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A case–control study to investigate an association between adverse pregnancy outcome and periodontal disease

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Abstract

Objectives: The aim of this case–control study was to ascertain if women who experienced a preterm (or premature) birth had any differences in periodontal disease severity compared with women who delivered at term.

Material and Methods: Subjects were recruited postpartum. Case subjects delivered a baby before 37 weeks of gestation whereas control subjects gave birth at or around term. A questionnaire was administered by a Research Midwife, designed to collect demographic information, pregnancy outcome variables and information on other factors which may influence health in pregnancy. A periodontal examination was then performed at the bedside.

Results: Demographic variables were similar between case and control subjects. There was a higher proportion of case subjects who reported smoking. There were no differences in oral hygiene, bleeding on probing or loss of attachment; however, control subjects had a higher proportion of periodontal pockets probing 5 mm or greater.

Conclusions: There was no association between the severity of periodontal disease and pregnancy outcome in this population.

Key words: periodontal disease; pregnancy; preterm birth

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There is interest in a hypothesis that periodontal disease during pregnancy is associated with a higher incidence of adverse pregnancy outcome. A case–control study (Offenbacher et al. 1996) and more recently several prospective studies (Jeffcoat et al. 2001, Lopez et al. 2002) have found that preterm birth is associated with poorer periodontal health in populations from North and South America. It is proposed that periodontal disease in pregnancy is a source of chronic infection which has the potential to have a deleterious effect on the mother and fetus leading to an early delivery (Offenbacher et al. 1996).

However, two studies from the UK have failed to find such associations between maternal periodontal disease and poor obstetric outcome. Davenport et al. (2002) performed a case–control study on a population delivering at the Royal London Hospital, Whitechapel, UK. They found no differences in the levels of periodontal disease between mothers who delivered at term and those who delivered before 37 weeks gestation. Our research group (Moore et al. 2004) performed a large-scale prospective study on 3738 subjects and found no association between periodontal health at 12 weeks of pregnancy and the incidence of preterm birth. Over 60% of this population were of white ethnic origin with a wide range of socioeconomic backgrounds and a level of periodontal disease consistent with that for the UK when compared with the Adult Dental Health Survey, 1998 (Kelly et al. 2000).

A limitation of our prospective study was that recruitment was performed at the end of the first trimester on attendance to an ultrasound scan. Poor antenatal care is a known risk factor for adverse pregnancy outcome (Harbert 1994) and we were concerned that we were not recruiting a subset of subjects who did not attend this early antenatal visit and were potentially at higher risk of adverse pregnancy outcome. A case–control study was therefore performed in the same hospital setting with the objective of attempting to recruit all

women who experienced a preterm birth within a given period, regardless of whether they attended the early ultrasound scan or not.

Material and Methods

This study was approved by the Guy's and St Thomas' Hospital Trust Local Ethical Committee. Subjects were recruited from obstetric wards, Guy's site, Guy's and St Thomas' Hospital Trust, within 5 days postpartum. Subjects were identified by a Research Midwife from the departmental delivery book and from patients' notes.

Subjects were divided into case and control groups on the basis of their pregnancy outcome. Case subjects had experienced a preterm birth (at less than 37 weeks gestation), as a result of either spontaneous premature rupture of membranes or preterm labour. This included preterm caesarean delivery as a result of preterm labour or premature rupture of membranes. Control subjects experienced uncomplicated term vaginal delivery or elective caesarean.

Exclusion criteria included multiple births, any medical history that would require the administration of prophylactic antibiotics in order to carry out a periodontal examination, other caesarean deliveries or cases where pregnancy induced hypertension or gestational diabetes were complicating factors.

Each subject chosen was invited to take part and informed consent was obtained. The Research Midwife administered a questionnaire designed to collect demographic, medical and obstetric risk factors and details about the current pregnancy outcome. Socioeconomic status was classified according to the Standard Occupational Classification of the Office of Population Censuses and Surveys (1990, 1991 and 1995). The periodontal examination was performed by S. M. at the bedside. To ensure that the examiner was blind, if the infant was with the mother (as with most control subjects), it was taken to another area in advance and cared for by the Research Midwife.

The periodontal examination was performed with the woman supine on a hospital bed. A light source was provided by a fibre optic light system (Universal Dual Quartz Halogen, Keeler Ltd, Windsor, UK) with autoclavable light source tips (constructed at Scientific Workshops, Guy's and St Thomas' Hospital Trust) and mirror heads (Mirodent disposable mouth mirrors, Guest Dental and Medical Products, Montefiori, Switzerland). A Hu-Friedy PQW manual periodontal probe (Hu-Friedy, Chicago, IL, USA) with a tip diameter of 0.45 mm and millimetre markings, was used. Missing and partially erupted teeth were noted and the latter excluded from the periodontal assessment. Each tooth was examined at two sites: for maxillary teeth midbuccal and mesiobuccal sites were assessed; for mandibular teeth midlingual and mesiolingual sites were examined. The clinical parameters measured were: absence or presence of plaque, pocket probing depth (in mm), loss of periodontal attachment (in mm), bleeding on probing.

After the questionnaire and examination, each subject was informed of any periodontal problems that had been detected, although it was stressed that this was not a full dental examination. Subjects were advised to visit their general dental practitioner on a regular basis. Each subject was given an oral hygiene pack (courtesy of Colgate–Palmolive, Guildford, UK).

Statistical methods

The data for each subject were coded and input onto a database for statistical analysis using Statistical Package for Social Sciences for Unix (SPSS) and, after data had been reformatted, Stata 7 for PC (Stata Corporation, College Station, TX, USA). Socioeconomic status was recalculated as the highest socioeconomic group of either the mother or her partner (if the data were available). For the analyses, socioeconomic groups were combined: groups 1 and 2; 3, 4 and 5; and all other groups (including unemployed, student, housewife/husband, missing). Basic frequencies were generated for each categorical variable and exact χ^2 tests were used where appropriate. The only continuous variable that approximated to a normal distribution was that of maternal age at delivery (''age''), for which means, standard deviations and *t*-tests were used in the analyses. Other continuous variables were investigated by comparing medians and interquartile ranges (IQRs), using Mann–Whitney *U* (MWU) tests. The demographic characteristics of the case–control study were compared with that of our prospective study where a similar questionnaire was administered.

Results

One hundred and fifty-four subjects were recruited to this study, 93 of whom were in the control group and 61 were case subjects. Of subjects who were approached by the Research Midwife to participate in the study, five (7.6%) potential case subjects refused consent. Approximately 90% of potential control subjects consented to participate in the study.

By definition, the case subjects exhibited a lower gestational age (of approximately 32 weeks 4 days) and lower birth weight than the control group, as shown in Table 1. There were no statistically significant differences in the mean age, proportion of subjects from each of the three main ethnic and socioeconomic groups, and proportion of primigravida subjects. However, among the case subjects there was a higher proportion of smokers, during and prior to pregnancy. There was no difference in the proportion of women experiencing a urinary tract infection in both groups, although the case subjects had a higher proportion of those who had taken antibiotics during pregnancy and a shorter time lapsed since taking the last course of antibiotics.

Table 2 demonstrates that the case subjects tended to have a lower mean probing depth and a lower mean proportion of sites probing 4 mm or greater than the control subjects, but both failed to reach statistical significance ($p = 0.100$ and 0.074, respectively). The proportion of sites probing 5 mm or greater was lower in the case subjects (2% versus 4% of sites in control subjects) and this was statistically significant ($p = 0.016$). All other periodontal variables were similar between the two groups. There were no statistical differences in the periodontal health between the 58 subjects who took antibiotics during pregnancy and the 96 subjects who did not. For example, the median whole-mouth probing depth for the subjects who took antibiotics was 2.28 versus 2.23 mm for those who did not take antibiotics during pregnancy ($p = 0.616$ by MWU).

The demographic characteristics of the prospective and case–control study populations are summarised by Table 3. There was no statistically significant difference between the mean age of the prospective study subjects and the case–controls. However, there were differences in the proportions of main ethnic and socioeconomic groups between the

Table 1. Demographic and pregnancy variables between control and case subjects

	Control subjects, $n = 93$	Case subjects, $n = 61$	p value
Age, years, mean (SD)	29.2 (6.1)	28.8 (6.5)	0.731*
Ethnicity, *n* (%)			
White	42 (45.2)	31 (50.8)	0.763
Black	41 (44.1)	25 (41.0)	
other	10 (10.7)	5 (8.2)	
Socioeconomic group, *n* (%)			
I/II	40 (43.0)	19 (31.1)	0.336
III/IV/V	35 (37.6)	28 (45.9)	
others	18 (19.4)	14 (23.0)	
Smokers in pregnancy, *n* (%)	16 (17.2)	24 (39.3)	0.002
Smokers before pregnancy, *n* (%)	23 (26.4)	32 (56.1)	<0.001
First pregnancy, *n* (%)	36 (38.7)	23 (37.7)	0.519
Urinary tract infection in pregnancy, *n* (%)	17 (18.3)	14 (23.0)	0.306
Antibiotics in pregnancy, *n* (%)	26 (28.0)	32 (52.5)	0.002
Time since last course of antibiotics, months, median (IQR)	11.0 (1.5–2.4)	3.0 (0.3–12.0)	0.020†
Gestational age, days, median (IQR)	280 (274–286)	228 (198–241)	<0.001†
Birth weight, g, median (IQR)	3374 (3118–3780)	1980 (1170–2210)	<0.001†

IQR, interquartile range.
p values by exact χ^2 test except
*t-test, †Mann–Whitney U-test.

Table 2. Periodontal variables compared between control and case subjects)

	Control subjects, $n = 93$	Case subjects, $n = 61$	p value
Number of teeth, median (IQR)	28 (27–30)	28 (26–29)	0.146
Proportion of sites with plaque, %, median (IQR)	67 (48–84)	71 (46–81)	0.786
Mean PD, mm/site, median (IQR)	2.27 (2.02–2.52)	2.20 (1.88–2.46)	0.100
Mean LA, mm/site, median (IQR)	0.43 (0.23–0.58)	0.36 (0.21–0.55)	0.659
Proportion of sites bleeding on probing, %, median (IQR)	20 (9–29)	19 (8–36)	0.708
Proportion of sites PD $\geqslant$4 mm, %, median (IQR)	11 (5–17)	8 (2–14)	0.074
Proportion of sites PD $\geqslant$5 mm, %, median (IQR)	4 (0–7)	2 (0–5)	0.016
Proportion of sites LA $\geqslant$2 mm, %, median (IQR)	7 (2–13)	5 (2–13)	0.533
Proportion of sites LA $\geqslant$3 mm, %, median (IQR)	2 (0–4)	2 (0–6)	0.951

p value by Mann–Whitney U-test. PD, probing depth; LA, loss of attachment; IQR, interquartile range.

Table 3. Demographic variables between the prospective study subjects and the case–control subjects

	Prospective study subjects, $n = 3738$	Case–control subjects, $n = 154$	p value
Age, years, mean (SD)	29.9 (5.5)	29.1 (6.3)	0.074*
Ethnicity, *n* (%)			
White	2330 (62.3)	73 (47.4)	<0.001
Black	1055 (28.2)	66 (42.9)	
other	353 (9.5)	15 (9.7)	
Socioeconomic group, *n* (%)			
I/II	1994 (53.3)	59 (38.3)	<0.001
III/IV/V	1422 (38.0)	63 (40.9)	
others	322 (8.6)	32 (20.8)	
Smokers in pregnancy, *n* (%)	543 (14.5)	40 (26.0)	<0.001
First pregnancy, *n* (%)	1747 (46.7)	59 (38.3)	0.024

p values by exact χ^2 test except
*t-test.

two study populations: increased proportions of White subjects and those belonging to socioeconomic groups I and II were present in the prospective study. There were more smokers during pregnancy in the case–control group along with a lower percentage of those in their first pregnancy.

Discussion

The results of this study demonstrate that the main demographic variables of age, ethnicity and socioeconomic status were similar between case and control subjects but that there were more smokers both prior to and during pregnancy in the case group. Smoking has been shown to be an important risk factor in regard to adverse pregnancy outcome especially low birth weight (Brooke et al. 1989, Wilcox et al. 1995). The prevalence of smoking in the case subjects under observation here (39%) was higher than the figure of 27% which was reported for pregnant women in the UK in 1997 (Owen et al. 1998).

There was no difference between case and control subjects in the rate of urinary tract infection during pregnancy in the current study. The reported incidence of urinary tract infection in the USA case–control study (Offenbacher et al. 1996) was slightly higher than in our case–control study (25% versus 20%). In the work presented here, although there was no difference in the rate of urinary tract infection between cases and controls, a higher proportion of case than control subjects took antibiotics during pregnancy, with a lower average time since the last course taken before delivery. Approximately

half of the subjects who took antibiotics in pregnancy received a course of antibiotics within 1 month of parturition. This may have been as a result of antibiotics given to prevent ascending infection (Mercer et al. 1997) at the time of birth. The discrepancy between the rate of antibiotic usage during pregnancy between case and control subjects had the potential to have an effect on the periodontal health of these subjects (Rooney et al. 2002). However, analysis demonstrated that there were no differences in the periodontal health between those in this study who took antibiotics during pregnancy and those who did not.

Previous investigations of periodontal disease and adverse pregnancy outcome (Offenbacher et al. 1996, Jeffcoat et al. 2001, Davenport et al. 2002, Lopez et al. 2002) studied different populations compared with that within this study. Both the USA studies (Offenbacher et al. 1996, Jeffcoat et al. 2001) involved subjects who were younger and had a higher proportion of subjects from Black ethnic groups (approximately 60% for Offenbacher's population and 82% for Jeffcoat's population versus 43% for the study presented here). It was also stated that these populations were generally of a low socioeconomic status. Davenport's case–control population, from the catchment area of the Royal London Hospital, Whitechapel, UK, were primarily (54%) Bangladeshi in origin and of lower socioeconomic status than our study population (Davenport et al. 2002).

There were also differences between periodontal disease levels in the study presented here compared with previously reported studies. In this study, the mean probing depth was 2.23 mm. This was lower than the mean probing depths seen in Offenbacher's case–control study in which the group with the healthiest periodontal status (the primiparous controls with a ''normal'' pregnancy outcome) had a mean probing depth of 2.87 mm. Offenbacher's case (preterm and low birth weight) group had a mean probing depth of 3.17 mm. Only one subject in the study presented here (a case subject) had over 60% of sites with 3 mm or more loss of attachment, the Extent 3:60 criterion described by Offenbacher et al. (1996) as a predictor of poor obstetric outcome. The periodontal disease status of the subjects from Alabama USA (Jeffcoat et al. 2001) was also more severe than in this UK population. Only 1.9% of our population had loss of attachment of 3 mm or more in 25% or more sites, whereas one-third of the Alabama subjects had this level of disease. It has been reported that there is a high incidence of early-onset periodontitis among African-Americans in certain regions of USA (Oliver et al. 1998) and this may explain, in part, the higher prevalence of periodontal disease in the North Carolina and Alabama studies. Davenport et al. (2002) also gave some indication of the level of periodontal disease in their population: the control subjects had a mean probing depth of 3.85 mm and the case subjects had a mean probing depth of 3.72 mm. Again the levels of periodontal disease in the study presented here were lower than in the previous UK case–control study.

The latest study to be reported is from Chile (Lopez et al. 2002). This prospective (and intervention) study presented results for 351 subjects aged 18–35 years. This population had a lower proportion of subjects in their first pregnancy (approximately 25% versus 38% for this UK population). The baseline mean probing depth and mean loss of attachment were both higher than for this study (2.71–2.94 versus 2.23 mm; 1.75–1.86 versus 0.39 mm). Lopez found an association between preterm low birth weight birth and poorer periodontal health but again the population varied both in terms of demographic factors and periodontal health compared with this UK population.

In contrast to the previous studies from North and South America, we have seen no evidence of any association between poor periodontal health and preterm birth. There were no statistically significant differences between the case and control subjects in the variables of plaque score, bleeding score, mean probing depth and mean loss of attachment. However, the case subjects had a lower proportion of sites with deep periodontal pockets. Although this difference was statistically significant, it may not have been clinically significant.

The study presented here used a method of partial mouth recording of periodontal variables, despite reports that the use of a partial mouth recording method can result in the underestimation of the level of disease (Agerholm & Ashley 1996). However, it was imperative to keep the examination time and potential discomfort to a minimum for the subjects to maximise recruitment and therefore the power of the study. In addition, the full-mouth mesiobuccal–buccal measuring technique has been shown to be an effective way of determining the prevalence of periodontal disease compared with some other partial recording protocols (Kingman & Albandar 2002).

One of the reasons for performing this case–control study was the concern that, because of the design of our prospective study, potentially those who were at the highest risk of having an adverse pregnancy outcome would not be recruited. It was therefore important to compare the demographic characteristics of the case–control subjects with those in the prospective study. There was a higher proportion of case–control subjects from Black ethnic and lower socioeconomic groups. There were also more smokers, but less primigravida women, among the case–control subjects. These data highlight differences in the populations between the two studies and therefore the potential for selection bias in studies which recruit women early in pregnancy.

Conclusions

This case–control study has found no association between periodontal disease and preterm birth. However, this population did vary from previously reported case–control populations, in both demographic factors and in the severity of periodontal disease.

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