Odontogenic Infection Sources in Patients Scheduled for Cardiac Valve Replacement

Gerald Krennmair[a]/Johann Auer[b]/Martin Krainhöfner[c]/Eva Piehslinger[d]

Purpose: Odontogenic infection sources represent a predisposing risk factor for patients with cardiac valvular disease (CVD) awaiting cardiac valve replacement procedures.

Study design: The incidence and quality of odontogenic infection sources (foci) were evaluated on 152 consecutive patients (study group, SG) undergoing cardiac valve replacement and were compared to 150 age-, gender- and residence-matched non-cardiac patients (control group, CG). Clinical and radiographic examinations were used to evaluate the incidence of odontogenic infection sources, grouped into potential (high risk) and facultative foci (possible risk), and the presence/severity of periodontal disease (PD). Foci and PD were compared among the overall SG and the CG and also among a sophisticated subdivision of the study group, especially with respect to aortic valve (AVR) and mitral valve replacement (MVR).

Results: Overall, 218 potential and 116 facultative odontogenic foci were found in 87 (58.3%) and in 79 (51.9%) patients of the SG respectively. The overall incidence of odontogenic infection sources and the incidence and severity of PD did not differ between the SG and the CG. However, in comparison with the CG (48%), the incidence of potential odontogenic infection foci was significantly higher in patients scheduled for AVR than in those scheduled to undergo MVR (70.4% vs. 25.0%, $p<0.01$). Additionally, in patients scheduled for AVR, a significantly higher number ($p<0.01$) of individual potential dentogenic infection foci (1.7 vs. 0.8 foci/valve) and a higher prevalence of PD (60.2%) was seen than for patients scheduled for MVR (31.8%) or for patients without CVD (1.0 foci/valve; 39.3%; $p<0.05$).

Discussion: Although the overall incidence of odontogenic infection sources did not differ between the patients with and without CVD, a sophisticated subdivison of CVD may be crucial, demonstrating that patients with AVR differ significantly from those with MVR and with the healthy CG. Cardiologists and cardiac surgeons play an important role in organising oral rehabilitation of patients scheduled for valve replacement.

Key words: cardiac valve surgery, dentogenic infection foci, focus treatment, oral rehabilitation

Oral Health Prev Dent 2007; 2: 153-159. *Submitted for publication: 11.01.05; accepted for publication: 30.06.06.*

An infection focus is defined as a pathological process showing the potential of exerting a pathological effect on regions beyond its immediate environment (Berger, 1997; Meurman, 1997). Both inflow of bacteria and their toxins into the circulation and allergic reactions or vegetative disorders have been discussed as pathogenetic mechanisms (Gill and Scully, 1990; De Nardin, 2001; Gilon et al, 2002). Differentiation can be made between different foci according to their potential risk for bacteraemia. In dentistry, differentiation is possible between a potential focus such as a periapical granuloma, an apical periodontal cyst and a retained root and facultative foci such as devitalised teeth and marginal periodontopathy (Bottomly et al, 1972; Chow et al, 1987; Gill and Scully, 1990; Gilon et al, 2002).

The problem of dentogenic focus identification and treatment prior to scheduled organ transplant procedures has been discussed controversially in the litera-

[a] *Associate Professor, Clinical Lecturer, Dental School University of Vienna, Austria.*

[b] *Associate Professor, Department of Medicine, Cardiology, General Hospital Wels, Austria.*

[c] *Assistant, Dental School, University of Vienna, Austria.*

[d] *Head, Professor, Department of Prosthodontics, University of Vienna, Austria.*

Reprint requests: *DDr.med. Gerald Krennmair, Austria 4600 Wels, Traunegsiedlung 8. Tel: +/7242/62804 (private), +/7243/51813 (business). Fax: +/7243/518136. Email: krennmair@aon.at*

ture. Some authors recommend a radical approach with extraction of all devitalised teeth (Kirkpatrick and Morton, 1971; Eigner et al, 1986), with the most extreme approach proposed by Bottomly and colleagues (1972), who suggest removal of all teeth even in cases lacking oral hygiene. In obvious contrast, Eigner et al (1986) only recommend removal of those teeth showing definite periapical foci or cyst-like lesions.

Disseminated dentogenic foci are considered as infection sources and may contribute to inflammatory valvular heart disease (Chow et al, 1987; Gill and Scully, 1990; Waal, 1994; Terezhalmy et al, 1997). The well-known antibiotic screening of patients with cardiac defects undergoing treatment of dentogenic disorders is of similar importance (Thornton and Alves, 1981; Nissen et al, 1992; Fang et al, 1993; Bauernschmitt et al, 1998; Dyson et al, 1999; Meurman et al, 2003). Thus, routine dentogenic focus detection has become an established procedure in surgical departments involved in valve replacement surgery in order to eliminate any potential infection foci prior to the scheduled valve replacement (Zuckermann et al, 2002; Lassnig et al, 2004). Detection and treatment of foci in oral dentistry is part of the evaluation programme intended to avoid post-operative complications. Chronic oral infections have been suggested, contributing to the pathogenesis of artherosclerosis and consequently to coronary heart disease (Beck, 1998; Janket et al, 2003, 2004). Although several investigations have documented a relationship between oral status and coronary heart disease, there is paucity in the literature reporting on the oral status and cardiac valve diseases (Beck, 1998; Janket et al, 2004; Khader et al, 2004).

The present study was intended to evaluate the incidence of potential (high risk factors) or facultative (possible risk factors) odontogenic infection sources as well as the presence of periodontal disease (PD) in patients scheduled for cardiac valve replacement. In addition, the study was to assess any differences in the incidence rates of dentogenic infection foci and PD between non-cardiac patients and with patients scheduled for cardiac valve replacement.

Particular interest was focused on the incidence of odontogenic infection sources of patients awaiting different types of valve replacement surgery, aortic or mitral valve replacement. Based on the incidence found and the quantitative and qualitative type of oral surgical interventions performed, the importance of interdisciplinary responsibility in oral rehabilitation was evaluated. For this purpose, the importance of early evaluation of dentogenic treatment options was also discussed.

MATERIALS AND METHODS

This study included 152 consecutive patients (study group, SG) who were scheduled for cardiac valve replacement at the Department of Surgery I (Cardiothoracic Surgery), General Hospital Wels, Austria. The patients (91 male, 61 female) were additionally subdivided into an aortic valve replacement (AVR) group and a mitral valve replacement (MVR) group. Patients with dual valve replacement group (AVR+MVR) or tricuspidal or pulmonal valve replacement were excluded due to the small number of patients. In addition, 150 age- and gender-matched patients (control group, CG) from the same catchment area and with no evidence of heart valve disease, who were admitted to the same hospital, were recruited. All patients included in study gave informed consent. The study design was approved by the ethics commitee of the General Medical Hospital, Wels, Austria.

For all patients (302) the following general data were collected: age, gender, number of teeth, and cardiovascular risk factors, such as history of smoking and diabetes mellitus. All patients were also admitted to the Department of Oral Surgery for pre-operative screening for oral pathological risk factors/dental infection sources (foci).

Oral pathological risk factors were evaluated using a maxillofacial radiological and a specific clinical investigation. For detecting gross pathologic processes such as cysts, retained teeth, retained roots and periapical granuloma, the orthopantomogram (OPT) was usually sufficient for a basic radiographic examination (Flint et al, 1998). Although OPT (Orthophos, Siemens, Erlangen, Germany) was primarily used for detecting foci in this study, additional detailed dental films were also taken in special or doubtful cases.

Clinical oral assessment included the quantitative evaluation of presence of teeth, dental infection sources (foci) as well as the presence of periodontal disease. In general, dental foci were grouped into potential foci (high risk sources with potential infection) and facultative foci (possible risk factors but not evident). Potential foci included clinical and/or radiographical discernable acute/chronic apical periodontitis as well as cysts and retained roots. Facultative foci included any devitalised teeth with asymptomatically sufficient or insufficient endodontic treatment, or asymptomatic impacted teeth.

The incidence of dentogenic infection sources (number of potential and facultative foci) was evaluated and compared between the SG and the CG. The incidence of dentogenic infection sources was additionally compared between the CG and the subsets of the SG

Table 1a General characteristics of the study and control group

	Study group	Control group
Patients (n)	160	150
Age (years)	57.2 ± 8.9	59.5 ± 10.2
Men, n (%)	91 (57%)	94 (63%)
Women, n (%)	69 (43%)	56 (37%)
Dentition (n)	14.8 ± 6.7	16.3 ± 5.2
Nicotine abuse	64 (45.3%)	53 (29.5%)
Diabetes mellitus	25 (20.3%)	18 (6.8%)

Table 1b Patient data evaluated for patients (n = 152) scheduled for cardiac valve replacement [aortic valve replacement (AVR) or mitral valve replacement (MVR)]

	AVR	MVR
Patients (n)	108	44
Age (years)	63.2 ± 10.7	53.5 ± 8.9
Men, n (%)	68 (63%)	23 (52%)
Female, n (%)	40 (37%)	21 (48%)
Dentition (n)	13.6 ± 6.9	15.3 ± 6.2
Nicotine abuse	49 (45.3%)	13 (29.5%)
Diabetes mellitus	22 (20.3%)	3 (6.8%)

(AVR and MVR groups).

Simple periodontal parameters (plaque index, pocket depth, bleeding index, bleeding on probing) (Löe and Silness, 1963; Mombelli et al, 1987) were measured to evaluate the presence of PD. The summarisation of the obtained parameters assessed the severity of the PD using a simple grading scale from 0–3 (0 = absent PD, 1 = mild PD, 2 = moderate PD, 3 = severe PD). The severity of PD was compared between the SG and the CG. Additionally PD was compared between the CG and the patient's subsets with different heart valve diseases (AVR and MVR).

In cases of oral surgical interventions, surgical tooth or root removal was distinguished from root resection, removal of retained/impacted teeth and maxillary sinus endoscopy. PD treatment included simple oral hygiene instructions and performance as well as advanced treatment modalities such as root scaling and open flap debridement (OFD). Post-operative follow-up also included evaluation of post-operative complications such as bleeding and wound infection.

All data collected were tabulated and summarised with means and standard deviations. The Student *t*-test was used to compare the means. Non-parametric data were analysed for statistical significance using the chi-square test. A p-value of <0.05 was taken as the level of statistical significance.

RESULTS

General characteristics of the SG (heart valve disease) and the CG (non-heart valve disease) are listed in Table 1a. The groups were well matched with respect to age, gender and socioeconomic risk factors. However, the heart valve disease group had, on average, fewer teeth, and also the proportion of diabetic subjects and the incidence of nicotine abuse were higher than in the CG.

The subdivision of the SG presented 108 patients with isolated AVRs and 44 patients with isolated MVRs. The average age of the patients with AVR was 63.2 ± 10.7 years (41–77 years), while the patients with MVR were younger [53.5 ± 8.9 years; 43–64 years, not significant (NS)]. Regarding their oral status, the patients with scheduled MVR showed a significantly higher number of teeth than the patients with AVR (15.3 ± 6.2 vs. 13.6 ± 6.9 teeth/patient respectively; p<0.05, Table 1b).

Table 2a shows the overall incidence of potential and facultative dentogenic foci in the SG and CG (NS). In total, 218 potential dentogenic infection sources (foci) were identified in 87/152 (57%) of valve replacement patients (76 AVR, 11 MVR) and 151 potential foci were seen in 72/150 (48%) non-cardiac patients (NS, Table 2a). The incidence of facultative foci and of PD did not differ between the SG and CG (Table 2a).

Table 2b shows the details of AVR and MVR patients. Overall, 218 potential foci were found in 87 patients having isolated AVR and MVR. The incidence of potential foci/patients was significantly higher in patients with AVR (70.4%) than in patients without heart valve disease (CG 48%) and among patients with MVR (25.0%, p<0.05, Tables 2a and 2b).

In the group of aortic valve recipients (n = 108), 185 out of 218 potential foci were counted in a total of 76 patients, representing an average frequency of 1.7 teeth with periapical pathology per valve recipient patient (Table 2b). In contrast, the mitral valve recipients (n = 44) included only 11 patients with an overall 33 foci, representing an overall number of 0.8 teeth with chronic periapical periodontitis per patient (Table 2b).

The poor oral health of the patients with AVR was best reflected by the 'number of infection sources (foci) per cardiac valve' (1.7 vs. 0.8 for MVR) (Table 2b).

Table 2a Incidence of dentogenic infection sources in the study (AVR, MVR heart valve disease) and control group (non-heart valve disease)

	Study group (n = 152)	Control group (n = 150)
Potential foci	218	151
Patients with potential foci	87 (57.2%)	72 (48%)
Potential foci/patient	1.4	1.0
Facultative foci	116	83
Patients with facultative foci	79 (51.9%)	61 (40.6%)
Facultative foci/patients	0.8	0.6
Devitalised teeth per patient	2.2 ± 1.6	1.7 ± 1.9
Incomplete root treatment per patient (without any clinical and radiological findings)	1.9 ± 0.7	1.7 ± 1.1
PD (incidence)	79 (51.9%)	59 (39.3%)
PD (severity: 0–3)	1.7 ± 0.6	1.6 ± 0.6

Table 2b Incidence of dentogenic infection sources in patients with scheduled cardiac valve surgery [aortic (AVR) and mitral valve (MVR) replacement]

	AVR (n =108)	MVR (n = 44)	
Patients with potential foci (n = 87)	76/108 (70.4%)	11/44 (25.0%)	p < 0.01
Number of potential foci (n = 218)	185	33	
Potential foci/cardiac valve	1.7	0.8	
Potential foci/cardiac valve with potentials focus	2.4	3.3	
Patients with facultative foci (n = 79)	65/108 (60.2%)	14/44 (31.8%)	p < 0.05
Number of facultative foci (n = 116)	89	27	
Facultative foci/cardiac valve	0.8	0.6	
Facultative foci/cardiac valve with facultative focus	1.4	1.9	
Devitalised teeth per patient	2.4 ± 1.6	2.1 ± 1.5	
Incomplete root treatment per patient (without any clinical and radiological findings)	1.9 ± 0.7	1.7 ± 0.9	
PD (incidence)	65 (60.2%)	14 (31.8%)	
PD (severity: 0–3)	1.7 ± 0.6	1.6 ± 0.5	

The reduced oral status of patients with AVR is also supported by the increased number of oral risk factors such as smoking and diabetes (Table 1a).

Fig 1 shows the quantitative distribution of potential dentogenic foci relative to the isolated valve replacements (AVR and MVR) performed.

The incidence rate (n = 116) of facultative sources of infection was also significantly different between recipients of aortic valve group (60.2%) and the control group (40.6%) as well as between aortic valve (60.2%) and mitral valve groups (31.8%; p <0.05, Tables 2a and 2b). However, when evaluated on an individual basis, patients with aortic valve replacement (0.8 facultative foci/cardiac valve) showed no increased frequency of facultative infection foci as compared with patients with mitral valve replacement (0.6 facultative foci/cardiac valve) (Table 2b). The incidence of presence of PD differed significantly between AVR (60.2%) and MVR (31.8%, p<0.01) and between AVR and patients without heart valve disease (60.2% vs. 39.3%, p<0.05). The severity of the PD was not different between the two subgroups of the study group (AVR score 1.7 ± 0.6, vs. MVR score 1.6 ± 0.5)

Overall, the 152 patients with AVR and MVR had 268 oral surgical interventions including 135 removals of a tooth or root remnants and 46 removals of a retained/impacted tooth. In 74 and 12 cases respectively, apicoectomy and maxillary sinus en-

doscopy was performed. Periodontal disease was treated as follows: oral hygiene instructions and performance - 68 cases, deep scaling - 34 cases, OFD - 16 cases. All interventions were without complications and no wound infection and/or serious secondary bleeding was seen.

DISCUSSION

Degenerative cardiac valve changes necessitating valve replacement may be the result of various underlying cardiovascular conditions. Sclerotic deformation of the valve system has replaced disorders of inflammatory and post-infection genesis as the primary reason for valve replacement (Poggianti et al, 2003). However, colonisation of the endocardium in the course of a bacteraemia originating from infections in oropharynx, gastroduodenal or genitourinary tract is still considered as a valid pathogenetic infection scenario (Wahl, 1995; Berger, 1997; Meurman, 1997). Sterile puncture of dentogenic infection sources presenting as dentogenic infections in active form predominantly reveals the presence of streptococci (Thornton and Alves, 1981; Chow et al, 1987; Gill and Scully, 1990). Streptococci-induced endocarditis is known to represent the major part of the infectious genesis. Thus the conclusion that dentogenic infection sources are involved in the pathogenesis of endocarditis is still valid and supports the role and importance of detection of dentogenic foci (Nissen et al, 1992; Fang et al, 1993; Waal, 1994; Bauernschmitt et al, 1998; Dyson et al, 1999).

It is especially following cardiac valve replacement that existing foci may show a remote bacteriological effect and colonise the new valve as *locus minor resistentiae* (Nissen et al, 1992; Fang et al, 1993; Dyson et al, 1999; Meurman et al, 2003). Thus in order to minimise the risk of a graft endocarditis with poor prognosis, the search for dentogenic foci has been included in the evaluation programme for patients undergoing cardiac valve replacement (Zuckermann et al, 2002; Lassnig et al, 2004). Such evaluation will predominantly involve assessment of patients by OPT and dental radiographic films for detecting potential and facultative foci, subsequently treated by dental or oral surgical intervention (Flint et al, 1998).

The present study shows the incidence as well as the quality and quantity of treatment of dentogenic infection sources in patients scheduled for cardiac valve replacement. Interestingly, almost two thirds of all cardiac valve patients showed dentogenic infection sources requiring treatment. Patients scheduled to undergo aortic valve replacement showed a significantly higher number of potential and facultative dentogenic foci, as well as a higher incidence of periodontal disease, than patients scheduled for mitral valve replacement and patients without cardiac valve disease. This significant difference is considered to be due to the higher age of the patients and the reduced oral hygiene status due to the increased incidence of cardiac risk factors – predominantly a higher frequency of smokers among patients with aortic valve replacement (Papantonopoulos, 2004; Paulander et al, 2004). In smokers, deterioration of periodontal status is primarily due to the reduced oral hygiene, with nicotine consumption also being a factor predisposing for gingivitis (Johnson and Hill, 2004). Contraction of peripheral vessels induced by nicotine not only is a cause of cardiovascular disease but also causes changes in the perfusion of the oral mucosa with periodontal disorders, degeneration of alveolar bone and other exacerbations of dentogenic infections as possible consequences (Bauernschmitt et al, 1998; Poggianti et al, 2003; Johnson and Hill, 2004).

The difference in the incidence of odontogenic infection sources between aortic and mitral valve replacement could also be founded on the different pathogenesis of the valve degeneration. Aortic valve disease, especially aortic valve stenosis, is the result of sclerotic degeneration, while mitral valve insufficiency is usually the result of myocardial degeneration. Some studies have reported that periodontal disease might contribute to the generation of inflammatory me-

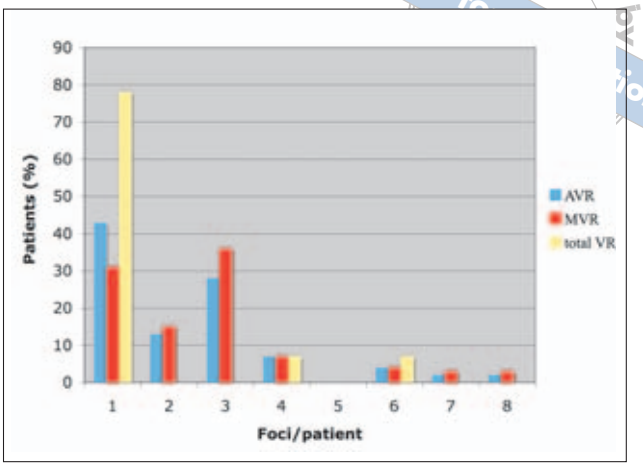

Fig 1 Distribution of frequency of potential dentogenic foci (n = 218) by type of isolated valve replacement performed [aortic valve replacement (AVR) or mitral valve replacement (MVR)].

diators, and in a meta-analysis of five cohort studies, an increased relative risk of coronary heart disease was reported, and dental disease was considered to be a cause similar to socioeconomic and behavioural risk factors for coronary heart disease (Beck, 1998; Janket et al, 2003, 2004; Khader et al, 2004). Because atherosclerotic aortic valve disease is similar to coronary heart disease, the inflammatory pathogenesis can be a relative risk for several types of aortic valve diseases (Beck, 1998; Janket et al, 2004; Khader et al, 2004). Therefore detection of dentogenic infection foci may have an impact on the inflammatory pathogeneses of sclerotic valve diseases and may also influence the peri- and post-operative care after valve replacement procedures, by excluding potential risk factors for the valve prosthesis.

In the patients with dentogenic infection sources an average of 2.4 ± 1.9 teeth required treatment. Thus with the patients showing a dentition with a mean number of 14 teeth, almost one fifth of all teeth required intervention. Apart from primary extractions or apicoectomies, such interventions also include the subsequent fabrication of a partial or full denture. In the present study, interventions for treatment were limited to the absolute minimum necessary and only potential foci were removed. In our opinion, devitalised teeth treated by regular root treatment present no risk (Bottomly et al, 1972; Dyson et al, 1999). Radical treatment measures, on the other hand, are associated with the problem of prosthetic treatment, which may subsequently also involve a social problem. As a positive finding and in contrast to treatment of patients scheduled for renal transplantation, none of the patients with cardiac valve replacement showed any post-operative complications such as bleeding (Bottomly et al, 1972; Eigner et al, 1986).

Frequently, just a single tooth extraction may affect aesthetics and thus also the psychosocial behaviour of the patient (McMillan and Wong, 2004). In view of the impending and prolonged rehabilitation for up to several weeks following the valve replacement procedure, the psychosocial component after dental interventions must also be considered. The coincidence of the considerable number of dental interventions required and their unproblematic performance therefore supports the stipulation that dental/oral surgical measures are done early or at least in due time ahead of the scheduled cardiac surgery. As anticoagulant therapy frequently will be initiated following valvular surgery, oral surgical measures will certainly be more difficult during this time (Bodner et al, 1998; Blinder et al, 1999).

It is beyond doubt that scheduling patients for dental and oral evaluation in due time will allow for adequate prosthetic and conservative dental treatment. Initiation of timely oral rehabilitation will also ensure that patients' accustomed oral/dentogenic situation is maintained and their usual daily activities are not essentially disrupted following the cardiac surgery (Wahl, 1995; Zuckermann et al, 2002; Johnson and Hill, 2004; Lassnig et al, 2004). By initiating referral to the dentist or oral surgeon, the cardiologist and/or cardiac surgeon will play an important role in oral rehabilitation. If dentogenic treatment measures are considered several weeks ahead of the cardiac surgery, patients with scheduled valve replacement surgery may certainly undergo appropriate treatment within due time and thus the associated psychological and social problems may be reduced to a minimum.

REFERENCES

1. Bauernschmitt R, Jakob HG, Vahl CF, Lange R, Hagl S. Operation for infective endocarditis: results after implantation of mechanical valves. Ann Thorac Surg 1998;65:359-364.
2. Beck JD, Offenbacher S, Williams R, Gibbs P, Garcia R. Periodontitis: a risk factor for coronary heart disease? Ann Periodontol 1998;3:127-141.
3. Berger D. Infection without infection focus: clinical relevance of bacterial translocation. Langenbecks Arch Chir Suppl 1997;114:941-946.
4. Blinder D, Manor Y, Martinowitz U, Taicher S, Hashomer T. Dental extractions in patients maintained on continued oral anticoagulant: comparison of local hemostatic modalities. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1999;88:137-140.
5. Bodner L, Weinstein JM, Baumgarten AK. Efficacy of fibrin sealant in patients on various levels of oarl anticoaguant undergoing oral surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;86:421-424.
6. Bottomly WK, Cioffi RF, Martin AF. Dental management of the patients treated by renal transplantation: preoperative and postoperative considerations. J Am Dent Assoc 1972;85:1330-1335.
7. Chow AW, Roser SM, Brady FA. Orofacial odontogenic infections. Ann Intern Med 1987;88:392-402.
8. De Nardin E. The role of inflammatory and immunological mediators in periodontitis and cardiovascular disease. Ann Periodontol 2001;6:30-40.
9. Dyson C, Barnes RA, Harrison GA. Infective endocarditis: an epidemiological review of 128 episodes. J Infect 1999;38:87-93.
10. Eigner TL, Jastak JT, Benett WM. Achieving oral health in patients with renal failure and renal transplantation. J Am Dent Assoc 1986;113:612-616.
11. Fang G, Keys TF, Gentry LO, Harris AA, Rivera N, Getz K et al. Prosthetic valve endocarditis resulting from nasocranial bacteraemia: a prospective multicenter study. Arch Intern Med 1993;119:560-567.
12. Flint DJ, Paunovich E, Moore WS, Wofford DT, Hermesch CB. A diagnostic comparison of panoramic and intraoral radiographs. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 1998;85:731-735.

13. Gill Y, Scully C. Orofacial odontogenic infections: review of microbiology and current treatment. Oral Surg Oral Med Oral Pathol 1990;70:155-158.
14. Gilon Y, Brandt L, Lahaye T, Heymans O. Systemic infections of dental origin. Rev Stomatol Chir Maxillofac 2002;103:26-29.
15. Janket SJ, Baird A, Chuang S, Jones JA. Meta-analyses of periodontal disease and risk of coronary heart disease and stroke. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2003;95:559-569.
16. Janket SJ, Qvarnström M, Meurman JH, Baird AE, Nuutinen P, Jones J. Asymptomatic dental score and prevalent coronary heart disease. Circulation 2004;109:1095-1100.
17. Johnson GK, Hill M. Cigarette smoking and the periodontal patient. J Periodontol 2004;75:196-209.
18. Khader YS, Albashaireh ZS, Alomari MA. Periodontal disease and the risk of coronary heart and cerebrovsacular disease: a meta-analysis. J Periodontol 2004;75:1046-1053.
19. Kirkpatrick TJ, Morton JB. Factors influencing the dental management of renal transplant and dialysis patients. Br J Oral Surg 1971;9:57-60.
20. Lassnig E, Auer J, Weber T, Berent R, Hartl P, Krennmair G, Eber B. Infection sources in ENT-and jawbone regions in patients before valve replacement surgery. Herz 2004;29:317-321.
21. Löe H, Silness J. Periodontal disease in pregnancy. II: Correlation between oral hygiene and periodontal condition. Acta Odontol Scand 1963;21:533-541.
22. McMillan AS, Wong MC. Emotional effects of tooth loss in community – dwelling elderly people in Hong Kong. Int J Prosthodont 2004;17:172-176.
23. Meurman JH. Dental infections and general health. Quintessence Int 1997;28:807-811.
24. Meurman JH, Qvarnstrom M, Janket SJ, Nuutinen P. Oral health and health behavior in patients referred for open-heart surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2003;95:300-307.
25. Mombelli A, Van Oosten MAC, Schürch E, Lang N. The microbiota associated with succesful or failing oseointegrated titanium implnats. J Oral Microbiol Immunol 1987;2:145-151.
26. Nissen H, Nielesen PF, Frederiksen M, Helleberg C, Nielsen JS. Native valve infective endocarditis in the general population: a 10-year survey of the clinical picture during the 1980s. Eur Heart J 1992;13:872-877.
27. Papantonopoulos GH. Effect of periodontal therapy in smokers and non-smokers with advanced periodontal disease: results after maintenance therapy for a minimum of 5 years. J Periodontol 2004;75:839-843.
28. Paulander J, Wennstrom JL, Axelsson P, Lindhe J. Some risk factors for periodontal bone loss in 50-year-old individuals. A 10-year cohort study. J Clin Periodontol 2004;31:489-496.
29. Poggianti E, Venneri L, Chubuchny V, Jambrik Z, Baroncini LA, Picano E. Aortic valve sclerosis is associated with systemic endothelial dysfunction. J Am Coll Cardiol 2003;41:136-141.
30. Terezhalmy GT, Safadi TJ, Longworth DL, Muehrcke DD. Oral disease burden in patients undergoing prosthetic heart valve implantation. Ann Thorac Surg 1997;63:402-404.
31. Thornton JB, Alves JC. Bacterial endocarditis: a retrospective study of cases admitted to the University of Alabama Hospitals from 1969–1979. Oral Surg Oral Med Oral Pathol 1981;52:379-383.
32. Waal MJ. Mythos of dental induced endocarditis. Arch Intern Med 1994;154:129-130.
33. Wahl MJ. Clinical issues in the prevention of dental-induced endocarditis and prosthetic joint infection. Pract Periodontics Aesthet Dent 1995;7:29-36.
34. Zuckermann A, Bohdjalian D, Deviatko E, Dunkler D, Rodler S, Ehrlich M et al. The Univerity of Vienna experience in heart transplantation. Clin Transpl 2002: 22-42.