacteremia are five times more likely to die from an anaphylactic reaction to the drug than to die from contracting endocarditis.[1,35] It would thus seem from these statistics that the risk of providing antibiotic coverage to prevent bacteremias is far greater than those of not providing coverage?

Table 1. Prevalence of bacteremia after dental procedures.[31]

Procedure	Prevalence of bacteremia
Extractions (single)	51%
Extractions (multiple)	68-100%
Endodontics (intra-canal instrumentation)	0-31%
Endodontics (extra-canal instrumentation)	0-54%
Periodontal surgery (flap procedure)	36-88%
Periodontal surgery (gingivectomy)	83%
Scaling and root planning	8-80%
Periodontal prophylaxis	0-40%
Tooth brushing	0-26%
Dental flossing	20-58%
Interproximal cleaning with toothpicks	20-40%
Irrigation devices	7-50%
Chewing	17-51%

Table 2. Incidence stratification of bacteremic dental procedures.[3,32]

Incidence	Dental procedure
Higher incidence†	Dental extractions Periodontal procedures, including surgery, subgingival placement of antibiotic fibres/strips, scaling and rootplaning, probing, recall maintenance Dental implant placement and replantation of avulsed teeth Endodontic instrumentation beyond the apex Endodontic surgery Placement of retraction cord Initial placement of orthodontic bands but not brackets Intraligamentary and intraosseous local anesthetic injections Prophylactic cleaning of teeth or implants where bleeding is anticipated
Lower incidence‡§	Restorative dentistry¶ (operative and prosthodontic) with/without retraction cord Local anesthetic injections Intracanal endodontic treatment, post placement and build-up Placement of rubberdam Post-operative suture removal Placement of removable prosthodontic/orthodontic appliances Taking of oral impressions Fluoride treatments Taking of oral radiographs Orthodontic appliance adjustment

†Prophylaxis should be considered for patients with total joint replacement who meet the criteria in Table 3. No other patients with orthopedic implants should be considered for antibiotic prophylaxis prior to dental treatment / procedures. ‡Prophylaxis not indicated. §Clinical judgement may indicate antibiotic use in selected circumstances that may create significant bleeding . ¶Includes restoration of carious (decayed) or missing teeth.

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Guidelines

Patients, especially immunocompromised patients, who are about to have a total joint arthroplasty should be in good dental health prior to surgery and should be encouraged to seek professional dental care if necessary. Patients who have already had a total joint arthroplasty should perform effective daily oral hygiene procedures to remove plaque and to establish and maintain good oral health.[3] The risk of bacteremia is far more substantial in a mouth with ongoing inflammation than in one that is healthy.[36]

Bacteremia can cause hematogenous seeding of total joint implants, both in the early post-operative period and for many years following impantation.[37] It appears that the most critical period is up to two years after implantation.[38] Presently, no scientific evidence supports the position that antibiotic prophylaxis to prevent hematogenous infections is required prior to dental treatment in patients with total joint prosthesis.[36]

Antibiotic prophylaxis is not indicated for dental patients with pins, plates and screws, nor is it routinely indicated for most dental patients with total joint replacement. Antibiotic prophylaxis may be considered when the higher-risk dental procedures (Table 2) are performed on dental patients within two years post–implant surgery, on those who have had previous prosthetic joint infections and on those with some other conditions (Table 3).[3] This position agrees with that taken by the ADA Council on Dental Therapeutics[39] and the American Academy of Oral Medicine[40] and is similar to that taken by the British Society for Antimicrobial Chemotherapy.[41]

There is limited evidence that some immunocompromised patients with total joint replacements (Table 3) may be at higher risk of experiencing hematogenous infections.[42-49] Antibiotic prophylaxis for such patients undergoing dental procedures with higher bacteremia risk should be considered using an empirical regimen (Table 4). In addition, antibiotic prophylaxis may be considered when the higher-risk dental procedures (Table 2) are performed on dental patients within two years post-implant surgery,[37] on those who have had previous prosthetic joint infections and on those with some other conditions (Table 3).[3] Antibiotic prophylaxis is warranted in three groups of patients with a prosthetic joint who must undergo an invasive procedure that could cause bacteremia: patients with a predisposing immunocompromising systemic condition or those receiving immunosuppressive therapy, patients with a dermatological infection, and patients with an obvious focal infection, e.g., urosepsis.[50]

Table 3. Patients at potential increased risk of experiencing hematogenous total joint infection.[3]

Patient type	Risk condition
All patients during first two years following joint replacement	N/A†
Immunocompromised/suppressed patients	Inflammatory arthropathies such as rheumatoid arthritis, systemic lupus erythematosus Drug- or radiation-induced immunosuppression Previous prosthetic joint infections Malnourishment
Patients with comorbidities‡	Hemophilia HIV infection Insulin-dependent (type 1) diabetes mellitus Malignancy

†N/A: Not applicable; ‡ Conditions shown for patients in this category are examples only; there may be additional conditions that place such patients at risk of experiencing hematogenous total joint infection.

Table 4. Suggested antibiotic prophylaxis regimens.[3]

Patient type	Suggested drug	Regimen
Patients not allergic to penicillin	Cephalexin, cephradine or amoxicillin	2 g† orally 1h prior to dental procedure
Patients not allergic to penicillin and unable to take oral medication	Cefazolin or ampicillin	Cefazolin 1g or ampicillin 2 g intramuscularly or intravenously 1h prior to the dental procedure
Patients allergic to penicillin	Clindamycin	600 mg orally 1h prior to the dental procedure
Patients allergic to penicillin and unable to take oral medications	Clindamycin	600 mg intravenously 1h prior to the dental procedure*

*†There is evidence that 2 g is equivalent to 3 g oral amoxicillin with less risk of nausea.[46] *No second doses are recommended for any of these dosing regimens.*

Conclusions

It is generally accepted that all patients undergoing joint replacement should maintain good oral hygiene[51-53] and be dentally fit, thus without any existing infection in the oral cavity. This should be confirmed by a dentist after full oral examination and radiographs. The common situation of the orthopedic surgeon asking the patients if their teeth are "OK" is not enough. A patient can be unaware of a painless condition like chronic periodontitis or chronic tooth-abscess which may arguably be a focus of infection. Patients who have already had a total joint arthroplasty should perform effective daily oral hygiene procedures to remove plaque (for example, by using manual or powered toothbrushes, interdental cleaners or oral irrigators) to establish and maintain good oral health. The risk of bacteremia is far more substantial in a mouth with ongoing inflammation than in one that is healthy and employing these home oral hygiene devices. Dental treatment in the pre-implantation phase should be aggressive to eliminate current foci of infection. If the condition cannot be rapidly resolved by restorative, endodontic or periodontal treatment the involved teeth should be extracted. Antibiotic prophylaxis would not usually be required for such pre-implantation treatment. In the initial phase following placement of a joint prosthesis, dental treatment would not normally be required if the patients have been made dentally fit prior to the procedure. The patients in this first three-month phase after receiving a prosthetic joint are usually in some orthopedic discomfort and are not usually sufficiently mobile for routine dental treatment.

The guidelines recommended for use in South Africa are based solely on those used outside South Africa. South Africa is regarded as a developing country with its own population and demographic characteristics. Eleven percent of our population is infected with HIV[54,55] which make them immunocompromised. The clinician is not always fully informed about the HIV-status of the patient. Therefore administration of antibiotic prophylaxis must be considered within the two years after joint replacement to all patients. Specific guidelines for prophylactic antibiotic treatment to prevent a bacteremia are, therefore, essential for South Africa.

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