Periodontitis, female fertility and conception (Review)

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Abstract. Periodontal disease (PD) has been shown to increase the risk of preterm birth, preeclampsia and low birth weight. These observations have suggested that PD may also affect the early phase of pregnancy, including conception. The present study aimed to evaluate whether an association exists between oral health status and the chance of clinical pregnancy, according to the currently published literature, by performing a systematic review. The PubMed and EMBASE databases were searched from their start dates to October 2021 using the following keywords: ‘Infertility’ OR ‘conception’ OR ‘pre‑pregnancy’ OR ‘time‑to‑pregnancy’ AND ‘periodontitis’ OR ‘periodontal disease’ OR ‘dental infection’ OR ‘gingivitis’ OR ‘odontogenic infection’ (limits: Full article, English, Human). A total of 6 papers reporting observational information on PD and spontaneous (4 studies) or medically induced conception (2 studies) were retrieved. As such, there were limited studies with different designs (randomized controlled trials and observational studies) and different settings. Moreover, in the selected studies, the ethnicity of the women was heterogeneous. According to the limited published literature, oral health might affect fertility in women. However, only results from prospective randomized trials, comparing PD treatment vs. no treatment in women seeking pregnancy, may clarify the real effectiveness of treatment in improving the conception rate.

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1. Introduction

During the last decades, observational studies have suggested a possible link between chronic periodontitis and adverse pregnancy outcomes (1-3). Periodontal disease (PD) is associated with the risk of pregnancy complications and adverse outcomes, such as preterm birth, preeclampsia and low birth weight, in a bidirectional relationship (4). The published data, however, are not totally consistent: systematic reviews and meta‑analyses showed different conclusions that were not robust (3,5-7). Furthermore, these findings were also challenged by the fact that systematic reviews, evaluating the effectiveness of therapeutic interventions to treat PD during pregnancy, showed inconsistent results with regard to the risk of adverse pregnancy outcomes (8-10).

Along this line, a recent review underlined the fact that PD is associated with conditions associated with fertility, such as polycystic ovary syndrome, endometriosis and bacterial vaginosis (11). These observations suggested that PD may also affect the early phases of pregnancy, including conception. Furthermore, PD was associated with impaired semen parameters, suggesting a potential positive association between male factor infertility and dental health status (12).

Several studies have analyzed the association between PD and clinical pregnancy. The present review revised the available data on the association between oral health status and the chance of spontaneous and medically induced pregnancy.

2. Literature search

This review was registered in the PROSPERO database (registration number: CRD42021273066). The PubMed and EMBASE databases were searched from their initial start dates to October 2021 using the following keywords as both a free text and index terms search: ‘Infertility’ OR ‘conception’ OR
Table I. Patient, intervention, comparator, outcome, study design criteria for the inclusion and exclusion of studies.

| Parameter   | Inclusion criteria                              | Data extraction                                      |
|-------------|-----------------------------------------------|------------------------------------------------------|
| Patient     | Women seeking pregnancy                       | Location, age, type of patients                      |
| Intervention| Assessment of dental health                   | Type of assessment                                    |
| Comparator  | Absence of periodontitis                      | Group definition                                     |
| Outcome     | Clinical pregnancy (yes/no)                   | Details of conception                                |
| Study       | Cross-sectional, cohort and case-control studies | Type of study design                                 |

‘pre-pregnancy’ OR ‘time-to-pregnancy’ AND ‘periodontitis’ OR ‘periodontal disease’ OR ‘dental infection’ OR ‘gingivitis’ OR ‘odontogenic infection’. Only studies published in English and conducted on humans were included. Letters to the editor, commentaries, historic reviews and laboratory studies were excluded. The reference lists of identified articles were also checked to search for other pertinent studies. Two authors reviewed the papers and independently selected the articles eligible for the systematic review. Studies were selected for the review if they met all the following criteria: Cross-sectional, cohort and case-control design, studies reporting original data, studies reporting the diagnosis of PD and studies reporting the number of conceptions.

Data extraction. A patient, intervention, comparator, outcome, study design structure was used to define the study aims and the inclusion and exclusion criteria (13). The review aimed to assess whether there is an association between periodontitis and conception in women seeking pregnancy, spontaneously or by in vitro fertilization (IVF) (Table I).

For each study, the following information was extracted: Last name of the first author, year of publication, country where the study was conducted, number and characteristics of included subjects, design of the study, criteria for the diagnosis of periodontitis and clinical pregnancy (spontaneous or induced), and potentially confounding variables.

Quality assessment. The Newcastle-Ottawa Scale was used to evaluate the quality of the studies (14). This scale includes items for cohort and case-control studies: Selection (max 4 points) and comparability (max 2 points) of study groups, assessment of outcome (cohort studies; max 3 points) or ascertainment of exposure (case-control studies; max 3 points). For cohort and case-control studies, 8 or 9 points indicated a high-quality study, 6 or 7 points indicated a medium-quality study, and ≤5 points indicated a low-quality study. For cross-sectional studies, items for selection (max 3 points), comparability (max 2 points) and outcome (max 3 points) were included (15). A score of 7 or 8 points indicated a high-quality study, 6 points indicated a medium-quality study and ≤5 points indicated a low-quality study.

3. Spontaneous pregnancy and pregnancy after IVF

Search results. In PubMed/MEDLINE, the initial search retrieved 161 papers, and after inclusion criteria were applied, such as the requirements to be written in English (n=35) and be a human study (n=40), 86 published studies were screened. The same search, performed in EMBASE, retrieved 48 studies, with 15 duplicates of those studies retrieved in PubMed/MEDLINE. Overall, 119 studies were screened.

Of these 119 studies, 28 (27 in PubMed/MEDLINE + 1 in EMBASE) were reviews or editorials or commentaries, 17 (13+4) were regarding pregnancy outcome, 7 (6+1) were on male fertility, 6 (4+2) discussed the association between dental disease and presence of infertility or infertility-related factors, 4 were on gestational diabetes, 3 were on body mass index (BMI) and PD in pregnancy, 3 reported on oral health during IVF treatment, 2 reported on Chinese traditional medicine, 1 was a case report, 1 was a study protocol and 41 were animal or laboratory studies, or did not regard female fertility. Overall, 6 studies (16-21) were included in the present systematic review.

Of the 6 studies, 4 included healthy women seeking pregnancy (16,18,19,21) and 2 studies enrolled patients attending fertility clinics (17,20). Table II reports the main methodological characteristics of the studies. A total of 4 studies were prospective cohorts (17,19-21), 1 was a cross-sectional study (18) and 1 was a sub-analysis of a randomized controlled trial (RCT) of treatment for PD in mid-pregnancy (16).

In all but a single study (21), the patients received a comprehensive oral examination to diagnose caries, periodontal status and/or other possible dental infection sources. Only 1 study evaluated the presence of major periodontal pathogens in the saliva and the presence of antibodies in the serum and saliva (19).

Of the 6 studies, 2 studies (17,20) did not assess confounding variables. The study by Nwhator et al (18) adjusted the data for age, and the study by Hart et al (16) adjusted the data for BMI, ethnicity and smoking. Finally, the studies by Paju et al (19) and Bond et al (21) assessed several confounders such as age, current smoking, socioeconomic status, bacterial vaginosis, previous deliveries and clinical periodontal attachment loss.

Regarding study quality, all retrieved studies scored at least 4 out of 9 [out of 8 for the cross-sectional study (18)] (Table III). No study may be considered truly representative of the general population, but only of the specified target population (healthy women and women from fertility clinics).

Studies on spontaneous pregnancy. Hart et al (16) conducted a sub-analysis of the SMILE study (22), a multi-center RCT of treatment for PD in mid-pregnancy. Planned pregnancies accounted for 1,956 of the 3,416 pregnancies available for study: 1,439 pregnancies in women without PD and 517 pregnancies in women with PD. Women with planned pregnancies were asked about the time taken to conceive (TTC).
### Table II. Characteristics of selected studies.

| First author, year | Country | Type of study | Sample size | Criteria of diagnosis of PD | Confounders | Study quality | Outcome-results |
|--------------------|---------|---------------|-------------|----------------------------|-------------|--------------|----------------|
| **Spontaneous conception** | | | | | | | |
| Hart *et al*., 2012 | Australia | Sub-analysis of a RCT of treatment for PD in mid-pregnancy | 1,956 planned pregnancies; 1,439 pregnancies without PD; 517 pregnancies with PD | Presence of pockets ≥4-mm deep at ≥12 probing sites in fully erupted teeth | BMI, ethnicity, smoking | 9/9 | TTC >12 months (16) |
| | | | | | | | Reference: Caucasian women without PD. Non-Caucasian women with PD: 13.9 vs. 6.2%; OR, 2.88 (95% CI, 1.62-5.12); P=0.001. Caucasian women with PD: 8.6 vs. 6.2%; OR, 1.15 (95% CI, 0.74-1.79); P=0.534 |
| Nwahor *et al*., 2014 | Nigeria | Cross sectional study | 70 women | Oral hygiene index score, community periodontal index and periodontitis risk score using matrix metalloproteinase-8 (neutrophil collagenase-2) | Age | 4/8 | TTC, <12 months. Periodontitis risk score associated with odds of TTC: OR, 0.157; 95% CI, 0.041-0.600; P<0.01 |
| Paju *et al*., 2017 | Finland | Observational prospective study | 256 women | Major periodontal pathogens in the saliva and serum, and saliva antibodies against major periodontal pathogens | Age, current smoking, socioeconomic status, bacterial vaginosis, previous deliveries, and clinical periodontal attachment loss | 8/9 | Not becoming pregnant within a year. Women positive for *P. gingivalis* by polymerase chain reaction and with high salivary antibodies: HR, 3.75 (95% CI, 1.01-13.9; P=0.048). Women with high levels of serum *P. gingivalis* IgA and signs of periodontal infection: HR, 1.62 (95% CI, 1.03-2.54; P=0.035) |
| Bond *et al*., 2021 | USA | Prospective cohort study | 2,764 pregnancy planners; 1,506 pregnancies in women; 2,499 women without PD diagnosis; 152 pregnancies in 265 women with PD diagnosis | Self-reported diagnosis of PD | Ethnicity, history of bacterial vaginosis, diabetes, endometriosis, polycystic ovarian syndrome, age, education, annual income, BMI in kg/m², insurance coverage, weekly servings of sugar-sweetened soft drinks, marital status, current employment, partner’s education level, maternal and paternal education level, use of a prenatal or multi-vitamin at baseline, use of folic acid supplementation at baseline, frequency of intercourse at baseline, doing anything to improve conception chances at baseline, healthy eating index score, parity, smoking | 6/9 | Time to pregnancy. Reference: Women without self-reported PD diagnosis. Women with self-reported PD diagnosis: aHR, 0.89 (95% CI, 0.75-1.06). Reference: Women without self-reported PD treatment. Women with self-reported PD treatment: aHR, 0.79 (95% CI, 0.67-0.94) |
| **In vitro fertilization** | | | | | | | |
| Pavlatou *et al*., 2013 | Greece | Cohort study | 20 women with healthy periodontium; 19 women with gingivitis; 21 women with periodontitis | Gingivitis was defined as >10% of surfaces bleeding after light mechanical stimulation by the periodontal probe with no evidence of periodontal pockets. Adult periodontitis was defined when two or more sites exhibited a probing depth of ≥4 mm | Not reported | 7/9 | Number of follicles, number of embryos, attainment of pregnancy. Trend for negative correlation between the number of follicles, transferred embryos, attainment of pregnancy and the gingival index was recorded in all women (17) |
In the group of 146 women with a TTC >12 months, the cases of PD were more frequent (34.9 vs. 25.7%; \( P=0.015 \)) than in the group with TTC ≤12 months. Patients with a diagnosis of PD took an average of 7 months (95% CI, 5.7-8.6) to conceive compared with 5 months (95% CI, 4.4-5.5) in healthy controls (\( P=0.019 \)).

The cross-sectional study by Nwhator et al (18) included 70 pregnant women. The diagnosis and the risk of PD were based on the oral hygiene index score (23), community periodontal index (CPI) (24) and matrix metalloproteinase-8 immunoassay (25). The odds ratio (OR) for TTC <12 months decreased with increasing CPI [OR, 0.48; 95% confidence interval (CI), 0.26-0.90] and periodontitis (OR, 0.16; 95% CI, 0.04-0.60), suggesting that chronic periodontitis was positively associated with a lower chance of pregnancy.

The study by Paju et al (19) evaluated 256 non-pregnant women who underwent clinical oral and gynecological examinations. The major periodontal pathogens in the saliva were detected, and serum and saliva antibodies against major periodontal pathogens were analyzed. The follow-up period for becoming pregnant was 12 months. Porphyromonas gingivalis was detected in the saliva of 8.3% of women who did not become pregnant and in 2.1% of those who became pregnant (\( P=0.032 \)), resulting in a hazard ratio for not becoming pregnant of 3.8 (95% CI, 1.0-13.9) in the women with polymerase chain reaction results positive for P. gingivalis, and high salivary antibodies, and a hazard ratio for not becoming pregnant of 1.6 (95% CI, 1.0-2.5) in subjects with elevated levels of serum P. gingivalis IgA and a clinical diagnosis of periodontal infection.

The prospective cohort study by Bond et al (21) involved 2,764 women who had been attempting to become pregnant for six or fewer menstrual cycles at enrollment and were not using fertility treatment. Oral health was self-reported by the woman. Fecundability ratios were 0.89 (95% CI, 0.75-1.06) comparing women with and without a previous periodontitis diagnosis, 0.79 (95% CI, 0.67-0.94) comparing women with and without previous periodontitis treatment, and 0.71 (95% CI, 0.44-1.16) comparing women with and without a tooth that became loose. Among the limitations of the study, the fact that PD diagnosis was self-reported and that the disease severity could not be measured was highlighted.

Studies on pregnancy after IVF. The study by Pavlatou et al (17) considered 60 women eligible for IVF: 20 with healthy periodontium, 21 with PD and 19 with gingivitis. No association with the number of follicles, the number of embryos and dental health was found among the three groups. No statistically significant difference emerged when comparing between IVF success and oral diseases.

The study by Khalife et al (20) included 34 women who underwent IVF. PD was classified according to the American Academy of Periodontology criteria (26). The outcomes of 28 women were analyzed: 17 had a positive pregnancy test (60.7%), with a total of 13 live births (46.4%) and 4 pregnancy losses (14.3%). All women had different degrees of gingivitis (mild, 47.1%; mild-to-moderate, 8.8%; and severe, 23.5%). No statistically significant associations emerged between the severity of gingivitis and clinical pregnancy.
4. Discussion

Findings from this systematic review are based on a very limited number of studies, thus the results should be considered cautiously. Taking this aspect into account, the general results suggested that periodontitis is associated with conception. In all the studies, the chance of conception was significantly lower in women with PD, except for that in a single study (20) that only included women with different grades of gingivitis.

The present systematic review was conducted to provide a summary of the evidence about the potential association between periodontitis and conception. As periodontitis is a modifiable risk factor, this association could be of clinical interest and have health policy consequences.

The limitations of the present review should be considered. Populations enrolled in the included studies were different: Hart et al (16) included women who were enrolled in an RCT, whereas the remaining studies reported on observational studies conducted in different settings. Moreover, in the selected studies, the ethnicity of the women was heterogeneous; it has been observed that PD was more common among non-Caucasian women, although in the study by Hart et al (16) PD did not affect TTC, which in turn did not differ among Caucasian and non-Caucasian women. Another major limitation was that the selected studies showed a difference in the ascertainment of PD. Lastly, the sample size was adequate in just 2 studies (16,21), and in 1 of these (21) the criteria for PD diagnosis did not rely on an objective evaluation, as oral health was self-reported by the women.

Despite these limitations, consistent results were observed among the studies. All the studies reported an inverse association between conception (spontaneous or induced) and the presence of PD. The findings regarding IVF, although not statistically significant (20), were of note also in consideration of the fact that ovulation induction exacerbates gingival inflammation (27).

The biological and clinical explanations of these findings are not clear. Smoking and diabetes (28,29) were shown to increase the risk of PD and they may also be associated with infertility and/or TTC (30,31). Smoking was considered as a confounding factor in 2 studies (16,19). Moreover, there is some evidence that PD is associated with endometriosis, which is in turn associated with fertility problems (32).

It is recognized that systemic inflammation may affect reproduction (33), and PD is associated with inflammation.
Thus, it is conceivable that the biological mechanism linking fertility to PD is inflammation. Otherwise, a recent review of the literature has clearly shown that PD reduces the quality of semen parameters (11). No information was reported in the considered studies on male semen parameters and the oral health of the men. It is at least partially conceivable that dental status may be in part similar among the partners of a couple who share similar risk factors (for example, socioeconomic status). Thus, factors in males may at least in part explain the observed association.

Periodontal therapy was reported to lower glycemic levels in diabetics (34), serum pro-inflammatory cytokines levels (11), white blood cell count, and fibrinogen and C-reactive protein (35) and increase sperm motility (36).

Overall, this review is preliminary as more articles would be necessary to draw a definite conclusion. However, the scope of a review is collecting all evidence (only published evidence in the present case) to evaluate if there are inconsistencies among findings, to determine if the evidence is sufficient to draw certain conclusions and to see if further studies are needed. Thus, reports from small-size studies are also important to add to the current knowledge.

Conclusion. This review suggests that PD may be associated with fertility, although there is a definite lack of studies on this issue. The disappointing outcomes with regard to the efficacy of PD treatment in pregnancy for lowering the risk of preeclampsia and a low birth weight, however, suggest that only the results from prospective RCTs, comparing PD treatment vs. no treatment in women seeking pregnancy, may clarify the real effectiveness of treatment in improving the conception rate.

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Authors’ contributions
SCic, FP and MV designed the study; PAM, ERo and AF searched the literature and selected the papers; FF, SCip and GE extracted the data; FP, SG and ERI wrote the paper. All authors have read and approved the final manuscript. Data authentication is not applicable.

Ethics approval and consent to participate
Not applicable.

Patient consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

References
1. Boggess KA, Beck JD, Murtha AP, Moss K and Offenbacher S: Maternal periodontal disease in early pregnancy and risk for a small-for-gestational-age infant. Am J Obstet Gynecol 194: 1316-1322, 2006.
2. Boggess KA, Lieff S, Murtha AP, Moss K, Beck J and Offenbacher S: Maternal periodontal disease is associated with an increased risk for preeclampsia. Obstet Gynecol 101: 227-231, 2003.
3. Veregnes JN and Sixou M: Preterm low birth weight and maternal periodontal status: A meta-analysis. Am J Obstet Gynecol 196: 135.e1-e7, 2007.
4. Saaadou M, Singh P and Al Khodor S: Oral microbiome and pregnancy: A bidirectional relationship. J Reprod Immunol 145: 103293, 2021.
5. Chambrone L, Guglielmetti MR, Pannuti CM and Chambrone LA: Evidence grade associating periodontitis to preterm birth and/or low birth weight: I. A systematic review of prospective cohort studies. J Clin Periodontol 38: 795-808, 2011.
6. Xiong X, Buekens P, Goldenberg RL, Offenbacher S and Qian X: Optimal timing of periodontal disease treatment for prevention of adverse pregnancy outcomes: Before or during pregnancy? Am J Obstet Gynecol 205; 111.e1-e6, 2011.
7. Wei BJ, Chen YJ, Yu L and Wu B: Periodontal disease and risk of preeclampsia: A meta-analysis of observational studies. PLoS One 8: e70901, 2013.
8. Kunnen A, Van Doormaal JJ, Abbas F, Aarnoudse JG, Van Pampus MG and Faas MM: Periodontal disease and pre-eclampsia: A systematic review. J Clin Periodontol 37: 1075-1087, 2010.
9. Kim AJ, Lo AJ, Pullin DA, Thornton-Johnson DS and Karimbux NY: Scaling and root planing treatment for periodontitis to reduce preterm birth and low birth weight: A systematic review and meta-analysis of randomized controlled trials. J Periodontol 83: 1508-1519, 2012.
10. Schwendicke F, Karimbux N, Allareddy V and Gluud C: Periodontal treatment for preventing adverse pregnancy outcomes: A meta- and trial sequential analysis. PLoS One 10: e0129060, 2015.
11. Machado V, Lopes J, Patrão M, Botelho J, Proença L and Mendes JJ: Validity of the association between periodontitis and female infertility conditions: A concise review. Reproduction 160: R41-R54, 2020.
12. Kellesarian SV, Yunker M, Malmstrom H, Almas K, Romanos GE and Javed F: Male infertility and dental health status: A systematic review. Am J Mens Health 12: 1976-1984, 2018.
13. Eriksson MB and Frandsen TF: The impact of patient, intervention, comparison, outcome (PICO) as a search strategy tool on literature search quality: A systematic review. J Med Libr Assoc 106: 420-431, 2018.
14. Wells GA, Shea B, O’Connell D, Peterson J, Welch V, Losos M and Tugwell P: The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analysis. http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp, 2019.
15. Ribeiro CM, Beserra BTS, Silva NG, Lima CL, Rocha PRS, Coelho MS, Neves FAR and Amato AA: Exposure to endocrine-disrupting chemicals and anthropometric measures of obesity: A systematic review and meta-analysis. BMJ Open 10: e03509, 2020.
16. Hart R, Doherty DA, Pennell CE, Newnham IA and Newnham JP: Periodontal disease: A potential modifiable risk factor limiting conception. Hum Reprod 27: 1332-1342, 2012.
17. Pavlatou A, Tsami A, Vlahos N, Mantzavinos T and Vrotsos I: The effect of in vitro fertilization on gingival inflammation according to women's periodontal status: Clinical data. J Int Acad Periodontol 15: 36-42, 2013.
18. Ngwau A, Opeodu O, Ayanbadejo P, Umekuzideke K, Olajumoji J, Alade G, Agbelusi G, Årwojoulu M and Sorsa T: Could periodontitis affect time to conception? Ann Med Health Sci Res 4: 817-822, 2014.
19. Paju S, Oittinen J, Haapala H, Asikainen S, Paavonen J and Pussinen PF: Porphyromonas gingivalis may interfere with conception in women. J Oral Microbiol 9: 130644, 2017.
20. Khalife D, Khalil A, Itani M, Khalifeh F, Faour S, Salame A and Ghazeeri G: No association between the presence of periodontal disease and poor IVF outcomes: A pilot study. Int J Womens Health 11: 363‑370, 2019.

21. Bond JC, Wise LA, Willis SK, Yland JJ, Hatch EE, Rothman KJ and Heaton B: Self‑reported periodontitis and fecundability in a population of pregnancy planners. Hum Reprod 36: 2298‑2308, 2021.

22. Newnham JP, Newnham IA, Ball CM, Wright M, Pennell CE, Swain J and Doherty DA: Treatment of periodontal disease during pregnancy: A randomized controlled trial. Obstet Gynecol 114: 1239‑1248, 2009.

23. Greene JG and Vermillion JR: The simplified oral hygiene index. J Am Dent Assoc 68: 7‑13, 1964.

24. Nomura Y, Okada A, Kakuta E, Gunji T, Kajura S and Hanada N: A new screening method for periodontitis: An alternative to the community periodontal index. BMC Oral Health 16: 64, 2016.

25. Rathnayake N, Gieselmann DR, Heikkinen AM, Tervahartiala T and Sorsa T: Salivary diagnostics‑point‑of‑care diagnostics of MMP‑8 in dentistry and medicine. Diagnostics (Basel) 7: 7, 2017.

26. Armitage GC: Development of a classification system for periodontal diseases and conditions. Ann Periodontol 4: 1‑6, 1999.

27. Haytaç MC, Cetin T and Seydaoglu G: The effects of ovulation induction during infertility treatment on gingival inflammation. J Periodontol 75: 805‑810, 2004.

28. Javed F, Bashir Ahmed H and Romanos GE: Association between environmental tobacco smoke and periodontal disease: A systematic review. Environ Res 133: 117‑112, 2014.

29. Javed F and Romanos GE: Impact of diabetes mellitus and glycemic control on the osseointegration of dental implants: A systematic literature review. J Periodontol 80: 1719‑1730, 2009.

30. Soares SR and Melo MA: Cigarette smoking and reproductive function. Curr Opin Obstet Gynecol 20: 281‑291, 2008.

31. Thomas V, Uppoor AS, Pralhad S, Naik DG and Kushtagi P: Towards a common etiopathogenesis: Periodontal disease and endometriosis. J Hum Reprod Sci 11: 269‑273, 2018.

32. Dekel N, Gnainsky Y, Granot I, Racicot K and Mor G: The role of inflammation for a successful implantation. Am J Reprod Immunol 72: 141‑147, 2014.

33. Al Amri MD, Kellesarian SV, Al‑Kheraif AA, Malmstrom H, Javed F and Romanos GE: Effect of oral hygiene maintenance on HbA1c levels and peri‑implant parameters around immediately‑loaded dental implants placed in type‑2 diabetic patients: 2 Years follow‑up. Clin Oral Implants Res 27: 1439‑1443, 2016.

34. Igoumenakis D, Giannakopoulos NN, Parara E, Mourozis C and Rallis G: Effect of causative tooth extraction on clinical and biological parameters of odontogenic infection: A prospective clinical trial. J Oral Maxillofac Surg 73: 1254‑1258, 2015.

35. Nwhator SO, Umeizudike KA, Ayanbadejo PO, Opeodu OI, Olamijulo JA and Sorsa T: Another reason for impeccable oral hygiene: Oral hygiene‑sperm count link. J Contemp Dent Pract 15: 352‑358, 2014.

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