Correlation of Periodontitis with Mandibular Radiomorphometric Indices, Serum Calcium and Serum Estradiol in Postmenopausal Women: A Case–control Study

Abstract

Background: Osteoporosis and periodontitis have several risk factors in common. The majority of studies evaluating periodontal bone loss and systemic bone mineral density have found that low bone mineral density systemically is significantly associated with an increase in loss of alveolar bone height and periodontal destruction. Hence, the purpose of the study was to determine the effect of periodontitis on mandibular radiomorphometric indices, serum calcium and serum estradiol levels in postmenopausal women. Materials and Methods: Forty female patients in the age group of 35–55 years were included in the study. The participants were divided into two equal groups, i.e., control group A (twenty - postmenopausal women with healthy periodontium) and study group B (twenty - postmenopausal women with periodontitis). A thorough clinical examination of all the forty patients was carried out to detect the presence of periodontitis on the basis of clinical attachment level. Quantitative indices were measured on digital panoramic radiographs, and serum calcium and estradiol levels were estimated. Results: No statistically significant correlation of periodontitis with any of the radiomorphometric indices, serum calcium and serum estradiol levels was observed in postmenopausal women. Conclusion: There is little evidence of correlation of serum estradiol, serum calcium levels, and morphometric indices with periodontitis and therefore detailed further research about this correlation is required.

Keywords: Osteoporosis, periodontitis, postmenopause, radio morphometric indices, serum calcium, serum estradiol

Introduction

Osteoporosis and periodontitis have common mechanisms that contribute to bony wasting. Both the diseases have several risk factors in common. Infection with periodontal pathogenic bacteria at the subgingival site may lead to a local production of inflammatory cytokines. These inflammatory mediators may lead to elevated systemic cytokine levels that further exacerbate the loss of skeletal bone density in both the craniofacial and orthopedic regions of the body. The majority of studies evaluating periodontal bone loss and systemic bone mineral density have found that low bone mineral density, systemically, is significantly associated with an increased loss of alveolar bone height and periodontal destruction.[1]

Radiomorphometric indices including the mandibular cortical index (MCI), mandibular cortical thickness, or panoramic mandibular index (PMI) (Horner and Devlin, 1998) have also been used for panoramic radiographs to assess the bone quality and to observe the signs of resorption and osteoporosis (Klemetti and Kolmakow, 1997).[2]

Endogenous estrogen concentrations in elderly postmenopausal women have an important physiological effect on the skeleton.[3] The rapid loss of bone in postmenopausal women is due to loss of estrogen. Without estrogen, osteoclasts become more active which in turn result in increased bone destruction.[4]

Changes occurring at menopause have shown to affect the levels of serum calcium. Studies including that of Ramesh et al, concluded that serum total calcium declined with age and menopause affecting serum total calcium.[5]

Hence, the purpose of this study was to determine the effect of the periodontitis on radiomorphometric indices, serum calcium and serum estradiol levels in postmenopausal women.

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Materials and Methods

After obtaining permission from Institutional Ethics Committee of DMIMSU, the present study was conducted in the Department of Oral Medicine and Radiology. All the patients were briefed about the study and prior written consent from patient was taken. A total of forty female patients in the age group of 35–55 years attending the outpatient Department of Oral Medicine and Radiology were included in the study. The participants were divided into two equal groups as Group A - control group (twenty - postmenopausal women with healthy periodontium) and Group B - study group (twenty - postmenopausal women suffering from periodontitis).

All the females were screened by taking the detailed menstrual history including years since menopause. The clinical attachment loss (CAL) was measured using William’s periodontal probe. The attachment levels were stratified into CAL \leq 3 mm as the absence of periodontitis or mild periodontitis, >3–\leq 6, and CAL >6 mm defined as severe periodontitis. The digital panoramic radiographs of all the participants were taken using the orthopantomograph machine Planmeca Proline EC.

Method for estimation of quantitative radiomorphometric mandibular indices

Dental digital panoramic radiograph of each participant was taken with the X-ray machine (Planmeca PM 2002 CC Proline, Helsinki, Finland) at 12 mA, 15 s, and 70–80 kV.

Panoramic mandibular index

PMI is a radiomorphometric index introduced in 1991 by Benson et al. It was defined as the ratio of the thickness of the inferior mandibular cortex in the mental region over the distance between inferior and/or superior border of the mental foramen. Three measurements comprising mandibular index (MI) and PMI were carried out both for the left and right sides using the following technique [Figure 1] and by using the measuring tool of the software:

1. The mental foramina was identified
2. A line (b) was drawn which passed perpendicular to the tangent to the lower border of the mandible (a) and through the center of the mental foramina.
3. Measurements were made along this line of
   - Cortical width (C)
   - The distance between the lower border of the mandible and the inferior margin of the mental foramina (inferior foraminal distance, I)
   - The distance between the lower border of the mandible and the superior margin of the mental foramina (superior foraminal distance, S).

Superior and inferior PMI (IPMI) were calculated as:

Superior PMI (SPMI) = cortical thickness (C)/distance from superior margin of mental foramen to inferior border of mandible (S).

IPMI = cortical thickness (C)/distance from inferior margin of mental foramen to inferior border of mandible (I).

When the superior border of the mandibular cortex was ill defined on the radiographs, the smallest width of compact cortical bone lying below the mental foramen was measured.

Mental index or cortical width or mean cortical thickness

Mental index is defined as the cortical width (C) below the mental foramina [Figure 1].

Antegonion index (AGI or AI)

The antegonion index is a measurement of cortical width in the region anterior to the gonion at a point identified by extending a line of best fit on the anterior border of the ascending ramus down to the lower border of the mandible. Where the anterior border of the ramus was markedly curved, the line was drawn as closely as possible to the straighter, inferior, part of the bone margin above the third molar region [Figure 2].

Gonion index

Gonion index (GI) was measured according to the method of Bras et al. Thickness of the mandibular angular cortex on the panoramic radiographs was measured. To determine the location of the gonion, a vertical tangent to the posterior border of ramus was drawn. The angle made by this line with the tangent to the lower border of the mandible at mental foramen was bisected. At a point of intersection of this bisector line with the angle of mandible, the thickness of angular cortex was measured [Figure 3].

For the particular index, the index score for a patient was determined by calculating the average of right and left side scores of that index.[6]
Estimation of serum estradiol and serum calcium

The patients were asked to sit comfortably on dental chair, after applying the tourniquet in arm and cleaning the antecubital fossa with cotton swab soaked in 70% alcohol; 5 ml of blood was withdrawn from cubital vein with a 24-gauge needle and 4.5 ml of blood was then transferred to plain sterile bulb which was kept undisturbed for ½ h at room temperature. The supernatant was removed and centrifuged at 3000 rpm for 4–5 min. Samples were stored at −20°C. The serum was taken to the laboratory for estimation of serum estradiol and serum calcium level.

Method for serum Estradiol II estimation: Serum Estradiol II was estimated by Vidas method, an automated quantitative estimation of serum estradiol, using Vidas estradiol kit (Biomerieux kit).

Method for serum calcium estimation: Serum calcium was estimated by modified Arsenazo method (Pathozyme kit) and instrument used was ultraviolet-visible spectrophotometer (ELICO SL-244).

Statistical analysis

Statistical analysis for the correlation of calcium and estradiol levels with radiographic indices of each group was carried out. All the variables from the study were analyzed for the mean values, standard deviation, standard error, range, and “P” value to find out the significant difference between those values. The statistical tests used for the analysis of the result were one way ANOVA, multiple comparison Tukey test, Chi-square test, and Student’s t-test. In all the above tests, P < 0.05 was taken to be statistically significant; P > 0.05 was taken to be statistically nonsignificant.

Results

During the clinical examination of patients, duration since menopause was recorded, mean duration in Group A (n = 20) was 5.3 ± 2.47 years and in Group B (n = 20) was 5.4 ± 2.77 years. The difference was statistically nonsignificant (P > 0.05). In Group B (n = 20), severity of periodontitis was found to be moderate in 11 (55%) and severe in 9 (45%) patients.

On correlating the patients of Group B (study group) according to severity of periodontitis with duration since menopause (years) showed that out of twenty patients, 11 (55%) with moderate periodontitis had mean duration of 5.63 ± 2.76 years and 9 (45%) with severe periodontitis had mean duration of 5.11 ± 2.93 years. The difference was statistically nonsignificant (P > 0.05).

On correlating patients of Group A (control group) n = 20 according to levels of mean serum calcium 10.99 ± 1.42 mg/dl [Table 1] and also on correlating patients of Group A (control group) n = 20 according to levels of mean serum estradiol 89.97 ± 205.27 pg/ml with the study parameters including mean age 48.10 ± 4.68 years.

Table 1: Correlation of mean serum calcium level (mg/dl) with mean age (years), duration since menopause (years), mandibular index (mm), superior panoramic mandibular index, inferior panoramic mandibular index, antegonial index (mm), and gonial index (mm) in Group A

| Clinical parameters          | Mean±SD  | n  | Correlation “r” | P    |
|------------------------------|----------|----|-----------------|------|
| Serum calcium (mg/dl)        | 10.99±1.42 | 20 | -               | -    |
| Age (years)                  | 48.10±4.689 | 20 | 0.21            | 0.374|
| Duration since menopause     | 5.30±2.47  | 20 | 0.05            | 0.805|
| Cortical width (MD) (mm)     | 4.10±0.87  | 20 | 0.32            | 0.156|
| SPMI                         | 0.25±0.06  | 20 | 0.07            | 0.740|
| IPMI                         | 0.29±0.07  | 20 | 0.04            | 0.843|
| AGI (mm)                     | 2.85±0.41  | 20 | −0.08           | 0.710|
| GI (mm)                      | 1.33±0.21  | 20 | 0.25            | 0.285|

MI=Mandibular index, SPMI=Superior panoramic mandibular index, IPMI=Inferior panoramic mandibular index, AGI=Antegonial index, GI=Gonial index, SD=Standard deviation.
mean of duration since menopause 5.3 ± 2.47 years, mean cortical width 4.10 ± 0.87 mm, mean SPMI 0.25 ± 0.06, mean IPMI 0.29 ± 0.076, mean AGI 2.85 ± 0.41 mm, and mean GI 1.33 ± 0.21 mm, respectively, showed statistically nonsignificant differences [Table 2].

Similarly, on correlating patients of Group B (study group) n = 20 according to levels of mean serum calcium level 10.25 ± 1.02 mg/dl [Table 3] and also on correlating patients of Group B (study group) n = 20 according to levels of mean serum estradiol 43.46 ± 65.75 pg/ml with the study parameters including mean age 51.15 ± 4.23 years, mean duration since menopause 5.4 ± 2.77 years, mean cortical width 3.42 ± 0.68 mm, mean SPMI 0.22 ± 0.04, mean IPMI 0.27 ± 0.05, mean AGI 2.72 ± 0.53 mm, and mean GI 1.21 ± 0.3 mm, respectively, showed statistically nonsignificant differences with all parameters except that of estradiol levels and cortical width (P = 0.04) and estradiol levels and antegonial index which showed statistically significant difference with positive correlation [Table 4 and Graphs 1 and 2].

On correlating patients of Group B (study group) according to severity of periodontitis with the study parameters including mean age 51.15 ± 4.23 years, mean duration since menopause 5.4 ± 2.77 years, mean cortical width 3.42 ± 0.68 mm, mean SPMI 0.22 ± 0.04, mean IPMI 0.27 ± 0.05, mean AGI 2.72 ± 0.53 mm and mean GI 1.21 ± 0.3 mm, mean serum calcium 10.25 ± 1.02 mg/dl, and mean serum estradiol 43.46 ± 65.75 pg/ml level, respectively, showed statistically nonsignificant differences (P > 0.05) [Tables 5,6 and Graph 3].

| Table 2: Correlation of mean serum estradiol level (pg/ml) with mean age (years), duration since menopause (years), mandibular index (mm), superior panoramic mandibular index, inferior panoramic mandibular index, antegonial index (mm), and gonial index (mm) in Group A |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Clinical parameters | Mean±SD | n | Correlation “r” | P |
| Serum estradiol (pg/ml) | 89.97±205.27 | 20 | - | - |
| Age (years) | 48.10±4.689 | 20 | -0.12 | 0.58 |
| Duration since menopause (years) | 5.30±2.47 | 20 | -0.27 | 0.24 |
| Cortical width (MI) (mm) | 4.10±0.87 | 20 | 0.01 | 0.96 |
| SPMI | 0.25±0.06 | 20 | 0.16 | 0.49 |
| IPMI | 0.29±0.07 | 20 | 0.20 | 0.37 |
| AGI (mm) | 2.85±0.41 | 20 | 0.19 | 0.40 |
| GI (mm) | 1.330±0.21 | 20 | -0.33 | 0.15 |

MI=Mandibular index, SPMI=Superior panoramic mandibular index, IPMI=Inferior panoramic mandibular index, AGI=Antegonial index, GI=Gonial index, SD=Standard deviation

| Table 3: Correlation of mean serum calcium level (mg/dl) with mean age (years), duration since menopause (years), mandibular index (mm), superior panoramic mandibular index, inferior panoramic mandibular index, antegonial index (mm), and gonial index (mm) in Group B |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Clinical parameters | Mean±SD | n | Correlation “r” | P |
| Serum Calcium (mg/dl) | 10.25±1.02 | 20 | - | - |
| Age (years) | 51.15±4.234 | 20 | -0.21 | 0.37 |
| Duration since menopause (years) | 5.40±2.77 | 20 | -0.05 | 0.81 |
| Cortical width (MI) (mm) | 3.42±0.68 | 20 | -0.12 | 0.60 |
| SPMI | 0.22±0.04 | 20 | -0.11 | 0.63 |
| IPMI | 0.27±0.05 | 20 | -0.15 | 0.52 |
| AGI (mm) | 2.72±0.53 | 20 | -0.05 | 0.80 |
| GI (mm) | 1.21±0.30 | 20 | 0.05 | 0.83 |

MI=Mandibular index, SPMI=Superior panoramic mandibular index, IPMI=Inferior panoramic mandibular index, AGI=Antegonial index, GI=Gonial index, SD=Standard deviation

| Table 4: Correlation of mean serum estradiol level (pg/ml) with mean age (years), duration since menopause (years), mandibular index (mm), superior panoramic mandibular index, inferior panoramic mandibular index, antegonial index (mm), and gonial index (mm) in Group B |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Clinical parameters | Mean±SD | n | Correlation “r” | P |
| Serum estradiol (pg/ml) | 43.46±65.75 | 20 | - | - |
| Age (years) | 51.15±4.234 | 20 | 0.06 | 0.78 |
| Duration since menopause (years) | 5.40±2.77 | 20 | -0.14 | 0.55 |
| Cortical width (MI) (mm) | 3.42±0.68 | 20 | 0.45 | 0.04 |
| SPMI | 0.22±0.04 | 20 | 0.19 | 0.42 |
| IPMI | 0.27±0.05 | 20 | 0.16 | 0.49 |
| AGI (mm) | 2.72±0.53 | 20 | 0.48 | 0.02 |
| GI (mm) | 1.21±0.30 | 20 | 0.27 | 0.23 |

MI=Mandibular index, SPMI=Superior panoramic mandibular index, IPMI=Inferior panoramic mandibular index, AGI=Antegonial index, GI=Gonial index, SD=Standard deviation

| Table 5: Correlation of severity of periodontitis with mean age (years), duration since menopause (years), mandibular index (mm), superior panoramic mandibular index, inferior panoramic mandibular index, antegonial index (mm), and gonial index (mm) in Group B |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Clinical parameters | Mean±SD | n | Correlation “r” | P |
| Severity of periodontitis | 1.45±0.51 | 20 | - | - |
| Age (years) | 51.15±4.234 | 20 | -0.03 | 0.89 |
| Duration since menopause (years) | 5.40±2.77 | 20 | -0.09 | 0.89 |
| Cortical width (MI) (mm) | 3.42±0.68 | 20 | 0.02 | 0.91 |
| SPMI | 0.22±0.04 | 20 | 0.03 | 0.91 |
| IPMI | 0.27±0.05 | 20 | 0.08 | 0.72 |
| AGI (mm) | 2.72±0.53 | 20 | 0.009 | 0.96 |
| GI (mm) | 1.21±0.30 | 20 | -0.10 | 0.65 |

MI=Mandibular index, SPMI=Superior panoramic mandibular index, IPMI=Inferior panoramic mandibular index, AGI=Antegonial index, GI=Gonial index, SD=Standard deviation
Discussion

The age range of the patients of the present study was similar to that in study by Ramesh et al.,[5] who included females with age range of 35–55 years and Devlin et al.,[7] who included 45–70-year-old women in his study, which differed from the study done by Jagelaviciene et al.,[8] in which mean age of their studied group was 62.5 ± 6.1 years, with 38% of them at the age of 60–64 years.

The mean duration since menopause in Group A (n = 20) was 5.3 ± 2.47 years and 5.4 ± 2.77 years in Group B (n = 20), which was similar to that in study by Ramesh et al.[5] who also included postmenopausal women within 5 years of menopause while contradictory to that Jagelaviciene et al.[8] in whose study, mean duration of menopause was 12.5 ± 6.5 years.

Because osteoporosis and periodontal diseases both are clinical entities with multifactorial etiologies, it is difficult to establish a relationship between the two conditions. However, studies have shown strong correlation between severe periodontal disease and skeletal osteoporosis. In a recent study, low systemic bone density was associated with greater CAL among postmenopausal women without

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**Table 6: Correlation of severity of periodontitis in Group B with mean serum calcium (mg/dl) and mean serum estradiol (pg/ml)**

| Clinical parameters          | Mean±SD | n  | Correlation “r” | P   |
|------------------------------|---------|----|-----------------|-----|
| Severity of periodontitis    | 1.45±0.51 | 20 | -               | -   |
| Serum calcium (mg/dl)        | 10.25±1.02 | 20 | -0.29           | 0.20 |
| Serum estradiol (pg/ml)      | 43.46±65.75 | 20 | -0.31           | 0.17 |

SD=Standard deviation

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**Table 7: Correlation of mean duration of menopause with mean mandibular index (mm), superior panoramic mandibular index, inferior panoramic mandibular index, antegonial index (mm), and gonial index (mm) in Group A**

| Clinical parameters       | Mean±SD | n  | Correlation “r” | P   |
|---------------------------|---------|----|-----------------|-----|
| Duration of menopause     | 5.30±2.47 | 20 | -               | -   |
| Cortical width (MI)       | 4.10±0.87 | 20 | -0.19           | 0.41 |
| SPMI                      | 0.25±0.066 | 20 | -0.26           | 0.25 |
| IPMI                      | 0.29±0.076 | 20 | -0.27           | 0.24 |
| AGI (mm)                  | 2.85±0.415 | 20 | -0.27           | 0.24 |
| GI (mm)                   | 1.33±0.213 | 20 | 0.16            | 0.47 |

MI=Mandibular index, SPMI=Superior panoramic mandibular index, IPMI=Inferior panoramic mandibular index, AGI=Antegonial index, GI=Gonial index, SD=Standard deviation
subgingival calculus, but no association was found among those with subgingival calculus.\textsuperscript{[9]}

Although there are number of studies showing participants with osteoporosis had fewer remaining teeth\textsuperscript{[10]-\textsuperscript{12}} very few studies are there to show correlation of severity of periodontitis and duration of menopause, one of them is study by Reinhardt\textsuperscript{[13]} which suggested that the periodontitis patients were further past menopause (1.3 years) than nonperiodontitis individuals.

The results of the present study were similar to the study by Ramesh \textit{et al.}\textsuperscript{[5]} they also correlated the levels of mean serum calcium with PMI in premenopausal women, and the postmenopausal women and not found any statistically significant correlation.

Unlike the present study, Ahmed \textit{et al.}\textsuperscript{[14]} in their study found that there was a significant decrease in serum calcium levels in postmenopausal females with osteoporosis and low bone mass; the duration of menopause correlated negatively with serum calcium levels.

According to Ettinger \textit{et al.}\textsuperscript{[15]} serum estradiol levels vary with age with levels decreasing as age progresses and as the serum levels fall into the postmenopausal range (30 pg/mL), accelerated bone loss ensues. Women with undetectable estradiol levels (5 pg/mL) were about 2.5 times more likely to suffer hip or vertebral fracture than women with detectable levels (5–25 pg/mL). However, in the present study, there was statistically nonsignificant correlation of mean estradiol levels with mean age in any of the study groups, but three out of twenty patients within Group B, i.e., postmenopausal women with periodontitis showed highly significant correlation with age and duration of menopause with very low estradiol (<12 pg/ml) levels.

There are many studies, directly or indirectly (through the markers of estradiol metabolism and binding proteins of estradiol) positively correlating estradiol levels with bone mineral density of postmenopausal women at various sites.\textsuperscript{[16]-\textsuperscript{19}}

None of the radiographic parameters evaluated in the present study correlated with serum estradiol except the cortical width and antegonial index with which it showed positive correlation in Group C, i.e., postmenopausal women with periodontitis. This difference can be attributed to the possibility that estradiol is a marker for other confounding factors that were not measured in the present study. The present study did not measured free or bioavailable estradiol neither adjusted the readings of the same.

According to Renvert \textit{et al.}\textsuperscript{[12]} it is more reasonable to define periodontitis by the extent of alveolar bone loss and then to correlate such findings with measures of osteoporosis derived from bone density measurements due to the chronic nature of both osteoporosis and periodontitis. The difference in periodontitis did not seem to differ as much between the younger and older groups of women although the severity of osteoporosis as reflected by the T-scores was significantly higher in older women and the number of teeth is less in the osteoporotic patients with old age.\textsuperscript{[10]-\textsuperscript{12}} This was in consistence with the result of the present study where no significant correlation of severity of periodontitis with age and duration of menopause was observed.

Renvert \textit{et al.}\textsuperscript{[12]} also observed significant correlation between mandibular cortex index and periodontitis with the bone mineral density of Dual energy X ray absorptiometry scan, unlike in the present study where no correlation of severity of periodontitis with any of the indices was observed.

A 1-year study by Payne \textit{et al.}\textsuperscript{[20]} indicated that estrogen status may influence alveolar bone density changes. A subsequent 2-year study by the same authors demonstrated that estrogen deficiency was associated with alveolar bone crestal height and density loss in postmenopausal women with a history of periodontitis as against the results of the present study. According to Koduganti \textit{et al.}\textsuperscript{[21]} estrogen deficiency was associated with increased frequency of alveolar bone crestal density loss in the osteoporotic/osteopenic women. They also concluded that osteoporosis/osteopenia and estrogen deficiency are risk factors for alveolar bone density loss in postmenopausal women with a history of periodontitis. However, the results of the present study are conflicting with no correlation of serum estradiol with periodontitis.

With regard to the effects of calcium, it has been suggested that low calcium intake may increase the risk of periodontal disease and oral bone destruction\textsuperscript{[20]} although no significant correlation between mean serum calcium levels and periodontitis is observed in the results of the present study.

As the levels of hormones decline more within 3–5 years of menopause, the effect of estradiol on osteoporotic changes in alveolar bone of periodontium, which might

### Table 8: Correlation of mean duration of menopause with mean mandibular index (mm), superior panoramic mandibular index, inferior panoramic mandibular index, antegonial index (mm), and gonial index (mm) in Group B

| Clinical parameters | Mean±SD  | n | Correlation “r” | P  |
|---------------------|---------|---|----------------|----|
| Duration of menopause | 5.40±2.77 | 20 | -  | -  |
| Cortical width (MI) (mm) | 3.42±0.68 | 20 | -0.29 | 0.20 |
| SPMI | 0.22±0.04 | 20 | -0.07 | 0.75 |
| IPMI | 0.27±0.05 | 20 | -0.03 | 0.87 |
| AGI (mm) | 2.72±0.53 | 20 | -0.36 | 0.11 |
| GI (mm) | 1.21±0.30 | 20 | -0.06 | 0.78 |

MI=Mandibular index, SPMI=Superior panoramic mandibular index, IPMI=Inferior panoramic mandibular index, AGI=Antegonial index, GI=Gonial index, SD=Standard deviation
further affect the cortical bone and radiographic indices; therefore, in the present study, the correlation duration of menopause of patients with all the radiographic indices was carried out.

Martinez-Maestre et al.[22] found that MCI and MI values were related with the mean age of the onset of menopause but there is little evidence of studies in which duration of menopause and radiographic indices were correlated.

Conclusion

There is meager evidence of correlation of periodontitis with serum estradiol and calcium levels; therefore, more number of studies and detailed further research about this correlation to assess periodontitis as a risk factor for estradiol and calcium deficiency and reason for early loss of teeth in postmenopausal women are required. Furthermore, correlation of various indices with periodontitis showed statistically nonsignificant differences with morphometric indices necessitating detailed further research with larger sample size.

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Conflicts of interest

There are no conflicts of interest.

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