Influence of Periodontal Infection as a Possible Risk Factor for Preterm Low Birth Weight

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ABSTRACT

Background: There is emerging interest and increasing amount of evidence that support the interrelationship between periodontitis and systemic conditions. Epidemiological and microbiological–immunological studies have lent credence to the concept that periodontal disease may be a separate risk factor for cardiovascular disease, cerebrovascular disease, and respiratory disease, as well as preterm delivery of low-birth-weight infants. Aim: The aim of this study was to evaluate the influence of periodontal infection as a possible risk factor for preterm low birth weight (LBW) based on age, literacy, and hemoglobin level of mother. Materials and Methods: The observational study was conducted on 200 subjects, which were selected from the free labor ward, District Hospital, Saifai, Etawah, UP, India. Periodontal examinations were performed using the World Health Organization criteria. The periodontal status of the mother was recorded using Community Periodontal Index. Results: For this study, chi-square test was performed to know the effect of variables and to find out the statistical significance of the study. Age of mother shows statistical insignificant association with periodontal disease, whereas literacy of mothers showed statistical significant association with periodontal disease, and periodontal status and hemoglobin levels of the mothers also showed a significant association. Conclusion: The prevalence of LBW infants was considerably less in mothers with a healthy periodontium and increased with progressive periodontal disease.

KEYWORDS: Hemoglobin, low birth weight, periodontitis, pregnancy

INTRODUCTION

Periodontal diseases comprise a variety of conditions affecting the health of the periodontium. They are a group of infectious diseases caused by predominantly gram-negative, anaerobic, and microaerophilic bacteria that colonize the subgingival area. Periodontitis can be considered a continuous pathogenic and inflammatory influence at a systemic level, as oral cavity is lined by epithelium surface, which can be ulcerated in the periodontal pockets due to this microorganism approach at different parts of cavity and create lesions at different levels.

In literature, much evidence is available, which support the interrelationship between periodontitis and systemic conditions. Miller published his “focal infection theory” in 1891, suggesting that “microorganisms or their waste products obtain entrance to parts of the body adjacent to or remote from the mouth,” his theory proofed oral foci of infection for a number of regional and systemic diseases. Periodontitis affect individual systemic health or vice versa. Epidemiological and microbiological–immunological studies lead to the concept that periodontal disease may be a separate risk factor for cardiovascular disease,
cerebrovascular disease, and respiratory disease, as well as preterm delivery of low-birth-weight (LBW) infants. Periodontitis is usually caused by gram-negative infection, which has severe influence on pregnancy. During the second trimester of pregnancy, the proportion of gram-negative anaerobic bacteria in dental plaque increases with respect to aerobic bacteria. A microbial component, lipopolysaccharide, can activate the macrophages and other cells to synthesize and secrete a wide spectrum of molecules, including cytokines, such as interleukin (IL)-1, tumor necrosis factor alpha (TNF-α), IL-6, and prostaglandin E2, and matrix metalloproteinases. These cytokines, produced in the mouth, migrate and create sufficient levels in the placental region to accelerate labor and restrict nutrients to the fetus, which cause poor pregnancy outcomes. They might interfere with fetal growth by inducing hypertension and secondary uterine vascular changes resulting in LBW infants.

The international definition of LBW for infants adopted by the 29th World Health Assembly in 1976 is a birth weight of “less than 2500 g” (up to and including 2499 g). Below this value, infant mortality begins to rise rapidly. LBW can be as a result of both, a short gestational period (preterm birth) and retarded intrauterine growth. According to the World Health Organization (WHO), preterm birth is considered if any live birth occurs at less than 37 weeks gestation.

The observational study was conducted in Department of Periodontology, Uttar Pradesh University of Medical Sciences, Etawah, Uttar Pradesh, India, with a sample size of 200 subjects that were selected from the free labor ward of the same institute. After obtaining the ethical approval to carry the study and consent of the subjects, the subjects were screened for the periodontal condition, and the data were also recorded from the hospital birth register.

Subjects included those in the age-group of 18–35 years and mothers with a singleton gestation.

Subjects excluded those with systemic conditions such as diabetes, cardiovascular disorders, hypertension, severe anemia, genitourinary tract infections, multiple pregnancies, preeclampsia or eclampsia, and gestational diabetes.

Data collected from hospital case records—age, hemoglobin (Hb in g%), obstetric history, gestational age and sex, and birth weight of the newborn. A structured questionnaire survey, including education, adverse oral habits, and h/o dental treatment, was recorded by directly asking the subjects.

Periodontal examinations were performed using the WHO criteria. The periodontal status of the mother was recorded using community periodontal index (CPI).

**Community periodontal index**

CPI is a modification of community periodontal index of treatment needs (CPITN). This modification includes “loss of attachment” and elimination of the “treatment needs” category.

**Indicators:** Three indicators of periodontal status are used for this assessment: gingival bleeding, calculus, and periodontal pockets. CPI probe is lightweight probe with 0.5 mm ball tip, with a black band between 3.5 and 5.5 mm and rings at 8.5 and 11.5 mm from the ball tip. (This probe was earlier known “CPITN-C” probe).

**Procedure**

**Sextants:** The mouth is divided into sextants, as in the case of CPITN, defined by tooth numbers, 18–14, 13–23, 24–28, 38–34, 33–43, and 44–48. A sextant is examined only if there are two or more teeth present, which are not indicated for extraction. (Note: This replaces the
former instruction to include single remaining teeth in the adjacent sextant).

**Index teeth:** For adults aged 20 years and older, the teeth to be examined are as follows:

| Tooth | 17 | 16 | 11 | 26 | 27 |
|-------|----|----|----|----|----|
| 17    | 16 | 11 | 26 | 27 |    |
| 47    | 46 | 31 | 36 | 37 |    |

**Examination and recording**

The index teeth or all remaining teeth in a sextant, where there is no index tooth, should be probed and the highest score should be recorded in the appropriate box. The scoring criteria are as follows:

**Code 4:** Pathological pocket of 6 mm or more. The colored end of the CPITN probe is not visible. If the designated tooth/teeth are found to have 6 mm or deep pockets in the sextant examined, and code 4 is given to the sextant, there is no need to record the presence or absence of pathological pockets of 4 or 5 mm, calculus, or bleeding.

**Code 3:** Pathological pocket of 5 mm or less, that is, only a part of the colored band is visible. If the deepest pocket is between 3.5 and 5.5 mm found in a designated tooth/teeth and code 3 is given, there is no need for recording calculus or bleeding.

**Code 2:** The whole of the colored band of the probe is visible, but supragingival or subgingival calculus or other plaque retentive factors such as ill-fitting crowns or defective margin of a filling are either seen or felt during probing shallow pockets only. If no pockets, which involve or exceed the colored area of the CPITN probe, and supra- or subgingival calculus or other plaque retentive factor are detected, and code 2 is given, it is not necessary to examine for gingival bleeding.

**Code 1:** Bleeding elicited during or after gentle probing without calculus or pocketing being present.

**Code 0:** Healthy periodontal tissues.

**Code X:** When only one tooth or no teeth are present in a sextant (third molars are excluded unless they function in place of second molars).

### Score Criteria

| Score | Criteria |
|-------|----------|
| 0     | Healthy  |
| 1     | Bleeding observed, directly or by using a mouth mirror, after probing |
| 2     | Calculus detected during probing, but all of the black band on the probe is visible |
| 3     | Pocket ≤5 mm (gingival margin within the black band on the probe) |
| 4     | Pocket ≥6 mm or more (black band on the probe not visible) |
| X     | Excluded sextant (less than two teeth present) |
| 9     | Not recorded |

### Results

This study was carried out with an objective to evaluate the periodontal infection as a possible risk factor for preterm LBW based on age, literacy, and Hb level of mother. All statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) statistical analysis software, version 16.0, and the data were presented in tabular form. For this study, chi-square test was performed to know the effect of variables and to find the statistical significance of the study.

Table 1 shows among 200 mothers only 20.5% had healthy periodontium, and 80.5% had variation in the distribution of CPI scores depicting periodontal disease progression among mothers. The periodontal disease did not show positive relation with age of mothers ($\chi^2 = 5.2$, df = 6, and $P = 0.760$).

Table 2 shows the literacy of the mothers among four groups. Among these groups, 2.5% of the illiterate mothers had healthy periodontium. Among the literate groups, there was a varied difference in the prevalence of mothers showing healthy periodontium. The highest prevalence (7.5%) of healthy periodontium was seen in mothers in the highest educated group in the study (degree holders). The CPI score 4 was found in 2.5% mothers in the illiterate group and in 1.5% in degree holders. Literacy of mothers showed statistical significant association with periodontal disease ($\chi^2 = 18.778$, df = 8, and $P = 0.002$).

### Table 1: Periodontal status and age

| Age   | Healthy | B  | C  | PPD ≤5 mm | PPD ≥6 mm | Total |
|-------|---------|----|----|-----------|-----------|-------|
| 18–20 | 11      | 10 | 12 | 25        | 8         | 66    |
| 21–24 | 25      | 23 | 15 | 30        | 10        | 103   |
| 25–29 | 3       | 2  | 6  | 10        | 2         | 23    |
| 30–35 | 1       | 2  | 21 | 2         | 2         | 8     |
| Total | 41      | 37 | 37 | 69        | 22        | 200   |

B = presence of bleeding on probing, C = presence of calculus, PPD = probing pocket depth
Table 3 shows the mothers categorized into three groups based on the Hb% (≤10, 10–11, and ≥11 g%). However, only 15% mothers with Hb levels ≥11 g% showed probing pocket depth ≥6 mm as compared to the other two groups. The periodontal status and Hb levels of the mothers showed a significant association ($\chi^2 = 9.009$, $df = 4$, and $P = 0.000$).

As anemia of chronic disease (ACD) [14,15] has been defined as the anemia occurring in chronic infections or inflammatory conditions, and periodontal disease could be one such condition because of the chronicity of the disease, it can be stated that periodontal disease could also be a risk factor for decreasing Hb concentration.

The mothers among our study also showed a positive correlation between periodontal disease and severity of periodontal disease. As Hb level of the mother plays a significant role for development of the fetus during pregnancy, the interrelationship between periodontal disease and Hb levels could be considered as an important factor during pregnancy. [16]

**DISCUSSION**

“Poor periodontal health of the pregnant women is associated with LBW of the newborn” was tested by our observational study. The patients were selected from the free labor ward of the hospital. The sample was homogeneous in nature as socioeconomic status of all the mothers belonged to the same strata of the population. The data were analyzed evaluating each component of the study individually to determine which risk factors affect LBW.

**Prevalence rate of periodontal disease**

The prevalence rate of periodontal diseases according to the National Health Examination Survey (NHES, 1960–1962) [8,9] and National Institute of Dental Research (NIDR, 1985) [17] was 73.9% and 57.9%, respectively. In our study, the prevalence rate of periodontal disease, as seen by the variations in the CPI scores among the different age-groups, was 80.5%, and remaining 20.5% of mothers had healthy periodontium. It has been recognized that estrogen and progesterone have receptors in the gingiva, and these receptors exacerbate the gingival response to plaque. [18] Thus, the variation in the clinical presentation of the disease seen in our study can be attributed to the fact that an imbalance or increase in the levels of hormones, estrogen and progesterone, modifies the bacterial composition of plaque which harbors growth of gram negative anaerobic microbiota which cause periodontal infection in pregnancy which leads to low birth weight of child.

**Age**

The prevalence of periodontal disease increases as age advances, with the highest prevalence seen above 35 years among normal individuals. [19] The age-group of mothers considered in our study was between 18 and 35 years. The average age of the mothers was 22.27 ± 2.80 years. The major age-groups of the study sample were between 20 and 24 years (26.8%) followed by 25–29 years (20.7%). Kristensen et al. [19] showed in their study that low maternal age <20 years was a risk factor for preterm delivery with the explanation that younger women are not completely developed anatomically to conceive a child. In our study, total 200 pregnant women were selected in which 66 women belonged to the age group of 18-20 years and remaining belong to age group of 20-35 years. Owing to the small number of mothers in both the groups with higher risk for preterm delivery, a significant association was not found between the age of mothers and LBW. Although high prevalence of periodontal disease was associated with the age of mothers and
periodontal disease, our study did not show significant result. This result is in accordance with studies conducted by Bayingana et al.[20] and NHANES III (1996) surveys.[21]

**Literacy**

Our study showed an association between periodontal disease and literacy among the mothers. Various data in literature have shown that mothers who are illiterate have higher chances of delivering LBW infants as this group is not much aware of the prenatal care.[13] In our study, we did not found any association between literacy and birth weight. Oral health awareness among mothers could be attributed to the literacy.

**Hemoglobin levels**

In our study, the average Hb level was 10.37 ± 1.26 g%; 14.2% of mothers with Hb levels ≤10 g% had periodontal disease as compared to 15% of mothers with Hb levels ≥11 g%. This finding may be related to elevated levels of pro-inflammatory cytokines in the plasma of patients with periodontitis, suppressing erythropoiesis.[22] The other cause may be the direct loss of blood due to bleeding from gingiva, leading to reduction in the number of erythrocytes. Sharma et al. 2009 stated that, Hb carries nutrition for the mother and the fetus, which acts as an important factor for fetal development. Therefore, reduced Hb can be a risk factor for LBW infants.

ACD has been described in the literature, and seems to be one of the most common forms of anemia observed in clinical medicine.[14-16] ACD is defined as the anemia occurring in chronic infections, inflammatory conditions, or neoplastic disorders, which are not due to marrow deficiencies or other diseases, and occurring despite the presence of adequate iron stores and vitamins.[14-16] Periodontitis, like other chronic conditions, may tend toward anemia, as the number of erythrocytes and levels of Hb are lower in affected patients. Thus, chronic conditions such as periodontitis may also lead to anemia, thereby increasing the incidence of LBW.

According to Singh et al.,[23] severe anemia (Hb < 7 g%) is a risk factor for LBW. It was observed during the study that only three mothers had severe anemia, but as they were a part of the exclusion criteria, we did not find a significant association between anemia and LBW.

Apart from this, many studies have shown that preterm delivery is due to ruptured membranes, and preterm labor is infection of the membranes and amniotic fluid caused by a variety of microorganisms and viral products.[24] Infection is not limited to amniotic fluid. In studies performed at cesarean delivery in 609 women with intact membranes, Hauth et al.[25] confirmed that recovery of organisms from the chorion-amnion was significantly increased with spontaneous preterm labor.

Bacterial entry into amniotic fluid with intact membrane is unclear. Gyr et al.[27] found that E. coli can penetrate living membranes, thus they are not a true barrier to ascending infection. Another pathway for bacterial initiation of preterm labor may not require bacteria in the amniotic fluid. Cox et al.[28] found that the cytokine network of cell-mediated immunity can be activated within the residual tissue that lines the presenting fetal membranes. In this scheme, bacterial products, such as endotoxin, stimulate residual monocytes to produce cytokines, which in turn stimulate arachidonic acid and then prostaglandin production. Prostaglandins E₂ and F₂α act in a signaling manner to stimulate adjacent myometrium to contract.[29]

Oral bacteria, especially *Fusobacterium nucleatum* and *Capnocytophaga* spp., have been associated with upper genital tract infection in pregnant women.[29] Offenbacher et al.[7] found that women with periodontitis have a sevenfold risk of preterm birth compared with that of controls. Hauth et al. and Fries K et al.[25,29] confirmed this in a prospective trial of more than 1300 women assessed at midpregnancy for periodontal inflammation. It is generally true to say that the majority of preterm births are also LBW. Our study showed an average gestational period of 38.0 ± 2.5 weeks; 48.5% and 17.3% infants had LBW in preterm and term deliveries, respectively, thus showing LBW significantly increases with preterm deliveries as compared to term deliveries.

**Conclusion**

In this study, periodontal status and gestational age emerged as risk factors for LBW infants. This result emphasizes the importance of periodontal care in perinatal health programs. Several surveys and clinical research have been carried out on this subject, and data from studies are exciting, but more importantly, biologic and plaque microbial exposure during pregnancy still remains a question. Hence, future perspectives should be aimed at conducting large epidemiological studies and clinical trials to further explore the nature of this association, which appears to be present in some but not all population.

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**Conflicts of interest**

There are no conflicts of interest.
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