Oral Health and Preterm Delivery Education: A New Role for the Pediatric Dentist

Joseph Katz, DMD[1] Ashley Brooke Orchard, BSc[2] Jennifer Ortega, BSc[3] Richard J. Lamont, PhD[4] Enrique Bimstein, CD[5]

Abstract

A variety of epidemiological, animal and intervention studies support a positive link between preterm delivery and the presence of periodontal disease in the pregnant women. Although the exact mechanism underlying this association is still unclear, evidence is accumulating that oral bacteria, and especially *P gingivalis*, can invade the placental tissues and trigger inflammatory responses which will result in release of effector molecules involved in preterm delivery. However, the medical profession has yet to assume a role in the education of the pregnant women about her oral health. We believe that the dental profession, including the pediatric dentist, should play an active role in transferring the current knowledge on this subject to the expecting mother in order to minimize the risks of preterm delivery. (Pediatr Dent 2006;28:494-498)

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Once thought to be exclusively tissue-specific, periodontal diseases and their associated bacteria are now thought to be involved with numerous systemic conditions such as: (1) cardiovascular disease; (2) diabetes mellitus; and (3) respiratory diseases.[1] Furthermore, recent literature has suggested that oral bacteria or its by-products, have the ability to cross the placenta and affect the fetus by stimulating an inflammatory response in the mother, which may ultimately result in preterm delivery (PTD—defined as birth before 37 weeks of pregnancy) and low birth weight (LBW).[2] These associations make it imperative for the pregnant woman to maintain optimum oral health; however, the reality is that most pregnant women do not seek oral care.[3,4]

Pregnancy is generally thought of as the time when a woman strives to be particularly aware of the need for "health" and what must be done to achieve the highest degree of well-being for her and her developing child. Despite these goals, neglecting dental health is not uncommon during pregnancy.[4] The difficulty faced in maintaining a satisfactory oral environment seems understandable when one considers the:

1. frequent bouts of nausea experienced;
2. physical restraints the pregnant woman faces with her growing abdomen;
3. problem presented by sensitivity and inflammation related to pregnancy gingivitis; or
4. fear that certain aspects of dental treatment are dangerous to the developing child.

Most importantly, many women may not be aware of the link that exists between their oral health and their systemic condition, as well as the impact these variables have on the developing child.

The purposes of this paper were to:

1. review the current literature that indicates a correlation between poor oral health status and risk of preterm delivery (PTD); and
2. identify a role for the pediatric dentist in the health education of expecting mothers.

Review of the literature

The literature that associates oral health with PTD can be classified into human and animal studies. The majority of the human studies involve epidemiological and correlation studies. A few recent studies have also evaluated the possible role for periodontal intervention in the prevention of PTD.

Human studies

Epidemiologic studies

To investigate the finding that a pregnant woman's poor periodontal health may be an independent risk factor for LBW, Dasanayake et al[5] conducted a longitudinal study in which over 400 African American women were examined during their second trimester of their first pregnancy. They

[1]Dr. Katz is Professor and Director of the Division of Diagnostic Sciences, [2]Ms. Orchard and [3]Ms. Ortega are dental students, [4]Dr. Lamont is Professor and Director of Translational Research, Department of Oral Biology, and [5]Dr. Bimstein is Professor of Pediatric Dentistry, all at the University of Florida College of Dentistry, Gainsville, Fla. Correspond with Dr. Bimstein at ebimstein@dental.ufl.edu

were evaluated for periodontal pathogen-specific maternal serum IgG (immunoglobulin G) levels; these results were then compared to the infant's birth weight. A significant inverse relationship was found between the mother's level of *Porphyromonas gingivalis*-specific serum IgG levels and birth weight. The authors concluded that LBW deliveries were associated with the presence of high *P gingivalis*-specific serum IgG levels.

When studying the association between maternal periodontal infections and preterm low birth weight (PLBW), Offenbacher et al[6] found inflammation present in the placenta without signs of infection, which would explain why about 25% of PLBW deliveries occur spontaneously. Offenbacher et al[6] hypothesized that maternally produced inflammatory mediators induced by periodontal bacteria or their products may be related to this finding. The study also showed that women with extensive and severe periodontal disease are 7 to 8 times more likely to have PLBW infants and concluded that about 18% of these cases may be attributable to periodontal disease.

The relationship between clinical, microbiological, and serological markers of periodontal disease and PTD has been studied in predominately postpartum Hispanic women with low levels of disease.[7] Cases showed greater mean attachment loss and higher prevalence of periodontitis. No differences in microbial or serum antibody levels were detected between the groups. Logistic regression revealed that PTD was associated with attachment loss. The results supported the idea that periodontal disease is independently associated with PTD and LBW.

Contradicting studies that indicate a link between periodontal disease and low birth rate/preterm birth, a London study of a population of Bangladeshi origin failed to observe a significant independent association between LBW and periodontal disease.[8] Genetic and demographic factors and socioeconomic status, as well as different criteria for patients and control selection, could account for these different results. Moreover, with over 70 recognized risk factors for PTD, it is unlikely that all studies will uncover a role for periodontal disease. In their systematic review of the literature, however, Xixong et al[9] found that, of 25 relevant studies, 18 suggested an association between periodontal diseases and increased risk of adverse pregnancy outcome, with odds ratios ranging between 1.1 and 20, while 7 studies found no evidence of association. The negative studies were in Europe and Canada and contained fewer economically disadvantaged women. Overall, therefore, the trends in the literature support an association between periodontal disease and adverse pregnancy outcomes, particularly in economically disadvantaged populations.

Hasegawa et al[10] aimed to evaluate the association of periodontal disease and generally healthy controls with threatened premature labor and preterm birth in relation to serum cytokine levels and the composition of subgingival plaque. They found that those at risk for PTD had worse periodontal conditions and elevated serum IL-8 (interleukin-8) and IL-1beta levels compared to the non-PTD women. This could have affected the maintenance of the proper uterine-fetus relationship, resulting in preterm contractions. PGE2 (prostaglandin E2) and TNF (tissue necrotizing factor) alpha levels rise within the amniotic fluid throughout pregnancy until a threshold is reached, which induces labor and delivery. These molecules are also produced in periodontal disease and can enter the general circulation along with bacterial products such as lipopolysaccharide (LPS). If these bioactive molecules cross the placenta, they can induce preterm labor.[10]

A dose-response relationship between increasing gingival crevicular fluid (GCF) PGE2 levels (a marker of current periodontal disease activity) and decreased birth weight has been shown.[11] Furthermore, the 4 organisms associated with mature plaque and periodontopathic potential—and found at higher levels in mothers whose infants were PLBW babies—were: (1) *Actinobacillus actinomycetemcomitans;* (2) *P gingivalis;* (3) *Fusobacterium nucleatum;* and (4) *Tannerella forsynthesis*. A significant difference, however, was not observed in the measurement of periodontal disease between cases and controls.[11] Another study showed that the ratio of anaerobic gram negative bacteria vs aerobics increases in dental plaque during the second trimester. If these organisms or their biologically active components enter the placenta, preterm labor could be stimulated through disruption of cytokines homeostasis.[12] Holst et al[2] examined the cervical fluid levels of Interleukin; IL-6 and IL-8 in pregnant women in relation to bacterial invasion of the amniotic fluid, intrauterine inflammation, and influence on preterm labor and delivery. They found that high levels of cervical IL-6 and IL-8 are moderately predictive of intrauterine infection/inflammation and preterm delivery.

A 2002 study sought to determine whether oral bacteria are found in the amniotic cavity using lab-based analysis of clinical samples from women undergoing elective Cesarean sections.[13] A significant association was found between detection of microbial DNA (streptococcal and *F nucleatum*) and complications in previous pregnancies, including: (1) miscarriage; (2) intrauterine death; (3) neonatal death; (4) preterm delivery; and (5) premature membrane rupture. All PGE-2 and cytokine levels except IL-1alpha were not significantly different between women with/without infection. Their results showed that oral bacteria may be present in the amniotic cavity.

Preeclampsia, a rapidly progressive condition characterized by hypertension and the presence of protein in the urine during pregnancy, is associated with abnormal cytokine responses in the mother and fetus, in particular high levels of TNF alpha, IL-10, and IL-6.[14] These responses encourage inflammatory vascular damage, which induces preeclampsia and other complications such as LBW and PTD. Therefore, it may be concluded that periodontal disease may have a significant role in the pathogenesis of preeclampsia, due to its nature as a chronic infection that exposes the host to microbial challenges.[14]

The effect of periodontal disease and the subgingival microbiota on preeclampsia was investigated in a case control study in Colombia involving 130 preeclamptic and 243 nonpreeclamptic women between 26 and 36 weeks gestation[14]; preeclampsia was defined as a blood pressure over 140/90 and having 2+ proteinuria, while LBW was defined as less than 2,500 g. In this study, chronic periodontal disease and the presence of *P gingivalis, T forsythensis,* and *Eikenella corrodens* were found to be associated with preeclampsia in pregnant women. The data also indicated that LBW occurred at a higher rate in the preeclamptic women vs the control group. These results support the hypothesis that chronic periodontal infection increases the risk of developing preeclampsia and is a risk factor for LBW babies.

The strong influence of periodontal disease on promoting the development of preeclampsia suggests that periodontal disease may represent a vascular stressor to the mother, placenta, and fetus. Also, a positive correlation is recognized between severity of disease destruction and possibility of increased rate of preeclampsia.

Interventional studies

The possibility that periodontal therapy in the form of scaling and root planning (SRP), prophylaxis, and/or prescription of metronidazole may play in reducing the risk of spontaneous preterm birth (SPTB) has been examined. A study involving over 300 pregnant women with periodontal disease showed that SRP may reduce SPTB. Metronidazole, however, did not improve pregnancy outcome.[15]

Yalcin et al[16] used an interventional study to explore the increase of progesterone during pregnancy that stimulates production of prostaglandins such as PGE2. This prostaglandin is released locally, and its proinflammatory effects include: (1) vasodilation; (2) activation of osteoclasts; and (3) vascular permeability at inflammation sites. In this study, 22 pregnant women had plaque index, gingival index, probing depths, and gingival crevicular fluid PGE2 levels measured before and after periodontal therapy. The results showed periodontal therapy significantly decreased levels of PGE2. Thus, periodontal therapy performed throughout pregnancy may help prevent the threat of pregnancy gingivitis.

Another study conducted in Chile provided promising evidence that LBW and periodontal disease are associated.[17] Lower LBW rates occurred in women treated for marginal periodontitis before week 28 of pregnancy vs those treated after delivery.

Animal models

A study utilizing a murine model showed that maternal *P gingivalis* infection in a subcutaneous chamber is associated with systemic induction of the maternal inflammatory response and with fetal growth restriction (FGR).[18] The results indicate that translocation of *P gingivalis* into the placenta may induce local immune responses that impair placental functions, thus mediating FGR. This would also explain why all in the litter are not affected. *P gingivalis*-associated immune responses were characterized by a shift of placental anti-inflammatory Th-2 (T helper-2) immunity to proinflammatory Th-1 immunity, which could consequently induce pregnancy complications such as FGR or fetal death. *P gingivalis* was detected only in placentas of FGR fetuses. mRNA (message RNA) levels for gamma interferon and IL-2 were increased in these fetuses, while IL-10 was significantly decreased.[18]

Another study with pregnant mice examined the possible mechanism underlying the link between periodontal disease and preterm birth following infection with *F nucleatum*.[19] Similar to the pattern in humans, the pathway of infection progressed from the: (1) blood vessels of the placenta; to (2) endothelial cells lining the blood vessels; to (3) endothelium; to (4) amniotic fluid. Increased rates of premature delivery, stillbirths, and nonsustained births were observed, providing evidence that *F nucleatum* is transmitted to the placenta and causes adverse pregnancy outcomes. This finding strengthens the link between periodontal disease and preterm birth.

A rabbit model of maternal exposure to *P gingivalis* was developed to determine whether fetal or placental exposure can occur.[20] *P gingivalis* cells were implanted into subcutaneous chambers in rabbits. Polymerase chain reaction (PCR) was then used to detect *P gingivalis* in the fetus liver and placenta. *P gingivalis* was absent in the control group, but detected in: (1) maternal livers (33%); (2) placentas (49%); and (3) fetal livers (34%). The study concluded that chronic maternal exposure to *P gingivalis* results in systemic dissemination, transplacental passage, and fetal exposure. All rabbits exposed demonstrated placental exposure to *P gingivalis*.[20]

The effects of the intra-amniotic injection of LPS from 3 periodontal organisms (*A actinomycetemcomitans, P gingivalis,* and *F nucleatum*) were investigated and compared with *Escherichia coli* LPS using a sheep model.[22] Periodontal LPS had high rates of fetal lethality compared to *E coli* LPS. Fetuses that did survive exposure to LPS showed inflammation in the amniotic fluid and cord blood at birth and enhanced lung maturation. Consequently, inflammatory sources distant from the uterus may underlie a portion of unexplained stillbirth and pregnancy complications. Periodontal disease may act as a distant source that provokes the intrauterine inflammation that is considered critical in the development of certain childhood diseases.[21]

Discussion

PTD, which occurs in about 12% of births, is a major public health concern. PTD rates are especially high (>20%) among poor, inner city, and minority pregnant mothers. Despite improvement in many health indicators, the PTD rate has not decreased over the last 30 years.[22] Although there have been decades of investigation, the pathophysiology of premature labor is incompletely understood, and therapies or preventive strategies tailored to each of

the many potential causes do not exist. Case-control and prospective studies in humans all argue for an existing relationship between periodontal disease and preterm delivery of LBW infants. One can also interpret these findings as demonstrating that those at increased risk for periodontal disease are more prone to experience pregnancy complications. Intervention-based studies and the pathogenicity of periodontal bacteria in animal models, however, strengthen the case for a causal role that periodontal bacteria, especially *P gingivalis*, has in adverse pregnancy outcomes.

In light of these findings, a multidisciplinary approach is needed to:

1. verify the role of periodontal pathogens in pregnancy complications;
2. define the molecular mechanisms' disease progression; and
3. identify targets for therapeutic intervention.

Such an approach will involve:

1. continued large-scale epidemiological studies;
2. animal models of disease;
3. analyses of human tissues; and
4. the cellular microbiology of bacterial interactions with gestational cells and tissues.

In the future, the role the dentist may take on concerning prenatal care could be dramatically altered and it may become imperative to eliminate periodontal pathogens from the mouths of pregnant women and women of childbearing age to escape the detrimental effects to both the mother and fetus.

During pregnancy, the obstetrician is responsible for the systemic well-being of both the mother and fetus. In addition, dental professionals should play a significant role in assuring the well-being of both the unborn and the newly born infant by maintaining and educating the mother about the importance of oral health and its links to systemic disease. There is a high probability that pediatric dentists will see pregnant mothers who bring their children for oral care. At this time, the pediatric dentist should take this opportunity to emphasize the importance of maintaining excellent oral care during pregnancy. The American Academy of Pediatric Dentistry's policy on oral health emphasizes the importance of prevention, diagnosis, and treatment required to maintain the oral health of infants, children, and adolescents. In accordance with this policy, pediatric dentists are capable of providing information and guidance regarding prenatal and postnatal oral development, as well as nutritional counseling that would aid in preventing the development of early childhood caries.[23,24]

It is important to use this critical time during pregnancy to create awareness and comprehensive preventive programs aimed at informing individuals and groups of the link that exists between systemic and oral health. Early education programs for the prevention of oral disease in pregnant women have the potential to lead to prevention of oral diseases in the unborn child.[26] These programs should also reach low-income families who have less capability to receive treatment, considering that this population usually has the highest prevalence and severity of oral diseases.[25]

In conclusion, a comprehensive and disease (systemic and oral) prevention program is possible and has the potential to establish new attitudes about the importance of maintaining optimum oral health. A multidisciplinary team that includes the family practice physician, obstetrician, dental practitioner, and pediatric dentist should assume an active role in providing health education to pregnant women and significantly decrease the possibility of preterm delivery.

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Abstract of the Scientific Literature

Effectiveness of Cordless LED Light-Curing Units

This study evaluated the battery lives of cordless LED's and their effect on orthodontic bracket bond strength. One hundred eighty-six metal orthodontic brackets were bonded to extracted molars. Two LED's (1) LE Demetron [SDS/Kerr, Orange, California] and (2) Ortholux [3M Unitek, Monrovia, California]) were evaluated. Each light was used to bond 93 specimens. One bracket was bonded every 5 minutes until the battery ran out. The lights were activated for 20 seconds, and then automatically turned off for 40 seconds every minute without recharging. Bonded specimens were stored in water at 37 degrees Celsius for 24 hours and then subjected to shear force with a universal testing machine until bracket failure. Repeated measures ANOVA detected significantly weaker mean shear bond strength and fewer consecutive cures with the Ortholux compared with the LE Demetron light-curing unit. However, when the first 5 time points were excluded, there were no differences between the 2 lights, demonstrating that the lights performed similarly after the first 20 minutes of operation just before battery failure, both lights still provided the same power density as at the beginning. Both light-curing units provided adequate power density for up to 2 hours without recharging at a 33% duty cycle (20 seconds on and 40 seconds off). There was no significant decrease in power in cordless LED's as the battery life approached its end point.

Comments: LED light-curing units offer a number of advantages over conventional quartz-tungsten-halogen curing lights. LED's are smaller and lighter in weight, and many run on battery allowing portability. The results showed that both LED's provided sufficient power density to bond orthodontic brackets to teeth just before battery failure. This study is particularly interesting for us who deal with patient movement during sealant placement and minor restorative treatment and the physical benefit of cordless LED's which allow for freedom of movement during care. RKY

Address correspondence to Dr. William J. Dunn, 3701 Point Clear Dr, Ocean Springs, MS 39564.

Judy RH, Dunn WJ, Patel AB, Swanson T. Effective single-charge end point of cordless light-emitting diode light-curing units. Am J Orthod and Dentofacial Orthop 2006;130(3):378-384

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