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Estimation and comparative evaluation of serum follicle stimulating hormone (FSH) levels in different age groups of post-menopausal women with and without chronic periodontitis: A clinico-biochemical-radiological study

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Abstract
Introduction: Menopause is the period when there is cessation of ovarian secretion of estrogen and progesterone. As a woman attains menopause, there is rapid bone loss which is believed to average approximately 2% to 3% over the following 5 to 10 years, and is greatest in the early post-menopausal years. A crucial regulator of reproductive physiology expressed by gonadotrophs in the anterior pituitary is follicle stimulating hormone which plays a critical role in modulating pro-inflammatory mediators and increases the risk of osteoporosis in post-menopausal women by causing osteoclast differentiation.
Materials & Methods: 60 postmenopausal women were selected who were aged between 45 and 65 years were divided into two groups: -
Group I: 30 postmenopausal women (aged between 45-54 years)
Group II: 30 postmenopausal women (aged between 55-56 years)
Each of the above groups were further divided into two subgroups i.e., 15 healthy subjects and 15 subjects with chronic periodontitis.
Serum FSH was estimated using the chemiluminescence technique after collection of blood from the anterior cubital vein and clinical parameters such as plaque index, gingival index, probing depth and clinical attachment loss were assessed for each patient. Intraoral periapical radiographs were taken of three different intraoral sites i.e., 11 & 21, 36 & 37 and 46 & 47.
Results: The results that there was an overall non-significant negative correlation between serum follicle stimulating hormone and periodontal parameters in the age group of 45-54 years of post-menopausal women.
Conclusion: The present study suggests that postmenopausal women with chronic periodontitis had a lower FSH level as compared to healthy subjects suggesting that FSH level does not directly correlate with the severity of periodontal disease or alveolar bone loss and increasing age alone can be a determinant of periodontal disease.

Keywords: Follicle stimulating hormone, menopause, alveolar bone loss.

Introduction
Hormonal factors influence periodontal treatment choices throughout a woman's life cycle. The clinician must therefore be able to identify, customize, and suitably modify periodontal therapy based on the woman's needs depending on the stage of her menstrual cycle [1]. Periodontitis is a chronic, multifactorial inflammatory condition linked to dental plaque accumulation (also known as dental biofilm) which is characterized by gradual destruction of supporting structures of the teeth, such as the periodontal ligament and alveolar bone [2]. The disease involves intricate and dynamic interactions between various pathogenic bacteria, harmful host immune responses, as well as environmental factors [3]. Hormones are specific regulatory molecules that modulate reproduction, growth and development, maintenance of the internal environment, as well as energy production, utilization, and storage [4]. Menopause is the period when there is cessation of ovarian secretion of estrogen and progesterone. It occurs approximately between 45-65 years of age.

The age of natural menopause in Indian women was found to be 46.2±4.9 years. It is characterized by physiological, psychological and biochemical changes that could lead to inflammation and metabolic bone disorders [5]. As a woman attains menopause, there is rapid bone loss which is believed to average approximately 2% to 3% over the following 5 to 10 years, and is greatest in the early post-menopausal years [6, 7]. A crucial regulator of reproductive physiology expressed by gonadotrophs in the anterior pituitary is FSH. Apart from playing a role in reproductive physiology, FSH also plays a critical role in modulating pro-inflammatory mediators. Pro-inflammatory mediators play a crucial role in bone resorption as they control the timing of osteoclast apoptosis [8]. FSH is known to elevate production of cytokines, primarily interleukin-6 (IL-6), IL-1β and tumor necrosis factor-alpha (TNFα) from macrophages to cause inflammation. It also enhances receptor activator of nuclear factor kB (RANK ligand) in monocytes and osteoclasts thereby promoting osteoclastic activity and increases the risk of osteoporosis in post-menopausal women by causing osteoclast differentiation [9]. Thus, considering the aforementioned facts; the purpose of this study is to estimate and compare serum FSH levels in different age groups of postmenopausal women with and without chronic periodontitis.

Materials and Methods

The present cross-sectional clinical study was carried out in the Department of Periodontics, Goa Dental College and Hospital. 60 postmenopausal women were selected for the study were divided into 4 groups:

Group 1: Healthy postmenopausal women in the age group of 45-54 years

Group 2: Healthy postmenopausal women in the age group of 55-65 years

Group 3: Postmenopausal women with chronic periodontitis in the age group of 45-54 years

Group 4: Postmenopausal women with chronic periodontitis in the age group of 55-65 years

Inclusion criteria

1. Women with no menses for 12 months or more after their final menstrual period (FMP) in the age group of 45-65 years.
2. Systemically healthy individuals.
3. Subjects who have at least 20 functional teeth.
4. Cooperative patients willing to participate in the study.
5. Probing depth (PD) ≥ 5mm or clinical attachment loss (CAL) ≥ 4mm on at least 6 teeth (periodontitis group).
6. Presence of maxillary central incisors, mandibular right and left first and second molars (periodontitis group).

Exclusion criteria

1. Patients with history of any systemic diseases.
2. Patients with thyroid/parathyroid disorder, osteoporosis and deficiency of vitamins.
3. Patients undergoing radiation therapy.
4. Patients under medications (antibiotics, anti-inflammatory drugs, bisphosphonates, calcium/vitamin D supplements) likely to alter parameters of the study.
5. Patients who are on hormone replacement therapy.
6. Patients with a history of periodontal treatment in the last 6 months.
7. Patients with any apparent oral infections (ex: herpes, candidiasis).
8. Tobacco (smoked or smokeless) users and.
9. Alcoholics.

Methodology

The study protocol was approved by the Institutional Ethics Committee, Goa Dental College & Hospital, Bambolim. All the subjects were explained about the procedures to be carried out and they willingly participated in the study. They signed a written informed consent form following which all subjects underwent a thorough history taking and clinical parameters such as plaque index (PI), gingival index (GI), probing depth (PD) and clinical attachment loss (CAL) were measured

Procedure for blood sample collection

A rubber tourniquet was tied slightly above the antecubital fossa of the subject's right/left arm. The vein was then palpated and the entire antecubital fossa was scrubbed with cotton soaked in surgical spirit. A 2ml disposable syringe was then used to withdraw 2ml of fresh blood sample from the anterior cubital vein of each subject, which was then transferred into a clean, plain, labelled vacutainer tube and allowed to clot at room temperature (Figure 1 and 2).

Estimation of FSH

The blood sample was stored at 4°C (if required) and centrifuged for 10 minutes at 3000 rpm and FSH was detected using the chemiluminescence technique using the Cobas e 411 machine (Figure 3).

Radiological procedure

IOPA radiographs were taken of the maxillary central incisors, mandibular right and left first and second molars using lone cone paralleling technique with the help of Rinn-XCP (X-ray cone paralleling) device. (Figure 4) The IOPAs were superimposed with a metallic grid with calibrations of 1mm × 1mm. The bone loss was measured interdentally between 11 & 21, 36 & 37 and 46 & 47 by measuring the calibrations from the cemento-enamel junction (CEJ) as the reference point to the apical most point of the bone defect (Figure 5).

Fig 1: Collection of blood from

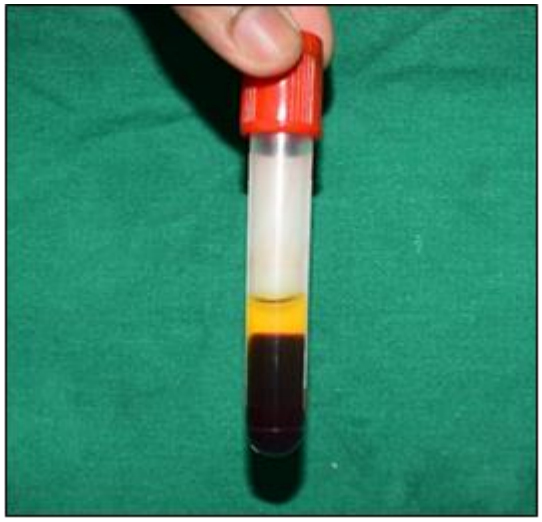

Fig 2: Collected serum sample anterior cubital vein

Fig 3: Cobas e 411 machine for

Fig 4: Radiograph taken using long cone paralleling technique

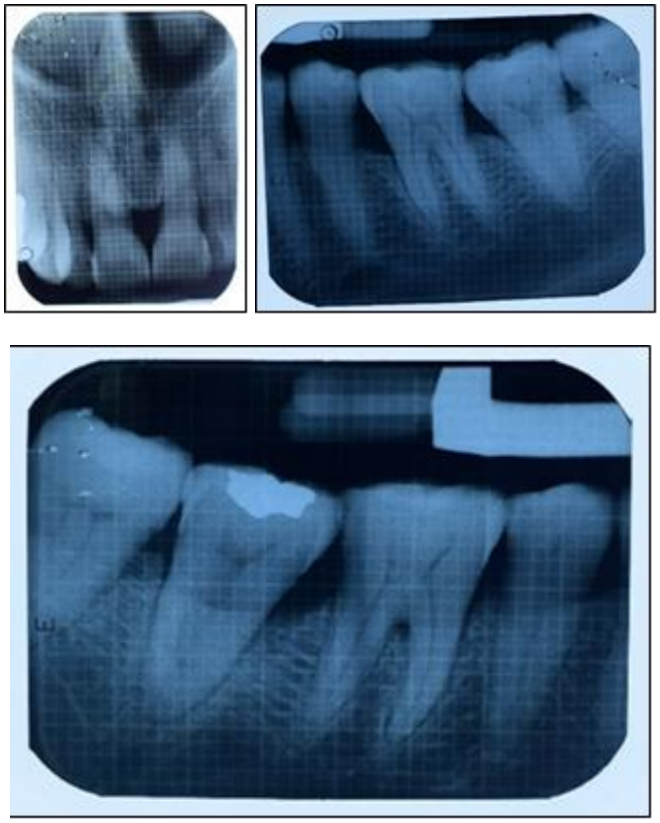

Fig 5: IOPA of 11 & 21, 36 & 37, 46 & 47

Statistical Analysis

STATA: Statistical software for data science by StataCorp LLC, version 15 was used for the analysis of data and to generate graphs and tables. The PI, GI, PD, CAL, FSH, current age and age of menopause initiation were reported for each group as mean and standard deviation. Shapiro Wilk test was conducted to check whether the data followed a normal distribution. For homogenous groups, a parametric test of Analysis of variance (ANOVA) was used to analyze if the four groups had any difference.

If significant, Tukey's Post Hoc test was then done to compare each group to the other pair-wise and gives the p-value and the mean difference between the two groups. For non-homogeneous groups, the non-parametric test of Kruskal Wallis was used to analyze if the four groups had any significance. Dwass-Steel-Critchlow-Flinger test was then done to compare each group to the other pair-wise providing with W- and p-value between the two groups. The null hypothesis of this study was that there is no correlation between serum FSH and chronic periodontitis. The research/alternate hypothesis was that there is a significant correlation between serum FSH and chronic periodontitis. 'p' value of < 0.05 was considered as statistically significant.

Results

Distribution of subjects

Group 1- 45-54 years (Healthy).
Group 2- 55-65 years (Healthy).
Group 3- 45-54 years (CP).
Group 4- 55-65 years (CP).

Demographics

The mean age of the study population was 54.35±5.2 years (Table 1) and the mean age of menopause in the study population was 48.65±3.52 years (Table 2).

Plaque index

The mean PI levels in Group 1 was 0.49, in Group 2 was 0.38, Group 3 was 1.12 and Group 4 was 0.89 (Table 3). Post hoc performed using Tukey's test showed statistically significant mean difference in PI levels between Group 1 and Group 3 (p=0.008), Group 2 and Group 3 (p=0.001), Group 2 and Group 4 (p=0.044). However, there was no statistically significant difference in PI between Groups 1 & 2 (p=0.940) and Groups 3 & 4 (p=0.638) (Table 4).

Gingival index

The mean GI levels in Group 1 was 0.24, in Group 2 was 0.15, Group 3 was 0.82 and Group 4 was 0.13 (Table 5). The Dwass-Steel-Critchlow-Flinger test showed statistically significant mean difference in GI between Groups 1 and 3 (p=0.008), Groups 1 and 4 (p<0.001), Groups 2 and 3 (p<0.001) and Groups 2 and 4 (p<0.001). However, there was no statistically significant difference between Groups 1 and 2 (p=0.869) and Groups 3 and 4 (p=0.677) (Table 6).

Probing depth

The mean PD levels in Group 1 was 1.86, in Group 2 was 1.85, Group 3 was 2.81 and Group 4 was 2.85 (Table 7). The Dwass-Steel-Critchlow-Flinger test showed statistically significant difference in PD between Groups 1 and 3, Groups 1 and 4, Groups 2 and 3, Groups 2 and 4 (p<0.001). However, the PD was statistically non-significant between Groups 1 and 2 (p=0.999) and Groups 3 and 4 (p=0.750) (Table 8).

Clinical attachment loss

The mean CAL levels in Group 1 was 1.9, in Group 2 was 1.87, Group 3 was 2.84 and Group 4 was 2.89 (Table 9). Post hoc performed using Tukey's test showed statistically significant mean difference in CAL between Groups 1 and 3, Groups 1 and 4, Groups 2 and 3, Groups 2 and 4 (p<0.001). However, the CAL was statistically non-significant between Groups 1 and 2 (p=0.998) and Groups 3 and 4 (p=0.978) (Table 10).

FSH

The mean FSH levels in Group 1 was 106.56, in Group 2 was 87.1, Group 3 was 83.15 and Group 4 was 65.8 (Table 11). Post hoc performed using Tukey's test showed statistically significant mean difference in FSH between Groups 1 and 3 (p=0.008), Groups 2 and 3 (p=0.001) and Groups 2 and 4 (p=0.044). However, there was no statistically significant difference between Groups 1 and 2 (p=0.940) and Groups 3 and 4 (p=0.638) (Table 12).

Interdental bone loss (BL)

The mean bone loss between 11 & 21 in Group 3 is 3.07 mm and Group 4 is 3 mm. The bone loss between 11 & 12 was significant in Group 3 (45-54 years) with p<0.001 (Table 13). The mean bone loss between 36 & 37 in Group 3 is 2.73 mm and Group 4 is 3.97 mm. However, the bone loss between 36 & 37 was statistically non-significant in both the groups (Table 14). The mean bone loss between 46 & 47 in Group 3 is 3.83 mm and Group 4 is 4.17 mm. The bone loss between 46 & 47 was significant in Group 3 (45-54 years) with p<0.001 (Table 15).

Overall correlation matrix

BL in 11 & 12 has a significant positive correlation between BL in 36 & 37, PD and CAL (p=0.017, p=0.003 and p=0.002 respectively). PI has a significant positive correlation with GI, PD and CAL (p<0.001). GI has a significant positive correlation with PD and CAL (p<0.001). PD has a significant positive correlation with CAL (p<0.001) and a significant negative correlation with FSH (0.045). CAL has a significant negative correlation with FSH (p=0.049), (Table 16).

Discussion

Periodontitis is characterized by resorption of the alveolar bone as well as loss of soft tissue attachment to the tooth, which further leads to tooth loss [10]. Endocrinal studies have shown that FSH elevates production of cytokines, namely IL-6, IL-1B and TNFα from macrophages to cause inflammation and also enhances formation of RANK ligand in monocytes and osteoclasts, thereby promoting osteoclastic activity and increases the risk of osteoporosis in post-menopausal women by causing osteoclast differentiation [11]. Hence, the present study was designed to estimate and compare serum FSH in different age groups of post-menopausal women with and without chronic periodontitis and to determine its association with periodontal inflammation and alveolar bone loss.

Menopause is a phase 12 months after a woman's last period or FMP [12]. The mean age of menopause of the study population is 48.65±3.52 years. The mean menopausal age of the Indian women as interpreted from a survey conducted by Ahuja in 2016 is 45.59±5.59 years [13].

The mean interdental bone loss between 36 & 37 was 2.73±1.29 mm in the age group of 45-54 years which was lower than the mean interdental bone loss noted in the age group of 55-65 years i.e., 3.97±2.09 mm and the mean interdental bone loss between 46 & 47 was 3.83±2.9 mm which was lower in the age group of 45-54 years than the mean interdental bone loss noted in the age group of 55-65 years i.e., 4.17±2.01 mm. These findings suggest that increasing age alone can be a determinant of alveolar bone loss. These results matched with the opinion of several researchers who stated that age would affect individual bone density. Along with increasing age, the bone mass will also decrease. Increased bone loss occurs with age, especially in elderly [11]. Other researchers also stated that bone mass loss might occur in the postmenopausal period at the rate of 0.5-1% of the total bone weight per year. Along with increasing age of one person, especially in postmenopausal period, the progressive bone mass loss will occur as a result of incomplete bone replacement or remineralization after resorption [14]. However, Sladina A, et al. stated that there is no association between age and tooth loss despite age being a risk factor for decreased bone mass in osteoporosis, and is not a causative factor, so it must be distinguished from the physiological ageing process [15].

Although statistically non-significant, the results of the study indicate that PI was higher in postmenopausal women in the age group of 45-55 years as compared to postmenopausal women in the age group of 55-65 years. In a study conducted by Deepa et al in 2016, among 90 postmenopausal women with a mean age of 55 years, 11 patients exhibited initial periodontal disease, 34 had established periodontal disease and 30 subjects had terminal periodontal disease. All the subjects exhibited a significantly high PI and this was attributed to the lack of awareness and absence of proper oral hygiene practices [16].

The GI is consistent with the PI of the healthy and chronic periodontitis groups. The increased gingival bleeding may be attributed to reduction in epithelial keratinization and drying of mucosa in postmenopausal women [17]. Post menopausal women may also develop menopausal gingivostomatitis, a

condition which is characterized by dry and shiny gingiva that bleed easily [18]. The results are consistent with the study conducted by Agrawal et al in 2021 which revealed a significantly higher gingival index in postmenopausal women between the age group of 40-60 years [19].

The mean PD in healthy postmenopausal women in the age group of 45-54 years and 55-65 years (1.86±0.29 and 1.85±0.25 respectively) was lower than in postmenopausal women with chronic periodontitis in the age group of 45-54 years and 55-65 years (2.81±0.45 and 2.85±0.34 respectively). This difference was statistically significant (p<0.001). The above results could be attributed to generalized bone loss that occurs in postmenopausal women which results in decreased BMD in the maxilla and mandible [20].

The mean clinical attachment loss in healthy postmenopausal women in the age group of 45-54 years and 55-65 years (1.9±0.33 and 1.87±0.22 respectively) was lower than in postmenopausal women with chronic periodontitis in the age group of 45-54 years and 55-65 years (2.81±0.45 and 2.85±0.34 respectively). This difference was statistically significant (p<0.001). These results were consistent with a study conducted by Iwasaki et al in 2013 and Brennan et al in 2007 where postmenopausal women with an average age of 68.2 years with a low BMD exhibited a greater CAL [20, 21].

In this study, the mean FSH level in healthy postmenopausal women was higher in the age group of 45-54 years (106.56±37.27 mIU/mL) than in the age group of 55-65 years (87.1±35.3 mIU/mL). But this difference was statistically non-significant (p=0.371). Likewise, the mean FSH level was higher in postmenopausal women with chronic periodontitis in the age group of 45-54 years (83.15±29.36 mIU/mL) than in the age group of 55-65 years (65.8±28 mIU/mL). But this difference was statistically non-significant (p=0.473). There was also a non-significant negative correlation between age of menopause and FSH levels (r=-0.05, p=0.728).

According to literature, FSH levels are relatively high during the early postmenopausal phase as compared to the late postmenopausal phase [22]. This is consistent with the results obtained in the present study. Although, statistically non-significant, FSH was higher in postmenopausal women in the age group of 45-54 years in healthy as well as in subjects with chronic periodontitis.

The mean FSH level in postmenopausal women with chronic periodontitis in the age group of 45-54 years and 55-65 years was lower (83.15±29.36 mIU/mL and 65.8±28 mIU/mL respectively) as compared to healthy postmenopausal women in the same age groups (106.56±37.27 mIU/mL and 87.1±35.3 mIU/mL respectively). There was an overall significant negative correlation between FSH levels and PD (r=-0.26, p=0.045) and CAL (r=-0.26, p=0.045) and a non-significant negative correlation between FSH and bone loss between 36 & 37 (r=-0.03, p=0.89) and bone loss between 46 and 47 (r=-0.21, p=0.255).

These results are in contrast to a previous study conducted on an animal model by Liu S et al in 2010 where FSH significantly increased alveolar bone resorption compared with non-FSH treated ovariectomized (OVX) rats (p< 0.05).(9) However, there was an overall non-significant positive correlation between FSH and bone loss between 11 & 21 (r=0.26, p=0.162), PI (r=0.04, P=0.783) and GI (r=0.04, p=0.76) which is in accordance with an animal study conducted by Qian H et al. in 2020 where high FSH increased mRNA expressions of proinflammatory cytokines such as IL-1β, IL-6, and TNF-α in human periodontal ligament cells.(23) In another study conducted by Park et al in 2021, increased FSH levels decreased BMD of spine and hip independent of estrogen [24]. The results of this study are in contrast to another animal study conducted by Liu et al in 2010 where FSH significantly increased alveolar bone resorption compared with non-FSH-treated OVX rats (p< 0.05) [7].

Limitations

1. Sample size of 60 (15 patients per group) may have posed limitations in establishing conclusions. Large and diverse sample size could have perhaps contributed to more accurate conclusions.
2. Serum estrogen was not taken into consideration in the present study. There is a decrease in the estrogen levels in postmenopausal women and estrogen plays a significant role in periodontal inflammation and alveolar bone loss and could have been a confounding factor.
3. Radiographs were taken of only 3 sites i.e., 11 & 21, 36 & 37 and 46 & 47 which did not reveal the overall status of the alveolar bone.
4. With respect to the age of menopause, there could have been a possible recall bias with some patients.
5. Higher bone loss was noted in the age group of 55-65 years suggesting that age could have been a possible confounding factor.

Table 1: Mean age of the study population.

Age group	N	Mean	Median	Standard deviation	Shapiro Wilk test	
					W	P
45-65	60	54.35	54.5	5.2	0.97	0.235

Table 2: Mean age of menopause of the study population.

Age group	N	Mean	Median	Standard deviation	Shapiro Wilk test	
					W	P
45-65	60	48.65	49	3.52	0.96	0.058

Table 3: Intergroup comparison of PI using Shapiro Wilk test

Age group	Group	N	Mean	Median	Standard deviation	Shapiro Wilk test	
						W	p
45-54	CP	15	1.12	1.1	0.72	0.9	0.085
	Healthy	15	0.49	0.26	0.48	0.77	0.001
55-65	CP	15	0.89	0.96	0.47	0.95	0.454
	Healthy	15	0.38	0.20	0.34	0.82	0.006

Table 4: Pairwise intergroup comparison using Tukey's Post hoc test

Groups	Mean Difference	P-Value
1 v/s 2	0.11	0.940
3 v/s 1	0.63	0.008
4 v/s 1	0.40	0.156
3 v/s 2	0.74	0.001
4 v/s 2	0.51	0.044
3 v/s 4	0.22	0.638

Table 5: Intergroup comparison of GI using Shapiro Wilk test

Age group	Group	N	Mean	Median	Standard deviation	Shapiro Wilk test	
						W	p
45-54	CP	15	0.82	0.50	0.67	0.77	0.001
	Healthy	15	0.24	0.20	0.26	0.85	0.017
55-65	CP	15	1.13	0.91	1.05	0.75	<0.001
	Healthy	15	0.15	0.07	0.19	0.74	<0.001

Table 6: Pairwise intergroup for GI using Dwass-Steel-Critchlow-Fligner Post hoc test

	W	P-Value
1 v/s 2	-1.09	0.869
1 v/s 3	4.49	0.008
1 v/s 4	5.43	<0.001
2 v/s 3	5.78	<0.001
2 v/s 4	6.02	<0.001
3 v/s 4	1.58	0.677

Table 7: Intergroup comparison of PD using Shapiro Wilk test

Age group	Group	N	Mean	Median	Standard deviation	Shapiro Wilk test	
						W	P
45-54	CP	15	2.81	2.6	0.45	0.75	<0.001
	Healthy	15	1.86	2.01	0.29	0.88	0.04
55-65	CP	15	2.85	2.71	0.34	0.88	0.05
	Healthy	15	1.85	1.84	0.25	0.93	0.305

Table 8: Pairwise comparison using Dwass-Steel-Critchlow-Fligner Post hoc test

	W	P-Value
1 v/s 2	-0.21	0.999
1 v/s 3	6.6	<0.001
1 v/s 4	6.6	<0.001
2 v/s 3	6.6	<0.001
2 v/s 4	6.6	<0.001
3 v/s 4	1.41	0.750

Table 9: Intergroup comparison of CAL using Shapiro Wilk test

Age group	Group	N	Mean	Median	Standard deviation	Shapiro Wilk test	
						W	P
45-54	CP	15	2.84	2.6	0.46	0.77	0.002
	Healthy	15	1.9	2.01	0.33	0.91	0.130
55-65	CP	15	2.89	2.85	0.34	0.90	0.082
	Healthy	15	1.87	1.88	0.22	0.94	0.405

Table 10: Pairwise inter-group comparison of CAL using Tukey Post hoc test

	Mean Difference	P-Value
1 v/s 2	0.02	0.998
3 v/s 1	0.94	**<0.001**
4 v/s 1	0.99	**<0.001**
3 v/s 2	0.96	**<0.001**
4 v/s 2	1.01	**<0.001**
3 v/s 4	0.05	0.978

Table 11: Intergroup comparison of FSH using Shapiro Wilk test (mIU/ml)

Age group	Group	N	Mean	Median	Standard deviation	Shapiro Wilk test	
						W	P
45-54	CP	15	83.15	83.04	29.36	0.97	0.905
	Healthy	15	106.56	98.66	37.27	0.94	0.338
55-65	CP	15	65.8	61.00	28	0.92	0.202
	Healthy	15	87.1	82.35	35.3	0.83	0.009

Table 12: Pair-wise intergroup comparison using Tukey Post hoc test

	Mean Difference	P-Value
1 v/s 2	19.46	0.371
1 v/s 3	23.41	0.215
1 v/s 4	40.76	0.006
2 v/s 3	3.95	0.987
2 v/s 4	21.29	0.292
3 v/s 4	17.34	0.473

Table 13: Descriptive statistics of BL-11 & 21 (mm)

Age group	Group	N	Mean	Median	Standard deviation	Shapiro Wilk test	
						W	P
45-54	CP	15	3.07	3	2.15	0.7	< 0.001
55-65	CP	15	3	3	1.07	0.93	0.316

Table 14: Descriptive statistics of BL-36 & 37 (mm)

Age group	Group	N	Mean	Median	Standard deviation	Shapiro Wilk test	
						W	P
45-54	CP	15	2.73	3	1.29	0.96	0.772
55-65	CP	15	3.97	4	2.09	0.82	0.007

Table 15: Descriptive statistics of BL-46 & 47 (mm)

Age group	Group	N	Mean	Median	Standard deviation	Shapiro Wilk test	
						W	P
45-54	CP	15	3.83	3	2.9	0.72	< 0.001
55-65	CP	15	4.17	3.5	2.01	0.82	0.006

Table 16: Overall correlation matrix to study association between variables using Pearson's correlation test

	BI-11&21	BL-36&37	BL-46&47	Meno-pause age	PI	GI	PD	CAL	FSH
BI-11&21									
BL-36&37	0.43 (0.017)								
BL-46&47	0.707 (0.708)	0.08 (0.664)							
Meno-pause age	0.05 (0.774)	0.29 (0.12)	-0.03 (0.89)						
PI	0.36 (0.054)	0.10 (0.587)	-0.22 (0.251)	-0.11 (0.418)					
GI	-0.03 (0.886)	0.18 (0.352)	-0.12 (0.542)	0.07 (0.614)	0.66 (<0.001)				
PD	0.52 (0.003)	0.32 (0.088)	0.08 (0.655)	0.05 (0.68)	0.59 (<0.001)	0.53 (<0.001)			
CAL	0.55 (0.002)	0.33 (0.072)	0.08 (0.68)	0.04 (0.756)	0.61 (<0.001)	0.57 (<0.001)	0.99 (<0.001)		
FSH	0.26 (0.162)	-0.03 (0.89)	-0.21 (0.255)	-0.05 (0.728)	0.04 (0.783)	0.04 (0.76)	-0.26 (0.045)	-0.26 (0.049)	

Conclusion

To our best knowledge, there are no studies assessing the relationship between FSH and chronic periodontitis. The present study suggests that postmenopausal women with chronic periodontitis had a lower FSH level as compared to healthy subjects suggesting that FSH level does not directly correlate with the severity of periodontal disease or alveolar bone loss and increasing age alone can be a determinant of periodontal disease.

Further studies with a larger sample size are required to identify FSH as a potential marker for periodontal disease.

Conflict of Interest

Not available

Financial Support

Not available

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