Prosthetic joint infection, dental treatment and antibiotic prophylaxis

Marthinus J. Kotzé
Department Maxillofacial and Oral Surgery, School of Dentistry, University of Pretoria, South Africa

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 prostheses 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 administrated 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 performed3 and in 2003, approximately 450,000 total joint arthroplasties were performed.4 In Australia, in the financial year 2002-2003, a total of 55,836 total hip and knee replacements were performed.1 In Norway 73,000 arthroplasties were performed between 1994 and 1999, i.e. in 11 years.5

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.6 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.7 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.8 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.9 The incidence of this is low and in the order of 0.97%.10 Antibiotic prophylaxis at the time of surgery reduced the prevalence of post-operative infection to approximately 1%.11

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.12 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.13 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.14

The prevalent bacteria causing late infec-

Correspondence: Marthinus J. Kotzé, Department Maxillofacial and Oral Surgery, School of Dentistry, University of Pretoria, South Africa E-mail: thinus.kotze@up.ac.za

Key words: prophylaxis, dental, joint, prosthesis, infection.

Accepted for publication: 22 May 2009.
Revision received: 4 May 2009.
Received for publication: 10 February 2009.

This work is licensed under a Creative Commons Attribution 3.0 License (by-nc 3.0)
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. 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. 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. 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.

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. Oral bacteria clearly do enter the bloodstream during chewing, teeth clenching and tooth brushing although the amounts are small and transient. Transient bacteremia that follow normal activities such as chewing are usually cleared by the host defences within ten minutes. 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). Dental procedures can be classified into high- and low-risk, based on the levels of bacteremia (Table 2).

Traditionally, ‘significant bleeding’ associated with a dental procedure has been 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.

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 bacteria is induced. Antibiotics may prevent infection either by killing bacteria or by damaging them to an extent in which the host defences can then destroy them, but no randomized, placebo-controlled study has established whether any of the antibiotic regimens recommended are efficacious. General preventive measures (good dental care and skin hygiene, avoidance of unnecessary procedures and instrumentation) remain essential.

Any dose of oral penicillin can cause an allergic reaction rate similar to that of intra muscular penicillin. 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. 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

| 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% |
| Irrigation devices | 20-40% |
| Chewing | 7-50% |
| Irrigation | 17-51% |

### Table 2. Incidence stratification of bacteremic dental procedures

| Incidence | Dental procedure |
|-----------|------------------|
| Higher incidence | Dental extractions, including surgery, subgingival placement of antibiotic fibres/straps, scaling and rootplaning, probing, recall maintenance |
| Lower incidence | Local anesthetic injections, Intracanal endodontic treatment, post placement and build-up |

*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 cavities (decayed) or missing teeth.*
Review

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. 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 implantation.2 It appears that the most critical period is up to two years after implantation.2 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.24

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). This position agrees with that taken by the ADA Council on Dental Therapeutics27 and the American Academy of Oral Medicine28 and is similar to that taken by the British Society for Antimicrobial Chemotherapy.29

There is limited evidence that some immunocompromised patients with total joint replacements (Table 3) may be at higher risk of experiencing hematogenous infections.52-56 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,27 on those who have had previous prosthetic joint infections and on those with some other conditions (Table 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.9

Conclusions

It is generally accepted that all patients undergoing joint replacement should maintain good oral hygiene 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 HIV57 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.

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, Malignancy |

Table 4. Suggested antibiotic prophylaxis regimens.3

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

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

1. Seymour RA, Withrow JM. Antibiotic prophylaxis for endocarditis, prosthetic joints, and surgery. Dent Clin N Am 2002;46:635-1.
2. American Academy of Orthopaedic Surgeons: National Centre of Health Statistics Rosemont. Illinois. American Academy of Orthopaedic Surgeons 14.1999.
3. Advisory statement: antibiotic prophylaxis for dental patients with total joint replacements. American Dental Association: American Academy of Orthopaedic Surgeons. J Am Dent 2003;134:895-8.
4. Peersman G, Laskin R, Davis J, Peterson M. Infection in total knee replacements: a retrospective view of 6489 total knee replacements. Clin Orthop Relat Res 2001;329:15-23.
5. Australian Orthopaedic Association National Joint Replacement Registry Annual Report. Adelaide: AOA 2004; ISSN:1455-366. http://www.dmac.adelaide.edu.au/aoanjr/aoanjrr.jsp. Accessed November 2005.
6. Havelin LI, Engeseter, E Ngesæ ter, E spehaug B, et al. The Norwegian Arthroplasty Register: 11 years and 73 000 arthroplasties. Acta Orthop Scand 2000;71:337-53.
7. Ansari A, Kamalasekaran S. Antibiotic prophylaxis for joint replacement surgery: the current practice in Britain. Eur J Orthop Surg Traumatol 2009;19:23-6.
8. Saleh KJ, Macaulay A, Radosевич DM, et al. The Knee Society Index of Severity for failed total knee arthroplasty: development and validation. Clin Orthop Relat Res 2001;392:153-65.
9. Scott JF, Morgan D, Avent M, Graves S Goss AN. Patients with artificial joints: do they need antibiotic cover for dental treatment? Aust Dent J 2005;50 Suppl 2:45-53.
10. Chronic oral sepsis and its relation to systemic disease. Focal infection. In: Stones HH, ed. Oral and dental diseases. 4th edition. Edinburgh & London: E&S Livingstone, 1962:679-90.
11. Little JW. Dental treatment in patients with joint replacements. Oral Surgery 1983;55:20-3.
12. Maderazo EG, Judson S, Pasternak H. Late infections of total joint prostheses. A review and recommendations for prevention. Clin Orthop Relat Res 1988;229:131-42.
13. Wright TI, Baddour LM, Berbari EF, et al. Antibiotic prophylaxis in dermatologic surgery: Advisory statement 2008. J Am Acad Dermatol 2008;59:464-73.
14. Sandhu SS, Lowry JC, Reuben SF, Morton ME. Who decides on the need for antibiot- ic prophylaxis in patients with major arthroplasties requiring dental treatment: Is it a joint responsibility? Ann R Coll Surg Engl 1997;79:143-7.
15. McPherson EJ, Woodson C, Holtom P, et al. Perioperative total hip infection. Clin Orthop Relat Res 2002;403:8-15.
16. Rhinelander FW. Physiologic responses of bone implants. In: Biocompatibility of orthopaedic implants. Boca Press 1982:51-74.
17. Thyne GM, Ferguson JW. Antibiotic prophylaxis during dental treatment in patients with prosthetic joints. Br J Bone Joint Surg 1991;73:191-4.
18. Ching DWT, Gould IM, Rennie JAN, Gibson PAH. Prevention of late haematogenous infection in major prosthetic joints. J Antimicrob Chemother 1989;23:676-80.
19. Maderazo EG, Judson S, Pasternak H. Late infections of total joint prostheses: a review and recommendations for prevention. Clin Orthop 1988;229:131-42.
20. Thyne GM, Ferguson JW. Antibiotic prophylaxis during dental treatment in patients with prosthetic joints. Br J Bone Joint Surg 1991;73:191-4.
21. Ainscow DAP, Denham RA. The risk of haematogenous infections in total joint replacement. J Bone Joint Surg 1984;66:589-2.
22. Ching DWT, Gould IM, Rennie JAN, Gibson PAH. Prevention of late haematogenous infection in major prosthetic joints. J Antimicrob Chemother 1989;23:676-80.
23. Maderazo EG, Judson S, Pasternak H. Late infections of total joint prostheses: a review and recommendations for prevention. Clin Orthop Relat Res 1988;229:131-42.
24. Rodgers J, Richards D. No evidence to link prosthetic joint infections with dental procedures. Evid Based Dent 2008;9:103-4.
25. Oswald TF, Gould FK. Dental treatment and prosthetic joints: antibiotics are not the answer! J Bone Joint Surg Br 2008;90:825-6.
26. Wray D, Ruiz F, Richey R, Stokes T. Prophylaxis against infective endocarditis for dental procedures – summary of the NICE guideline. Br Dent J 2008;204:555-7.
27. Seymour RA, Hogg SD. Antibiotics and chemoprophylaxis. Periodontology 2000, 2008;48:10-80.
28. Pendergast BD. The changing face of infective endocarditis. Heart 2006;92:879-85.
29. Singh J, Strazznicky I, Avent M, Goss AN. Antibiotic prophylaxis for endocarditis: time to reconsider. Aust Dent J 2005;50:60-8.
30. Guneroth WG. How important are dental procedures as a cause of endocarditis. Am J Cardioiu 1984;54:797-801
31. Malinverni R, Overholser CD, Bille J, Glauser MP. Antibiotic prophylaxis of experimental endocarditis after dental extractions. Circulation1988;129:761-9.
32. Dajani AS, Taubert KA, Wilson W, et al. Prevention of bacterial endocarditis: recommendations by the American Heart Association. From the Committee on Rheumatic Fever, Endocarditis and Kawasaki Disease, Council on Cardiovascular Disease in the Young. J Am Med A 1997;277:1794-801.
33. Roberts GJ. Dentists are innocent! “Everyday” bacteremia is the real culprit: a review and assessment of the evidence that dental surgical procedures are a principal cause of bacterial endocarditis in children. Paediatr Cardiol 1999;20:317-25.
34. Weiss ME, Adkinson NE. 8-lactam allergy. In: Mandell GL, Douglas RG, Bennett JE, editors. Principles and practice of infectious diseases. 3rd edition. New York: Churchill Livingstone: 1990. p. 265.
35. Tsuchak AA, Levinier E, Benoilel R, Katz J. Analysis of the American Heart Association for the prevention of infective endocarditis. Oral Surg Oral Med Oral Pathol 1986;62:276-9.
36. Pallasch TJ, Slott J. Antibiotic prophylaxis and the medically compromised patient. Periodontol 2000 1996;10:107-38.
37. Rubin R, Salvati EA, Lewis R. Infection in total hip replacement after dental procedures. Oral Surg Oral Med Oral Pathol 1976:41:13-23.
38. Hansen AD, Osmor DR, Nelson CL. Prevention of deep prosthetic joint infection. Am J Bone Joint Surg 1996;78:458-71.
39. Council on Dental Therapeutics. Management of dental patients with prosthetic joints. J Am Dent A 1990;121:537-8.
40. Eskinazi D, Rathburn W. Is systematic antimicrobial prophylaxis justified in dental patients with prosthetic joints? Oral Surg Oral Med Oral Pathol 1988;66:430-1.
41. Cawson RA. Antibiotic prophylaxis for dental treatment: for hearts but not for prosthetic joints. Br Dent J 1992;304:933-4.
42. Ching DWT, Gould IM, Rennie JA, Gibson PI. Prevention of late haematogenous infection in major prosthetic joints. J Antimicrob Chemother 1989;23:676-80.
43. Brause BD. Infections associated with prosthetic joints. Clin Rheum Dis 1986;12:523-35.
44. Murray RP, Bourne MH, Fitzgerald RH Jr. Metachronous infection in patients who have had more than one total joint arthroplasty. J Bone Joint Surg Am 1991;73:1469-74.
45. Ross P, Thornhill TS, Ewald FC, et al. Factors influencing the incidence and outcome of infection following total joint arthroplasty. Clin Orthop 1984;182:117-26.
46. Jacobson JJ, Millard HD, Plezia R,
Blankenship JR. Dental treatment and late prosthetic joint infections. Oral Surg Oral Med Oral Pathol 1986;61:413-7.
47. Johnson DP, Bannister GG. The outcome of infected arthroplasty on the knee. J Bone Joint Surg Br 1986;68:289-91.
48. Jacobson JJ, Patel B, Asher G, Wooliscroft JO, Schaberg D. Oral Staphylococcus in elderly subjects with rheumatoid arthritis. J Am Geriatr Soc 1997;45:1-5.
49. Berbari EF, Hanssen AD, Duffy MC, Ilstrup DM, Harmsen WS, Osmon DR. Risk factors for prosthetic joint infection: case-control study. Clin Infect Dis 1998;27:1247-54.
50. Rompen JC, Schrier JC, Walenkamp GH, Verheyen CC. [Indications for antibiotic prophylaxis in patients with a prosthetic joint] Ned Tijdschr Geneeskd. 2008;152:2282-6.
51. Bartzokas CA, Johnson R, Jane M, et al. Relation between mouth and haematogenous infections in total joint replacement. Br Med J 1994;309:506-8.
52. Lockhart PB, Loven B, Brennan MT, Fox PC. The evidence base for the efficacy of antibiotic prophylaxis in dental practice. J Am Dent Assoc 2007;138:458-74.
53. Oswald TF, Gould FK. Dental treatment and prosthetic joints: ANTIBIOTICS ARE NOT THE ANSWER! J of Bone & Joint Surg Br 2008;90:825-6.
54. HIV prevalence in South Africa. (Update). (Brief article). International Family Planning Perspectives 29.1 (March 2003):p5.
55. Shisana O and Simbayi L. Nelson Mandela/Human Sciences Research Council (HSRC) Study of HIV/AIDS. South African National HIV Prevalence, Behavioral Risks and Mass Media: Household Survey 2002, Cape Town, South Africa: HSRC, 2002.