Periodontal Disease is Not Associated With Preeclampsia in Canadian Pregnant Women

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Abstract

Background—The findings from the studies on the relationship between periodontal disease and preeclampsia are inconsistent. The objective of this study is to examine the relationship between periodontal disease and preeclampsia.

Methods—A multicenter case-control study was conducted in Quebec, Canada. Preeclampsia was defined as blood pressure $\geq 140/90$ mm Hg and $\geq 1+$ proteinuria after 20 weeks of gestation. Periodontitis was defined as the presence of ≥ 4 sites with a probing depth ≥ 5 mm and a clinical attachment loss ≥ 3 mm at the same sites.

Results—A total of 92 preeclamptic women and 245 controls were analyzed. The percentage of periodontal disease was 18.5% in preeclamptic women and 19.2% in normotensive women (crude odds ratio [OR] = 0.96, 95% confidence interval [CI] = 0.52 to 1.77). After adjusting for confounding variables, periodontitis remained not associated with preeclampsia (adjusted OR = 1.13, 95% CI = 0.59 to 2.17).

Conclusion—This study does not support the hypothesis of an association between periodontal disease and preeclampsia.

Keywords

Periodontitis; preeclampsia; pregnancy; pregnancy complications

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Preeclampsia is a common pregnancy complication, affecting 7% to 10% of pregnant women, and remains one of the two leading causes of maternal mortality worldwide.^{1,2} Although its etiology and pathophysiologic mechanism are still elusive, an excessive systemic inflammatory response during pregnancy may present an etiologic pathway to the development of preeclampsia.³ A link between preeclampsia and inflammation was demonstrated in previous studies.^{1,4-6} Periodontal disease is one of the most common chronic disorders of infectious origin known in humans and includes mainly gingivitis and periodontitis. Periodontitis, which affects the gingival soft tissues and bone supporting the teeth, is characterized by gingival inflammation, attachment loss (AL), and pocket formation.⁷ Periodontal disease can affect from 10% to 90% of adults worldwide^{7,8} and affects $\approx$ 20% to 50% of pregnant women.⁹⁻¹¹ Periodontal disease is initiated by overgrowth of specific Gram-negative anaerobic species, growing in subgingival sites. The host response to periodontal pathogens causes persistent inflammation and destruction of periodontal tissues that support the teeth.¹² Oral mechanical manipulations (e.g., toothbrushing, dental procedures, and even routine mastication) can cause bacteremia, and chronic periodontal infections can produce local and systemic host responses. The reported studies on the association between periodontal disease and preeclampsia showed inconsistent results.^{10,11,13,14} We hypothesized that periodontal disease, as a source of subclinical and persistent infection, induces systemic inflammatory responses that may increase the risk of preeclampsia. The objective of this study is to examine whether there is an association between maternal periodontal disease and preeclampsia in a Canadian population.

MATERIALS AND METHODS

Study Population

This case-control study was conducted at four hospitals in Quebec, Canada: Sainte-Justine Hospital and Jewish General Hospital in Montreal and Saint-François D'Assise Hospital and Saint-Sacrement Hospital in Quebec City. Women with preeclampsia (cases) and women without preeclampsia (controls) were recruited by obstetric nurses within 48 hours after delivery. A total of 92 cases of preeclamptic women and 245 controls were recruited from January 2003 to March 2006. Briefly, women were screened for their eligibility to participate in the study 48 hours postpartum. Women who were: 1) 18 years of age; 2) nulliparous; and 3) spoke either French or English were eligible for enrollment.¹⁴ Women were excluded from the study if they: 1) were multiparous; 2) had 20 teeth; 3) had chronic hypertension or hypertension before 20 weeks of gestation; 4) had gestational hypertension (without proteinuria); 5) had pregestational diabetes; 6) had heart disorders; 7) had history of fenfluramine-phentermine use; or 8) had human immunodeficiency virus-positive serology. Women were diagnosed with preeclampsia if they had blood pressure $\geq$ 140/90 mm Hg on two occasions $\geq$ 4 hours apart after 20 weeks of gestation, and 0.3 g proteinuria on a 24-hour urine collection, or $\geq$ 1 on a dipstick. Eligible women were asked to complete a questionnaire and provide written informed consent to participate in the study. This study was approved by the Ethics Committee of the University of Montreal, Montreal, Quebec, Canada; McGill University, Montreal, Quebec, Canada; and Laval University, Quebec, Quebec, Canada. This

study was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2000.

Oral Clinical Examination

Recruited women were scheduled to have an oral examination within 48 hours after delivery at the hospitals. Dental examinations were performed by certified dental hygienists (Christiane Maltais and Carole Collin, Faculty of Dental Medicine, Laval University, Quebec City; Francine Beaulieu, Sainte-Justine Hospital, Montreal; and Joanne Silverman, Jewish Hospital, Montreal). All data were collected on odontograms in the chart. Before the start of patient recruitment, the dental hygienists were trained and calibrated for measurements of the clinical parameters of periodontal disease by two periodontists (RV and GG). Interexaminer and intraexaminer reliability assessed by weighted κ scores was 85%. Intraclass correlation coefficients were 0.90. The dental hygienists and obstetricians were masked on the preeclamptic and periodontal status, respectively.

The clinical parameters of periodontal conditions, including probing depth (PD), gingival recession, clinical AL, and bleeding on probing (BOP) were measured for all patients. PD is defined as the distance in millimeters from the gingival margin to the tip of the periodontal probe during probing. Measurements were taken at six sites per tooth using a periodontal probe.[#] Gingival recession was determined by measuring the distance from the cemento-enamel junction to the gingival margin in millimeters. The clinical AL is the distance in millimeters from the cemento-enamel junction to the tip of the periodontal probe during probing. In the present study, periodontitis is defined as 4 sites exhibiting PD $\geq$ 5 mm and clinical AL $\geq$ 3 mm at the same sites.

In addition to dental examination, other information on socio-demographic, health behavior, medical data history, and oral hygiene habits was obtained from an interview of the participants before the dental examination. Information on outcomes of the pregnancy, labor and delivery, and health of the newborn was collected from a postpartum review of the hospital medical records by an obstetric nurse.

Statistical Analysis

Bivariable analysis was performed to compare the different periodontal disease measurements, as well as the characteristics of the study population between cases and controls. χ^2 tests were used to examine differences in proportions (e.g., periodontitis), and t tests were used to examine differences in means (e.g., number of teeth). χ^2 tests for linear trend were used to examine the relationship between periodontal disease severity measured in quartiles of PD and clinical AL with preeclampsia. Multivariable unconditional logistic regression was used to examine the association between periodontal disease and preeclampsia. This model was adjusted for maternal race, age, smoking, drinking alcohol, previous history of abortion, multiple pregnancies, time elapsed since last dental visit, and having dental insurance coverage. The adjusted odds ratio (OR) and its 95% confidence interval (CI) were derived from the coefficients of the logistic models and the standard

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errors. Using the lowest quartile of PD or clinical AL as reference, a dose–response relationship was analyzed to examine whether adjusted ORs (95% CIs) of preeclampsia increased with increasing quartiles of PD and clinical AL, respectively. Data were analyzed using statistical software.^{**} Statistical analysis was done using the Co-chran-Mantel-Haenszel test based on table scores to assess the effect of centers. This analysis showed that it was not necessary to adjust the logistic regression model by centers.

RESULTS

Table 1 reveals no significant differences in maternal age, race/ethnicity, socio-economic status, smoking, oral hygiene, and health comorbidities between the two groups. The proportion of alcohol consumption during pregnancy was significantly lower in preeclamptic patients. There were no differences between the case and control groups in terms of time elapsed since last dental visit, frequency of toothbrushing, frequency of gingival bleeding, and having dental insurance coverage. Preeclamptic women were more likely to give birth by cesarean section (63%) than normotensive women (29%). The frequency of preterm birth was markedly higher in preeclamptic women (70.7%) than in normotensive women (15.2%). The frequency of low birth weight was higher in preeclamptic women (63.9%) than in normotensive women (8.4%).

Table 2 presents the clinical periodontal parameters in preeclamptic and normotensive women. In general, there was no statistically significant difference in the clinical periodontal measures between cases and controls. The prevalence of periodontal disease was 18.5% in the preeclamptic women and 19.2% in the control group. No significant dose–response relationship was noted with increasing quartiles of PD and clinical AL (Table 2). The percentage of patients exhibiting 20% of BOP sites was higher in the preeclamptic patients (53.3%) than those in the normotensive women (41.6%) ($P<0.05$). In a crude (OR = 0.96, 95% CI = 0.52 to 1.77) and multivariable (adjusted OR = 1.13, 95% CI = 0.59 to 2.17) logistic model, no significant association was found between periodontal disease and preeclampsia.

The variations among centers were not considered because we did not find evidence of heterogeneity across centers. The potential relationship between preeclampsia and periodontitis was the same among centers. The dental examinations were performed by trained and calibrated dental hygienists and the diagnosis of preeclampsia was made by obstetricians in each hospital according to the definition. Of the 337 participants, Saint-François-D'Assise Hospital contributed 23, Sainte-Justine Hospital contributed 248, Saint-Sacrement Hospital contributed 9, and Jewish General Hospital contributed 57.

DISCUSSION

Periodontal disease has been reported to be associated with the development of certain adverse pregnancy outcomes, such as low birth weight, preterm birth, and preeclampsia.^{10,11,15} It was hypothesized^{10,11} that women with periodontal disease during pregnancy may

^{**}SAS version 9.1, SAS Institute, Research Triangle Park, NC.

have transient translocation of oral bacteria¹⁶ to the maternal and fetal blood circulation, leading to placental inflammation¹⁷ or increased oxidative stress early in pregnancy, which may cause placental abnormalities and clinical manifestations of preeclampsia. Results of Barak et al.¹⁶ indicated that bacterial counts were significantly higher in preeclamptic women for all periopathogenic bacteria ($P < 0.0055$). However, in this multicenter case-control study, we did not observe an association between periodontal disease and preeclampsia.

Several observational studies (e.g., case-control or cohort studies) have reported that periodontal disease is positively associated with preeclampsia (with ORs ranging from 1.88 to 7.9).^{18–25} Boggess et al.²⁵ first reported that periodontal disease may be associated with an increased risk of preeclampsia (OR = 2.4, 95% CI = 1.1 to 5.3). Canacki et al.¹⁸ demonstrated that preeclamptic women had worse periodontal health than normotensive women (OR = 3.5, 95% CI = 1.1 to 11.9). However, other studies found no association between these two disorders,^{6,26–29} including three clinical trials.^{30–32} The pooled relative risk from two trials was 1.11 (95% CI = 0.70 to 1.76, $P > 0.05$), indicating that periodontal treatment during pregnancy does not significantly reduce the rate of preeclampsia.^{30,31} In fact, a review of the literature confirmed that it is not clear whether periodontal disease plays a causal role in adverse pregnancy outcomes, including pre-eclampsia.³³ In addition, the validity of inflammatory markers, including C-reactive protein, as indicators of potential preeclampsia attributable to periodontal disease reveals deficiencies because they include several systemic inflammatory conditions.³⁴ Furthermore, contradictory results, such as a more prevalent presence of periopathogenic *Campylobacter rectus* in the control group ($P = 0.047$), indicate that periopathogenic bacteria may not be an appropriate indicator of periodontitis in pregnant women.²⁴ In the present study, we compare different periodontal disease measurements between preeclamptic women and normotensive controls and find that periodontal disease is not associated with preeclampsia.

Several factors may contribute to the conflicting results among the studies. First, there is great variation in the definition of periodontal disease among the published studies. Because there are no universally accepted criteria for periodontal disease diagnosis, researchers use their own case definitions (generally based on disease distribution within the study population) that combine PD and clinical AL.^{10,11,35} Selecting different criteria to define periodontal disease may lead to a selection bias that may alter the conclusions.³⁵ In the present study, we use a more objective approach to assess periodontal disease in association with preeclampsia. We categorized each participant according to quartiles determined by the distribution of PD and clinical AL in controls to assess whether the risk of preeclampsia increases with increased severity of periodontal disease (dose–response relation). In addition, to further ensure the presence of periodontal disease among cases and controls, only women with >20 teeth are included. Using this methodology, we did not find any difference in the prevalence of periodontal disease between cases and controls.

Second, in studies that reported an association between periodontal disease and preeclampsia, questions remain whether the observed associations represent a causal relationship or are attributable to the confounding effects of other variables. Several variables were not controlled in previously published studies, including previous history of

preeclampsia,¹⁵ oral hygiene habits,¹⁵ smoking,^{15,25} and socio-economic status.²⁵ In our study, multivariable regression analysis was performed to adjust for these potential confounding variables. We did not find an association between periodontal disease and preeclampsia before and after the adjustment. Furthermore, because the risk for preeclampsia varies in primiparous and multiparous women, only nulliparous cases and controls were included.¹⁴

Third, the effect of periodontal disease on preeclampsia may vary according to the targeted populations. Our population study included a large proportion of white women: 84% in the preeclamptic group and 85% in the normotensive group. In our systematic review of the literature on the relationship between periodontal disease and adverse pregnancy outcomes, differences in outcome were found in studies conducted in the United States or in developing countries compared with those conducted in European countries or Canada.^{10,11} The former tended to include African Americans and women from economically disadvantaged families, and these studies consistently reported significant associations between periodontal disease and adverse pregnancy outcomes. In contrast, the studies conducted in European countries or Canada (all of which offer their citizens universal health care) did not find a similar association.^{10,11} This suggests that the effects of periodontal disease on adverse pregnancy outcomes may be different according to the socio-economic status and access to dental care resources. In summary, although there is a biologic plausibility for a link between these two disorders, our study failed to reveal an association between them.

CONCLUSION

Periodontal disease is not associated with preeclampsia in this sample of Canadian pregnant women.

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Table 1

Demographic, Lifestyle, Oral Health, and Obstetric Characteristics of Preeclamptic and Normotensive Women

Characteristics*	Preeclamptic (n = 92) (%)	Normotensive (n = 245) (%)	P Value
Maternal age (years)			0.55
18 to 25	28 (30.4)	60 (24.5)	
26 to 33	47 (51.1)	140 (57.1)	
34 to 41	17 (18.5)	42 (17.1)	
>41	0	3 (1.2)	
Race/Ethnicity			0.97
White	72 (83.7)	203 (84.6)	
Black	5 (5.8)	11 (4.6)	
Asian	2 (2.3)	8 (3.3)	
Hispanic	4 (4.7)	10 (4.2)	
Other	3 (3.5)	8 (3.3)	
Annual household income [†]			0.25
<\$20,000	9 (10.2)	18 (7.8)	
\$20,000 to \$34,999	13 (14.8)	28 (12.2)	
\$35,000 to \$49,999	11 (12.5)	29 (12.6)	
\$50,000 to \$74,999	20 (22.7)	30 (13.0)	
>\$75,000	28 (31.8)	104 (45.2)	
Refuse to answer	7 (8.0)	21 (9.2)	
Smoking during pregnancy			0.59
Yes	10 (10.9)	32 (13.1)	
No	82 (89.1)	213 (86.9)	
Alcohol consumption in pregnancy			0.0003 [‡]
Yes	12 (13.0)	80 (32.7)	
No	80 (87.0)	165 (67.3)	
Last dental visit (months)			0.24
6	27 (30.3)	92 (38.0)	
7 to 12	29 (32.6)	82 (33.9)	
13 to 24	18 (20.2)	45 (18.6)	
>24	15 (16.9)	23 (9.5)	
Frequency of brushing			0.77
Two or more times a day	77 (84.6)	199 (81.2)	
Once a day	13 (14.3)	43 (17.6)	
Sometimes per week	1 (1.1)	3 (1.2)	
Bleeding gingiva during pregnancy			0.96
Always	15 (16.5)	37 (15.1)	

Characteristics*	Preeclamptic (n = 92) (%)	Normotensive (n = 245) (%)	P Value
Often	23 (25.3)	64 (26.1)	
Occasionally	39 (42.8)	101 (41.2)	
Never	14 (15.4)	43 (17.6)	
Dental insurance during pregnancy			0.12
Yes	39 (45.9)	85 (36.2)	
No	46 (54.1)	150 (63.8)	
Multiple births			0.07
Yes	6 (6.5)	6 (2.5)	
No	86 (93.5)	239 (97.5)	
History of induced abortions [§]			0.03
Yes	11 (12.0)	56 (22.9)	
No	81 (88.0)	189 (77.1)	
Mode of delivery			0.000
Vaginal	34 (37.0)	174 (71.0)	
Cesarean section	58 (63.0)	71 (29.0)	
Gestational age (weeks)			0.000
28	7 (7.6)	3 (1.2)	
29 to 32	25 (27.5)	9 (3.7)	
33 to 36	33 (36.3)	25 (10.4)	
37	26 (28.6)	204 (84.7)	
Birth weight (g) ^{//}			0.000
<2,500	53 (63.9)	20 (8.4)	
2,500 to 3,000	11 (13.2)	49 (20.6)	
>3,000	19 (22.9)	169 (71.0)	

* Excluding cases with missing information.

[†] There were four preeclamptic women and 15 normotensive women without information of income. Percentages were calculated based on 88 preeclamptic women and 230 normotensive women.

[‡] $P < 0.05$, χ^2 test.

[§] Nulliparous.

^{//} There were nine cases of preeclampsia without information of birth weight. Percentages were calculated based on 83 preeclamptic women.

Table 2

Clinical Periodontal Parameters in Preeclamptic (cases) and Normotensive (controls) Women

Periodontal Measures	Cases (n = 92)	Controls (n = 245)	Crude OR (95% CI)	Adjusted OR (95% CI)
Periodontal disease (%)				
No	75 (81.5)	198 (80.8)	NA	NA
Yes	17 (18.5)	47 (19.2)	0.96 (0.52 to 1.77)	1.13 (0.59 to 2.17)
Quartile of mean PD (%)				
25%	28 (30.4)	57 (23.3)	NA	NA
>25% to 50%	15 (16.3)	70 (28.5)	0.44 (0.21 to 0.89)*	0.39 (0.18 to 0.84)*
>50% to 75%	26 (28.3)	58 (23.7)	0.91 (0.48 to 1.74)	0.84 (0.42 to 1.67)
>75% to 100%	23 (25.0)	60 (24.5)	0.78 (0.40 to 1.51)	0.83 (0.42 to 1.66)
Quartile of mean clinical AL (%)				
25%	32 (34.8)	60 (24.5)	NA	NA
>25% to 50%	20 (21.7)	61 (24.9)	0.62 (0.32 to 1.19)	0.45 (0.22 to 0.93)*
>50% to 75%	17 (18.5)	64 (26.1)	0.50 (0.25 to 0.99)*	0.52 (0.25 to 1.06)
>75% to 100%	23 (25.0)	60 (24.5)	0.72 (0.38 to 1.37)	0.75 (0.38 to 1.46)
Mean (SD) number of teeth	27.41 (1.17)	27.35 (1.29)	NA	NA
20% of sites with BOP (%)				
No	43 (46.7)	143 (58.4)	NA	NA
Yes	49 (53.3)	102 (41.6)	0.63 (0.39 to 1.01)	1.57 (0.94 to 2.62)

* $P < 0.05$.

NA = not applicable.