Upsala J Med Sci 112 (1): 95–103, 2007

Association between High Blood Pressure and Deep Periodontal Pockets

A Nested Case-Referent Study

Sevek Engström[1,2,3], Lars Gahnberg[4], Hans Högberg[2], Kurt Svärdsudd[2,3]

[1]*Public Dental Service, Gävleborg County Council.*
[2]*Centre for Research & Development Uppsala University/Gävleborg County Council.*
[3]*Department of Public Health and Caring Sciences, Family Medicine and Clinical Epidemiology Section, Uppsala University.*
[4]*Public Dental Service, Uppsala County Council*

Abstract

A hypertension screening project was performed jointly at a dental clinic and a primary health care centre. In this report the hypothesis that there is an association between high diastolic blood pressure and deep periodontal pockets was tested. A total of 1,239 consecutive patients aged 35–65 years had their blood pressure measured before the dental examination or had a known hypertension. Information on medical history and tobacco use was obtained by interview and dental status was recorded. Fifty-four subjects had known hypertension and 141 had previously unknown diastolic blood pressure >90 mmHg (cases). For each case an age, sex and tobacco-use matched referent was chosen from those with diastolic blood pressure ≤ 90 mmHg. Significantly more cases than referents had periodontal pockets ≥5 millimetres deep. In multivariate analyses the prevalence of deep periodontal pockets was associated with blood pressure status also after adjustment for the small differences between the groups in age, sex, tobacco use and number of teeth. In conclusion there was an association between diastolic blood pressure and prevalent deep periodontal pockets. Whether the relationship is a causal one remains to be explored. Screening for high blood pressure at regulary visits at the dental clinic may give the dental care a new important role in the public health field.

Introduction

In the last decade several reports on a possible relationship between oral and general health have been published [1]. Such a relationship might be expected since some of the risk factors for cardiovascular disease and cancer may also be risk factors or precursors for oral diseases [2–4]. Associations between oral health and cardiovascular disease have been proposed [5,6] and current debates concern periodontal disease as a potential risk factor for systemic diseases and, more specifically, whether the dental infection is a risk factor for acute myocardial infarction [7–9]. In a prospective Finnish study, an association between dental infections and coronary heart disease was shown [7,10].

It is well known that some cardiovascular risk factors, such as smoking, also affect oral health. Recently published studies show that smoking has a negative influence on humoral immune response in early-onset periodontitis [11–13]. The effects of other cardiovascular risk factors, such as high blood pressure and hyperlipidemia

Received 1 June 2006
Accepted 25 June 2006

on oral health or vice versa are more uncertain [14–16] but a recently published study found that a group of postmenopausal women subjects with missing teeth had significantly higher diastolic blood pressure than others [17].

This report, based on a pilot project with blood pressure screening in dental patients, was performed jointly at a dental clinic and a primary health care centre. The aim of the study was to test the hypothesis that there is a correlation between high diastolic blood pressure and deep periodontal pockets in an unselected dental patient population.

Subjects and methods

The study was performed at a large dental clinic in the city of Gävle (population 92,000), capital of Gävleborg county (population 277,000) and located 170 kilometres north of Stockholm, Sweden. A total of 1,446 consecutive patients aged 35–65 years who came to the clinic for an annual dental check-up were invited to participate, and 1,239 agreed. The patients paid for the routine check-up, but all additional measurements due to the study were given free of charge.

A standardized interview was performed by a dental hygienist or a dental nurse, about the subjects' general health, medication and tobacco use. The eight participating staff members were co-trained before the study. Tobacco use was classified as never used tobacco, tobacco ex-user, current smoker, or moist snuff user. Blood pressure was read (before the dental examination) in the sitting position, after 5 minutes' rest with a blood pressure watch (FUZZY-Logic, maximum recording error ± 4 mmHg) around the left wrist placed at heart level. If the diastolic blood pressure reading was above 90 mmHg, a second reading was done at the end of the visit, and the lowest value used in the analyses. No blood pressure reading was performed on subjects with previously known hypertension.

Fifty-four (4.4%) subjects had previously known and treated hypertension (case group 1), and 141 (11.4%) subjects had a blood pressure reading of >90 mmHg but no previously known high blood pressure (cases group 2). The latter subjects were offered further assessment at the collaborating primary health care centre. For each case an age, sex and tobacco use matched referent was chosen from the group with diastolic blood pressure ≤90 mmHg, allowing an age mismatch of ± 6 years (because of the small group of snuff users among women). However, the interquartile range for the case-referent age difference was quite narrow, –1 to +2 years. The 195 cases and their 195 referents formed the study population for this report.

Dental status was determined on the basis of the traditional clinical examination, radiographic examination and periodontal pocket probe (HU-friedy) examination of all sides of the teeth, and recorded in the patient record. Pocket depth was measured from the margin of the gingiva to the bottom of the periodontal pocket, to the nearest millimetre. Based on patient record information, the number of periodontal pockets 5 millimetres or deeper (excluding the third molar) per subject was calculated. Number of erupted permanent teeth was counted.

Statistical analyses

Data were analyzed with the SAS statistical programme package [18]. The partial non-response rate (missing data in collected variables) was less than 4%. Summary statistics, such as means, standard deviations and confidence intervals were computed with standard parametric methods. Differences between the groups in terms of continuous variables were tested with Student's t-test and categorical data with the chi-square test. Odds ratios were computed with multivariate conditional logistic regression analysis as were the regression surfaces shown in Figure 1 A and Figure 1 B. P-values less than 5% were considered to indicate statistical significance.

Results

Patient characteristics

Patient characteristics are shown in Table 1. Those with known hypertension and their referents were on average 54 years old, and those with previously unknown high blood pressure and their referents were 49 and 48 years, respectively, a non-significant difference. Mean systolic and diastolic blood pressure were significantly higher in subjects with previously unknown high blood pressure than among their referents, but were fairly similar in the two reference groups.

Smoking habits were similar among cases and their referents with the exception that the proportion of previous tobacco users was lower among those with known hypertension than among their referents. Cases tended to have a smaller number of own teeth and a larger number of deep periodontal pockets than their referents, although these differences generally were small and insignificant. There was also a tendency towards a greater proportion of subjects with at least one deep periodontal pocket among the cases than among the referents, significant in the group with previously unknown high blood pressure.

Multivariate analyses

The results of multivariate logistic regression analyses in the two case-referent subgroups and in the total study population with being a case or referent as the dependent variable and presence of periodontal pocket ≥5 mm deep, age, sex, smoking habits, snuff taking and number of erupted teeth as independent variables is shown in Table 2. The findings were similar in the two sub-populations and the total study population. Subjects with periodontal pockets had 76% larger probability (adjusted odds ratio 1.76, 95%CI 1.14–2.72) of being a case than those who had no pockets.

The presence of deep periodontal pocket among cases and referents is in Figure 1A and Figure 1B visualized in strata according to age and smoking habits. The difference in deep periodintal pocket prevalence between cases and referents persisted in all strata.

Table 1. Patient characteristics. 95% CI = 95% confidence interval, period. = periodontal. Previously unknown high diastolic blood pressure = high DBP

	High DBP		Referents			Known hypertension		Referents		
	mean or %	95% CI	mean or %	95% CI	p	mean or %	95% CI	mean or %	95% CI	p
No. of subjects	141		141			54		54		
Age, years	49.0	47.7–50.4	47.8	46.5–49.1	n.s.	54.1	52.3–55.8	54.1	52.4–55.8	n.s.
Females, %	51.8		51.8		n.s.	42.6		40.7		
Mean blood pressure										
Systolic, mmHg	156.5	153.5–159.6	125.2	122.9–127.5	<0.001	–	–	125.0	121.7–128.3	
Diastolic, mmHg	97.9	96.8–99.0	75.2	74.0–76.5	<0.001	–	–	74.7	72.9–76.5	
Tobacco use										
Current smokers, %	17.7		17.7		n.s.	7.4		7.4		n.s.
Moist snuff users, %	9.9		9.2.		n.s.	3.7		3.7		n.s.
Previous users	17.7		17.0		n.s.	7.4		31.5		<0.005
Dental data										
No. of teeths	26.5	25.8–27.2	27.2	26.6–27.8	n.s.	25.5	24.4–26.6	26.9	26.1–27.6	<0.05
No. of period. pockets	3.5	2.6–4.4	2.6	1.6–3.5	n.s.	3.5	2.2–4.9	2.4	1.3–3.6	n.s.
Subjects with period. pockets, %	57.1		42.6		<0.05	54.7		38.9		n.s.

Table 2. Odds ratios of having a hypertension diagnosis or a diastolic blood pressure reading >90 mmHg. Adjusted estimates were obtained in multivariate analysis. OR=adjusted odds ratio, 95% CI=95% confidence interval. Previously unknown high diastolic blood pressure= high DBP

	Known hypertension/ Referents		High DBP /Referents		Total study population	
	OR	95%CI	OR	95%CI	OR	95%CI
Periodontal pocket ≥5 mm	2.00	0.83–4.86	1.74	1.03–2.93	1.76	1.14–2.72
Age	0.98	0.79–1.22	1.07	1.00–1.14	1.00	0.97–1.04
Sex	1.19	0.48–2.94	0.94	0.56–1.57	1.01	0.66–1.57
Smoke	0.97	0.16–5.87	0.73	0,36–1.49	0.90	0.47–1.73
Snuff	0.81	0.09–7.62	1.04	0.44–2.44	1.05	0.48–2.32
No. of teeth	0.82	0.69–0.96	0.96	0.90–1.02	0.94	0.88–1.00

Discussion

High blood pressure was significantly associated with the prevalence of 5 millimetres or deeper periodontal pockets after adjustments for the effects of age, sex, tobacco use and number of teeth. The project was conducted as an addendum to the normal routine in a general dental clinic, a form of opportunistic screening where the patient was offered the service when he or she visited the dental clinic for the annual dental check-up. More than 60 % of the adult population in Gävleborg County sees a dentist in the Public Dental Service at least annually [19]. The study population in this project is therefore fairly representative of the underlying age segment of the general population.

Altogether 15.8% of the subjects had previously known hypertension or a diastolic blood pressure reading above 90 mmHg. The prevalence of hypertension in the community has been estimated to 10–15% [20]. Since the classification of high diastolic blood pressure was based on one reading only in the majority of cases, the true hypertension prevalence in our study population appears to be approximately the same as in the general population.

All staff members involved in the project were co-trained for the data collection. The blood pressure maximum recording error of ± 4 mmHg is much less than average observer variation in manual readings [20]. The well-known problem of "white coat hypertension" [21–24], i.e. artificially high blood pressure readings owing to subjects` tension in the measurement situation, affects blood pressure readings in all situations, with the possible exception of home blood pressure readings [25], and is therefore not a problem particular to this study.

The automatic blood pressure measurements reduced the possibility of dependent misclassification in the blood pressure – periodontal pocket relationship. The fact that the blood pressure classification was based on only one or two readings

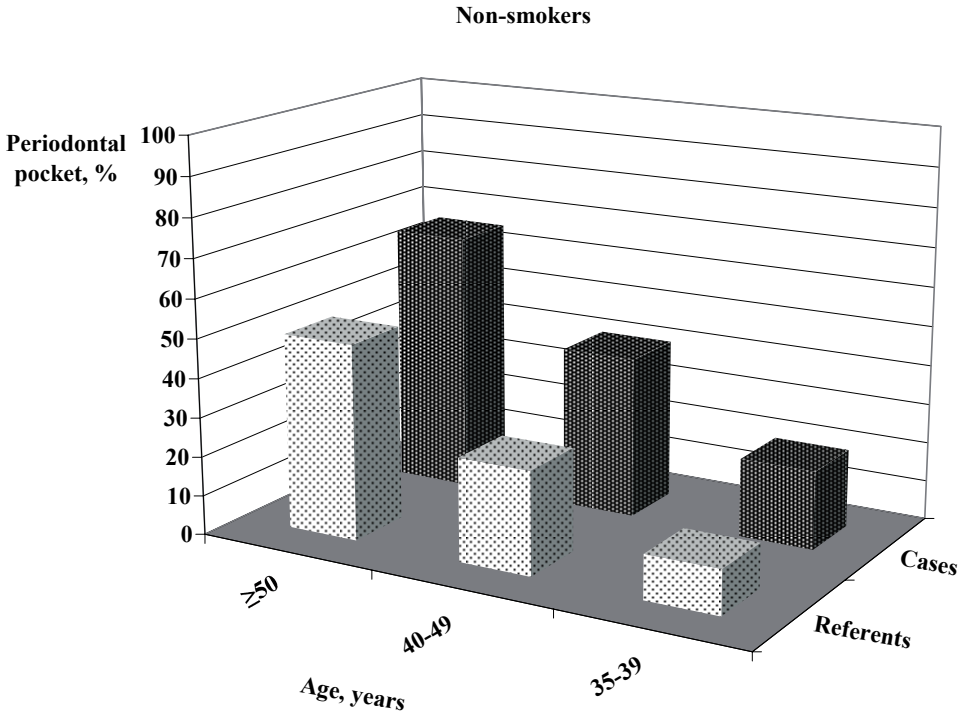

Figure 1 A. Proportion of periodontal pockets 5 millimetres or deeper in non-smoking cases (hypertension diagnosis or diastolic blood pressure reading higher than 90 mmHg) and referents in strata according to age.

rather than a clinical work-up for subjects with high readings lessens the precision, i.e. causes a non-differential misclassification bias in this classification. The effect is therefore most likely a dilution of the true relationship between periodontal pockets and their determinants rather than the creation of a false relationship.

Another possible source of bias is the number of remaining erupted teeth, since the potential number of deep pockets depends on the number of teeth. In addition, loss of teeth may also be linked to prevalent deep pockets. To get around this problem the number of remaining erupted teeth was taken into account in all analyses. We therefore have no reason to believe that the data are biased to such an extent that the conclusions would be affected.

Periodontitis is a chronic disease with multifactorial etiology and usually has slow development and few symptoms. Periodontitis and gingivitis share the same etiological factors, and represent different clinical manifestations of the same fundamental disease process. It is unclear why and in which cases gingivitis progresses to periodontitis. The differences could be attributable to the response of the host to the microbial challenge [26]. It is important to know that deep periodontal pockets that remain inflamed after local treatment may be due, to some extent, to deficient general health. Periodontitis is, for example, more common among subjects with

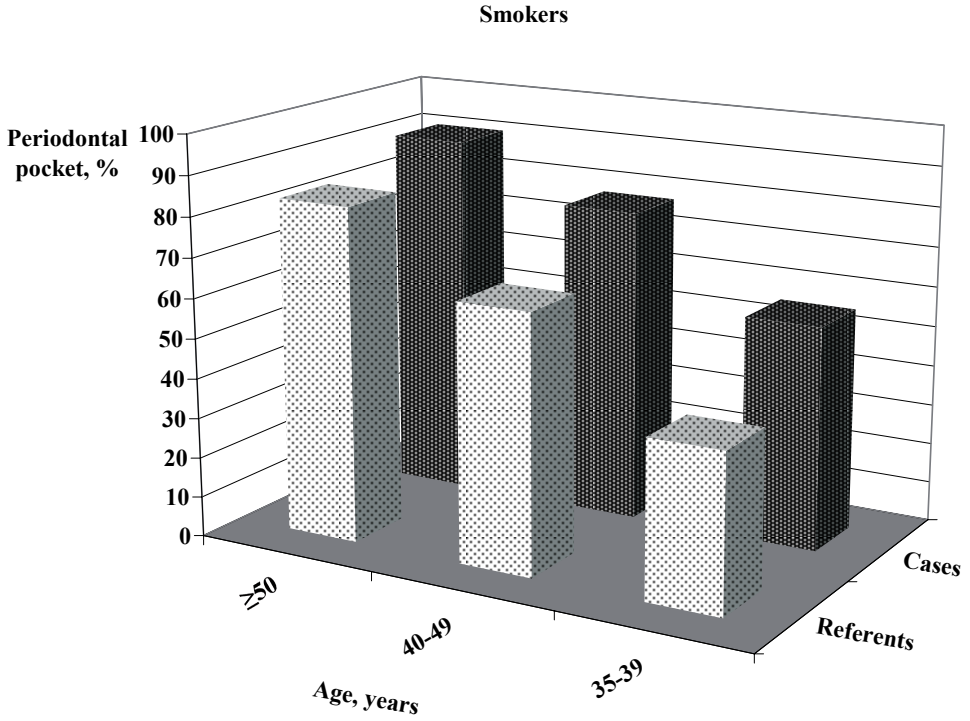

Figure 1 B. Proportion of periodontal pockets 5 millimetres or deeper in smoking cases (hypertension diagnosis or diastolic blood pressure reading higher than 90 mmHg) and referents in strata according to age.

diabetes and there is a statistically significant difference in clinical tooth attachment loss between diabetes patients with poor metabolic control, those with satisfactory metabolic control, and healthy referents [27–29]. A positive relationship between high blood pressure and risk of cardiovascular disease has long been recognized. Whether periodontal disease is a risk factor for systemic disease and whether dental infection is a risk factor for coronary heart disease remains to be shown [14,15]. The same applies to whether the association between deep periodontal pockets and blood pressure is a causal relationship or not. Studies on mechanisms involved in periodontal diseases show associations with various stressors; a relationship between negative events and psychological factors on the one hand and periodontal disease on the other [30]. It appears that psychological and oral risk factors together may cause periodontal disease [31,32].

The results of this study point towards new possibilities to improve public health. The Dental Service, public and private, is the only health care sector for the adult population that sees a large proportion of this population on a regular basis, even when no illness has occurred. This organization might therefore be useful for opportunistic screening [33]. The additional time needed for the blood pressure measurements in this project was on average 5–6 minutes and no extra staff was

needed. However, the efficacy of this type of opportunistc screening remains to be evaluated. This will be done later in this project. Presently few dentists screen for high blood pressure but more than 25% feel that involvement of dentists in the screening for hypertension is a good idea [34].

In conclusion, we found that prevalence of periodontal pockets 5 or more millimetres deep were associated with prevalent established hypertension or a high blood pressure reading after adjustment for the influence of age, sex, tobacco use and number of teeth. Whether the blood pressure – periodontitis relationship is a causal one remains to be explored. Screening for high blood pressure at regular visits at the dental clinic may give the dental care a new important role in the public health field.

Acknowledgements

The study was supported by grants from the Faculty of Health Sciences at Linköping University, Department of Public Health Medicine, County Council of Gävleborg, Centre for Development and Research and Public Dental Service in Gävleborg, and Uppsala University.

References

1. Genco R, Offenbacher S, Beck J. (2002) Periodontal disease and cardiovascular disease: epidemiology and possible mechanisms. J Am Dent Assoc 133:14–22.
2. Molgaard CA, Bartok A, Peddecord KM, Rothrock J. (1986) The association between cerebrovascular disease and smoking: a case-control study. Neuroepidemiology 5:88–94.
3. Reibel J. (2003) Tobacco and oral diseases, Update on the evidence, with recommendations. Med Princ Pract 12;1:22–32.
4. Sheiham A, Watt RG. (2000) The common risk factor approach: a rational basis for promoting oral health. Community Dent Oral Epidemiol 28:399–406.
5. Buhlin K, Gustafsson A, Hakansson J, Klinge B. (2002) Oral health and cardiovascular disease in Sweden. Periodontol 29:254–59.
6. Okoro CA, Balluz LS, Eke PI, Ajani UA, Strine TW, Town M, Mensah GA, Mokdad AH. (2005) Tooth loss and heart disease findings from the behavioral risk factor surveillance system. Am J Prev Med 29:50–6
7. Mattila KJ. (1993) Dental infections as a risk factor for acute myocardial infarction. Eur Heart J 51–3.
8. Beck JD, Offenbacher S, Williams R, Gibbs P, Garcia R. (1998) Periodontitis: a risk factor for coronary heart disease? Ann Periodontol 3:127–41.
9. DeStefano F, Anda RF, Kahn HS, Williamson DF, Russell CM. (1993) Dental disease and risk of coronary heart disease and mortality. Br Med J 306:688–91.
10. Mattila KJ, Valtonen VV, Nieminen M, Huttunen JK. (1995) Dental infection and the risk of new coronary events: prospective study of patients with documented coronary artery disease. Clin Infect Dis 20:588–92.
11. Gustavsson A, Asman B, Bergstrom K. (2000) Cigarette smoking as an aggravating factor in inflammatory tissuedestructive diseases. Increase in tumor necrosis factor-alpha priming of peripheral neutrophils measures as generation of oxygen radicals. Int J Clin Lab Res 30:187–90.
12. Bergstrom J, Eliasson S, Dock J. (2000) A 10-year prospective study of tobacco smoking and periodontal health. J Periodontol 71:1338–47.
13. Mooney J, Hodge PJ, Kinane DF. (2001) Humoral immune response in early-onset periodontitis: influense of smoking. J Periodont Res 36:227–32.

14. Joshipura KJ, Rimm EB, Douglass CW, (1996) Trichopoulos D, Ascherio A, Willett W C. Poor oral health and coronary heart disease. J Dent Res 75:1631–6.
15. Hujoel PP, Drangsholt M, Spiekerman C, DeRouen TA. (2002) Pre-existing cardiovascular disease and periodontitis: a follow-up study. J Dent Res 81:186–91.
16. The Swedish Council on Technology Assesment in Health Care. (2004) Chronic Periodontitis – Prevention, Diagnosis and Treatment, A Systematic Review. SBU Stockholm.
17. Taguchi A, Sanada M, Suei Y. (2004) Tooth loss is associated with an increased risk of hypertension in postmenopausal women. Hypertension 43:1297–300.
18. Statistical Analysis System version 6.12. (1996) SAS Institute Inc., Cary, NC.
19. Frensborg O. Public Dental Care in Gävleborg. (2003) A Public Opinion Survey 2003. Ipsos-Eureka AB, Stockholm.
20. Moderately elevated blood pressure. (1995) The Swedish Council on Technology Assessment in Health Care. J Intern Med suppl 737.
21. Sandvik E, Steine S. (1998) White coat hypertension in a general practice. Prevalence, cardiovascular risk factors and clinical implications. Scan J Prim Health Care 16:222–6.
22. MacDonald MB, Laing GP, Wilson MP, Wilson TW. (1999) Prevalence and predictors of white-coat response in patients with treated hypertension CMAJ 161:265–69.
23. Nichols C DDS. (1997) Dentistry and hypertension. JADA 128:1557–62.
24. Mancia G, Sega R, Milesi C, Cesana G, Zanchetti A. (1997) Blood–pressure control in the hypertensive population, The Lancet 349:454–57.
25. Welin L, Svardsudd K, Tibblin G. (1982) Home blood pressure measurements – feasibility and results compared to office measurements. The Study of Men Born in 1913. Acta Med Scand 211:275–79.
26. Van Dyke TE, Offenbacher S, Pihlstrom B, Putt MS, Trummel C. (1999) What is Gingivitis? Current understanding of prevention, treatment, measurement, pathogenesis and relation to periodontitis. J Int Acad Periodontol 1:3–15.
27. Firatli E. (1997) The relationship between clinical periodontal status and independent diabetes mellitus. Results after 5 years. J Periodontol 68:136–40.
28. Grossi SG, Skrepcinski FB, DeCaro T, Robertson DC, Ho AW, Dunford RG, Genco RJ. (1997) Treatment of periodontal disease in diabetics reduces glycated hemoglobin. J Periodontol 68:713–19.
29. Grossi SG, Skrepcinski FB, DeCaro T, Zambon JJ, Cummins D, Genco RJ. (1996) Response to periodontal therapy in diabetics and smokers. J Periodontol 67;1094–102.
30. Hugoson A, Ljungquist B, Breivik T. (2002) The relationship of some negative events and psychological factors to periodontal disease in an adult Swedish population 50 to 80 years of age. J Clin Periodontol 29:247–53.
31. Croucher R, Marcenes WS, Torres MC, Hughes F, Sheiham A. (1997) The relationship between life-events and periodontitis. J Clin Periodontol 24:39–43.
32. Axtelius B. (1999) Social, psychological and biological determinants in periodontal disease. PhD Thesis. Department of Periodontology, Faculty of Odontology Malmö University, Malmö.
33. Glick M. (2004) The new blood pressure guidelines: a digest. J Am Dent Assoc 135:585–6.
34. Greenwood M, Lowry RJ. (2002) Blood pressure measuring equipment in the dental surgery: use or ornament? Br Dent J 193:273–5.

Corresponding author:
Dr. Sevek Engström
Public Dental Health Service
Folktandvården
Lasarettsleden 4
811 89 Sandviken
Sweden
E-mail: sevek.engstrom@lg.se