

Original Research

Epidemiology of Periodontitis in Pregnancy and its Impact on Pregnancy Outcomes following Basic Periodontal Treatment: A Prospective Cohort Study

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Abstract

Background: This study aimed to investigate the detection of periodontal indicators in pregnant women with periodontal disease and its impact on pregnancy outcomes. Our goal is to provide guidance for the clinical diagnosis and outcome prognosis evaluation for pregnant patients. **Methods:** From August 2020 to February 2021, we conducted a study to investigate the detection of periodontal indicators in pregnant women with periodontal disease and its impact on pregnancy outcomes. A total of 84 pregnant women with periodontal disease were selected as the experimental group, while 86 pregnant women with normal periodontal health during pregnancy were selected as the control group. The general data of the women in both groups postpartum were similar. We measured the volume of gingival crevicular fluid (GCF) obtained and determined the concentration of interleukin-1 beta (IL-1 β) in the GCF. This research aimed to provide guidance for clinical diagnosis and pregnancy outcome prognosis. **Results:** The experimental group exhibited significantly higher levels of periodontal indicators such as the Simplified Oral Hygiene Index (sulcus bleeding index, SBI), probing depth (PD), and Oral Hygiene Index-Simplified (OHI-S) compared to the control group. Conversely, the clinical attachment levels (CAL) in the experimental group were significantly lower than those in the control group. Additionally, the IL-1 β levels and GCF levels in the experimental group were significantly higher than those in the control group. Furthermore, the incidence of adverse pregnancy outcomes in the experimental group was 2 patients (2.38%), which was significantly lower compared to the control group where it was 13 (15.11%). The adverse pregnancy outcomes included amniotic fluid contamination, premature delivery, and low body weight. **Conclusions:** We observed that periodontal indicators, including OHI-S, CAL, SBI, and PD, were significantly elevated in pregnant women with periodontal disease. Additionally, we found that IL-1 β levels had a substantial influence on pregnancy outcomes, such as amniotic fluid contamination, premature delivery, and low birth weight.

Keywords: pregnancy length; periodontal disease; interleukin-1 β ; pregnancy outcome; gingival sulcus bleeding index

1. Introduction

Periodontal disease, an infectious condition, has been associated with adverse pregnancy outcomes, such as low birth weight infants and premature delivery [1]. Pregnant individuals with periodontal disease are at a heightened risk of developing gingival infection due to poor oral hygiene practices [2]. Additionally, hormonal changes and increased blood flow to the gingiva during pregnancy exacerbate periodontal infection, thereby impacting the overall health of pregnant women [3]. Current clinical approaches often focus on promoting oral hygiene and educating patients on proper brushing techniques to remove plaque and calculus [4,5]. However, these measures only address surface-level symptoms of periodontal disease and do not target the underlying issues.

Several risk factors for premature birth have been identified, although the causes for 25% to 30% of cases remain unknown [6]. The similarities between periodontal infection and inflammation in the reproductive system

have attracted the attention of researchers [6]. In a survey conducted in 2006 with 1020 pregnant women, a significantly higher rate of premature delivery was observed among those with moderate to severe periodontal disease compared to those with a healthy periodontium (11.2% vs. 28.6%) [7]. Another study involving 152 pregnant women found a negative correlation between the extent of bleeding gums upon probing and the newborn's weight, suggesting that periodontal disease is associated with lower birth weights [7,8]. These findings suggest that periodontal infection may contribute to adverse pregnancy outcomes, such as premature delivery and low birth weight [9,10].

Pregnant women are at a higher risk of developing periodontal infections due to hormonal changes and increased blood flow to the gingival tissues [11]. Poor oral hygiene practices during pregnancy further increase the chances of gum infections progressing to periodontal disease, negatively impacting the overall health of pregnant women [12,13]. Additionally, numerous studies have shown that



inflammatory mediators originating from maternal periodontal infections can influence pregnancy outcomes and serve as a risk factor for preterm birth and low birth weight [14]. Given the above, it is crucial to effectively manage periodontal infections in pregnant women. Thorough tooth brushing is essential; however, it alone may not adequately address the accumulation of dental calculus and plaque in a timely manner [15]. This highlights the need for improved diagnostic methods in the clinical exploration and analysis of periodontal infections [16]. It is imperative to raise awareness among pregnant women about the importance of maintaining good oral hygiene and seeking proper dental care to prevent and manage periodontal infections. Implementing effective strategies for the early detection and treatment of periodontal diseases during pregnancy is crucial for improving pregnancy outcomes and overall maternal and infant health.

Consequently, the purpose of this study is to analyze the impact of periodontal indicators on pregnancy outcomes in pregnant women with periodontal disease, with the aim of providing guidance for clinical diagnosis and improving infant outcome.

2. Materials and Methods

2.1 Source of Data

From August 2020 to February 2021, we selected 84 pregnant women with periodontal disease in our hospital as the experimental group, and 86 pregnant women with normal periodontal health as the control group. The inclusion criteria were as follows: (1) age between 18 and 36 years old; (2) single gestation. The exclusion criteria were as follows: (1) body weight less than 40 kg; (2) body height less than 140 cm; (3) presence of infectious diseases of the reproductive system; (4) unhealthy habits such as smoking and alcohol abuse; (5) loss of follow-up for pregnancy outcomes. Prior to participation, patients and their families were informed about the study and provided their consent.

2.2 Method

The diagnosis of periodontal disease involved assessing periodontal indices such as probing depth (PD), sulcus bleeding index (SBI), and clinical attachment level (CAL). These assessments were performed at six sites in the lingual and buccal regions, and the average value was calculated. Periodontal disease was defined as the presence of CAL ≥ 1 mm at any site within the oral cavity and PD ≥ 3 mm at any site of a periodontal pocket. The severity of gingival bleeding was categorized using the SBI, which had six levels. Level 0 indicated no bleeding during probing, level 1 represented mild gingival edema without bleeding, level 2 denoted punctate bleeding, level 3 represented linear bleeding, level 4 indicated bleeding from the gingival sulcus, and level 5 denoted spontaneous gingival bleeding.

Prior to participating in the study, all patients and their families received thorough information about the nature and

purpose of the study, and their consent was obtained. Strict inclusion and exclusion criteria as described were applied to ensure the reliability and accuracy of the study results. To collect gingival crevicular fluid, a 2–10 mm filter paper from Whatman Company (Maidstone, UK) was disinfected, dried, and placed in an Eppendorf tube (Sangon, Shanghai, China). The filter paper was weighed using an electronic balance. Soft debris, calculus, and plaque were carefully removed from the gingiva using a probe. The pre-weighed filter paper was then inserted into the buccal gingival sulcus and periodontal pocket, kept in place for 1 minute, and retrieved for weighing to determine the net weight of gingival crevicular fluid. The measured filter paper was subsequently soaked in hydrochloric acid buffer, shaken for 1 hour, and centrifuged to obtain the supernatant, which was stored at -70°C . The interleukin-1 (IL-1) level was quantified using an ELISA kit from Wuhan Doctoral Biology Co., Ltd. (Wuhan, Hubei, China), following the instructions provided in the manual.

Obstetric clinical data were reviewed to record pregnancy outcomes, including contamination of amniotic fluid after delivery, premature birth, newborn Apgar score ≤ 7 , umbilical cord abnormalities, and low birth weight. Premature birth was defined as a gestational age ranging from 28 to 37 weeks. Low birth weight infants were defined as newborns with a birth weight less than 2.5 kg.

2.3 Observation Indicators

For this study, we aimed to observe the levels of interleukin-1 beta (IL-1 β) and periodontal index in two groups of pregnant women. The periodontal index included indicators such as CAL, SBI, and PD. Furthermore, we also examined the pregnancy outcomes of these two groups, including amniotic fluid contamination, premature delivery, newborn Apgar score ≤ 7 , umbilical cord abnormalities, and low birth weight. The interpretation standard for fetal heart rate was as follows: a fetal heart rate below 4 points was considered positive, while a suspicious fetal heart rate response was observed at 5–7 minutes. A normal fetal heart rate response was defined as one observed at 8–10 minutes. The criteria for determining neonatal outcomes utilized the Apgar score at 1 minute. Severe asphyxia was scored 0–3 points, mild asphyxia was scored 4–7 points, and 8–10 points were considered indicative of normal newborns.

2.4 Statistical Analysis

We utilized SPSS 17.0 (IBM Corp., Armonk, NY, USA) statistical software to perform statistical analysis on the data, with quantitative data represented by ($\bar{x} \pm s$) and comparison using *t*-test. Counting data is represented as an example (%) for comparison χ^2 Inspection. $p < 0.05$ indicates a statistically significant difference.

3. Results

3.1 Comparison of General Information between Two Groups of Pregnant Women

The control group consisted of 86 cases with an age of 28.36 ± 4.11 years, a body weight of 58.63 ± 5.11 kg, and a gestational age of 17.53 ± 2.11 weeks (Table 1). The experimental group included 84 cases with an age of 28.05 ± 3.96 years, body mass of 57.96 ± 6.23 kg, and gestational age of 17.59 ± 1.98 weeks (Table 1). Based on the general data, there were no statistically significant differences in the age, body mass, and gestational age between the two groups of women ($p > 0.05$), indicating comparability.

Table 1. Comparison of general information between two groups of pregnant women.

Group	Control	Experiment
Number of cases	86	84
Average age (year)	28.36 ± 4.11	28.05 ± 3.96
Average body mass (kg)	58.63 ± 5.11	57.96 ± 6.23
Average gestational age (week)	17.53 ± 2.11	17.59 ± 1.98

3.2 Periodontal Index Indicators

SBI, PD, and Oral Hygiene Index-Simplified (OHI-S) levels of women in the experimental group were significantly higher than those in the control group, whereas CAL levels were significantly lower than those in the control group ($p < 0.05$, Table 2).

Table 2. Periodontal index indicators.

Group	Experiment	Control	<i>p</i>
CAL (mm)	2.21 ± 0.45	3.86 ± 0.36	0.021
SBI (score)	2.89 ± 0.22	2.29 ± 0.31	0.042
PD (mm)	3.79 ± 0.38	2.66 ± 0.36	0.012
OHI-S	4.12 ± 0.98	2.23 ± 0.63	0.008

CAL, clinical attachment level; SBI, sulcus bleeding index; PD, probing depth; OHI-S, Oral Hygiene Index-Simplified.

3.3 IL-1 β Level and Gingival Crevicular Fluid (GCF) Levels

The levels of IL-1 β and GCF in the experimental group were significantly lower than those in the control group ($p < 0.05$, Table 3).

Table 3. IL-1 β Level and GCF levels.

Group	Control	Experiment	<i>p</i>
IL-1 β (pg/mL)	289.36 ± 51.36	156.35 ± 22.85	0.001
GCF levels (μ L)	3.86 ± 2.12	2.12 ± 0.98	0.001

IL-1 β , interleukin-1 beta; GCF, gingival crevicular fluid.

3.4 Pregnancy Outcomes of the Two Groups

The number of adverse pregnancy outcomes in the experimental group was 2 (2.38%), which was significantly lower than the 13 in the control group (15.11%) ($p < 0.05$, Table 4).

Table 4. Pregnancy outcomes of two groups of pregnant women.

Group	Control	Experiment
Amniotic fluid contamination	2	0
Premature birth	4	1
Apgar ≤ 7	2	0
Umbilical cord abnormality	1	0
Low birth weight	4	1
Adverse outcomes	13 (15.11%)	2 (2.38%)

4. Discussion

Periodontal disease is a common chronic infectious condition that affects the oral cavity of humans, with a high incidence rate. It is particularly prevalent among women of childbearing age [6]. Previous studies have established a direct relationship between the periodontal health of pregnant women and their levels of serum C-reactive protein (CRP). Serum CRP is an acute-phase protein found in low concentrations in normal plasma. However, during inflammation, CRP levels significantly increase before peripheral white blood cell count and body temperature elevations, making it a sensitive indicator of infection [17,18]. Elevated CRP levels during pregnancy are closely associated with preterm delivery, highlighting the significance of periodontal disease as a crucial risk factor for adverse pregnancy outcomes [19].

Periodontal disease is a chronic infectious condition caused by bacterial infection. Periodontal pathogenic bacteria and their metabolites, such as lipopolysaccharide, constantly stimulate host inflammatory and immune responses, leading to the upregulation of inflammatory mediators and acute-phase proteins [20]. Among these, CRP concentration is particularly sensitive to changes and positively correlates with the severity of periodontal disease [20]. Prior research has indicated that pregnant women with periodontal disease or poor periodontal health have an increased risk of giving birth prematurely or to low birth weight infants [21]. This suggests that chronic oral infections, including periodontal disease, may affect the mother's inflammatory state during pregnancy, contributing to the occurrence and development of adverse pregnancy outcomes [21]. CRP may serve as a crucial mechanism linking periodontal tissue inflammation and adverse pregnancy outcomes [20]. Recent studies have highlighted the elevated levels of periodontal disease indicators, such as PD and SBI, in pregnant women with periodontal disease. These indicators are closely associated with premature delivery, amniotic fluid infection,

and low body weight infants, further emphasizing the importance of monitoring these markers [22].

PD, SBI, and CAL are crucial indicators for evaluating the severity and prognosis of periodontal disease in clinical practice [23]. This study conducted basic periodontal treatment for pregnant women in the experimental group, resulting in a significant decrease in all periodontal index indicators compared to pre-intervention levels. This group outperformed the control group, which received only oral health education. These findings demonstrate that pregnant women with periodontal disease cannot effectively manage periodontitis solely through personal oral hygiene [24]. Standard basic periodontal treatment, involving thorough removal of dental calculus and plaque, can effectively address periodontal infection. IL-1 β levels and periodontal index indicators are crucial factors for assessing the severity of periodontal disease and predicting its prognosis [25]. During pregnancy, the elevated estrogen levels in women with periodontal disease enhance their sensitivity to external stimuli, necessitating more than maintaining oral hygiene to control the disease. Timely removal of periodontal soft deposits, plaque, and calculus becomes essential in reducing the risk of periodontal infection [25]. Moreover, pathogenic bacteria affect pregnant patients with periodontal disease by stimulating inflammatory mediators, leading to immune responses that can penetrate the placenta through the bloodstream. This process can influence pregnancy outcomes [26]. IL-1 β , an inflammatory mediator, inhibits bone formation and interacts with other cytokines to stimulate bone resorption. Its concentration has a significant impact on the proliferation of pericytes. Further studies have observed that IL-1 β , initiated by preterm labor, is closely related to the secretion of prostaglandin E2. Increased prostaglandin E2 beyond a certain threshold leads to cervical dilation, uterine contractions, and ultimately premature delivery [27]. Therefore, reducing IL-1 β levels significantly affects the control of periodontal inflammation in pregnant women. The entry of inflammatory mediators like IL-1 into periodontal tissue through damaged epithelium contributes to placental invasion via the bloodstream, stimulating the placenta to secrete prostaglandin E2 and tumor necrosis factor. This sequence of events induces uterine smooth muscle contractions, local inflammatory reactions, and negatively affects normal fetal growth and development, resulting in adverse pregnancy outcomes such as premature birth [28]. Consequently, periodontal disease during pregnancy becomes a significant factor in the increase noted of adverse pregnancy outcomes [29].

The study has several limitations that should be acknowledged. First, the sample size was relatively small, which may limit the generalizability of the findings. Additionally, the study design was observational, which implies that causality cannot be determined. There may also be potential confounding factors that were not accounted for in the analysis, which could have influenced the results.

However, the study also has strengths that should be recognized. The assessment of periodontal health and pregnancy outcomes was multifaceted, incorporating both clinical measures and biochemical markers. These findings were statistically significant, suggesting a strong association between periodontal health and pregnancy outcomes.

Based on the limitations of this study, future research directions should aim to address these biological mechanisms. Longitudinal studies with larger sample sizes would provide more robust evidence on the relationship between periodontal health and pregnancy outcomes. Controlled interventions could be conducted to assess the impact of periodontal interventions on pregnancy outcomes. Moreover, in future studies it is important to consider and control for potential confounding factors, such as socioeconomic status and other comorbidities. Lastly, including diverse populations in the research would assist in order to improve the generalizability of the findings and ensure that the results can be applied to a wider population.

Acknowledging these limitations and strengths is crucial for guiding future research in this area and advancing our understanding of the complex relationship between periodontal health and pregnancy outcomes.

5. Conclusions

In our study, we observed that periodontal indicators, including OHI-S, CAL, SBI, and PD, were significantly elevated in pregnant women with periodontal disease. Additionally, we found that IL-1 β levels had a substantial influence on pregnancy outcomes, such as amniotic fluid contamination, premature delivery, and low birth weight.

Availability of Data and Materials

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Author Contributions

QC designed the research study. HC and JL performed the research. SY, DZ and JS analyzed the data. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The constituted Ethics Committee of the Second Affiliated Hospital of Jiaxing University within which the work was undertaken has approved the protocol for the research project (JXEY-2021JX144). Prior to participation, patients and their families were informed about the study and provided their consent.

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Conflict of Interest

The authors declare no conflict of interest.

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