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Original article

Serum Biomarkers and Periodontal Disease in Gharyan Teaching Hospital Hemodialysis Libyan Patients

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Abstract
Periodontal disease is increasingly recognized as a contributor to systemic inflammation and complications in patients with chronic kidney disease (CKD) undergoing hemodialysis. This study aimed to examine the association between serum biomarkers—including hemoglobin (Hb), creatinine, urea, uric acid, triglycerides, random blood sugar (RBS), and C-reactive protein (CRP) and periodontal disease in hemodialysis patients at Gharyan Teaching Hospital (GTH), with a focus on understanding their potential impact on systemic inflammation and disease management. A longitudinal observational study was conducted on male and female hemodialysis patients at Gharyan Teaching Hospital. Serum levels of the selected biomarkers were measured monthly over three months, alongside assessments of periodontal status. Spearman's correlation analyses were used to explore relationships between serum biomarker levels and clinical variables, with significance set at $p < 0.05$. Among 99 patients (63 males, 36 females), xerostomia, gingival inflammation, and poor oral hygiene were observed in 58%, 65%, and 72%, respectively, with females more affected. Hemoglobin was low in 82%, while WBC and platelet counts were mostly normal; urea and creatinine were elevated in all. Bleeding on probing was strongly associated with worse periodontal outcomes: pathological probing depths (≥4 mm) and clinical attachment loss (≥3 mm) were more frequent in those with bleeding (98.5% vs. 59.4%, $p < 0.001$). Additionally, moderate to severe root exposure and abundant plaque were significantly higher in the bleeding group, whereas healthy pockets, normal gingival margins, and minimal plaque were more common among non-bleeding individuals ($p = 0.001$). The findings reveal gender-specific biochemical patterns in hemodialysis patients that may influence or reflect the systemic inflammatory burden related to periodontal disease. Elevated triglycerides linked with urea and associations between nutritional markers and uric acid highlight the metabolic disturbances exacerbated by renal dysfunction. The observed correlations between glucose metabolism and renal biomarkers in females emphasize the need to consider gender differences when addressing periodontal and systemic inflammation in this population. The significant associations, particularly between GI and CRP, support the inclusion of periodontal evaluation and care in the comprehensive management of hemodialysis patients. This study underscores the significant associations between serum biomarkers and systemic factors potentially related to periodontal disease in hemodialysis patients. The gender-specific variations in these associations highlight the importance of personalized monitoring and management of metabolic and inflammatory markers to improve outcomes for CKD patients undergoing hemodialysis, particularly in relation to periodontal health.
Keywords: *Hemodialysis, Periodontal Disease, Serum Biomarkers, Systemic Inflammation*

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Introduction

The mouth is a crucial diagnostic tool in the clinical assessment of systemic health. A patient's dental health may be impacted by a variety of medical conditions. Dentists expect to see more patients with complex medical issues because of improvements in medical research and higher survival rates for many illnesses [1]. Unusual mouth results have been associated with several systemic disorders, such as diabetes mellitus, coronary heart disease (CHD), graft versus host disease, infection, and chronic kidney disease (CKD).

Epidemiological research has connected dental illness, especially periodontitis, to poor health outcomes in non-oral tissues. However, systemic illnesses such as diabetes and chronic renal disease have been linked to a higher prevalence, severity, and progression of periodontitis in humans [2,3]. Furthermore, periodontitis is regarded as a risk factor for CKD because the inflammatory response to periodontal disease may contribute to the buildup of periodontal inflammation and chronic systemic inflammatory burden. As a result, it has been connected to the steady decline in renal function [4].

Additionally, according to current international recommendations, a patient is diagnosed with CKD if their glomerular filtration rate (GFR) is less than 60 ml/min per 1.73 m2, and they exhibit signs of renal impairment for at least three months [5]. In 2012, CKD was the fourteenth largest cause of death, with 12.2 deaths per 100,000. The World Health Organization (WHO) estimates that 864,226 individuals died from this condition in 2012 [6]. Nonetheless, it appears that periodontal disease stimulates inflammation based on the association between inflammatory markers and periodontitis in CKD patients. Moreover,

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periodontitis, which is associated with elevated levels of C-reactive protein (CRP) in individuals with CKD, may have a substantial impact on chronic inflammation [7].
Moreover, CKD has been shown to impact not only the periodontium, teeth, oral mucosa, salivary glands, and tongue [8], but also the mouth cavity, bone, and mandibular joints [9]. An inflammatory immune system and abnormal collagen synthesis are associated with this [10]. A systemic inflammatory response, immunosuppression, metabolic disturbance, a compromised defense mechanism against infections, and a diminished capacity for self-healing are some of the causes of periodontal disease [11].
In addition, dialysis patients may experience a range of oral symptoms in their oral cavity. These include changes in the oral mucosa, teeth (caries), salivary glands (xerostomia), and periodontium (gingivitis, periodontitis), causing bacteremia episodes and atherosclerotic consequences. Apart from oral health problems and certain diseases, people with HD should be especially mindful of their dental health due to certain systemic symptoms that are frequently linked to chronic kidney disease [12].
On the other hand, serum creatinine is a common metric for assessing renal function and GFR in the context of the relationship between certain variables and periodontitis in HD patients. Its serum level increases in people with chronic renal disease because renal clearance is decreased [13,14]. Additionally, some hematological and genetic disorders have been connected to the development and course of periodontitis [15]. The presence of periodontopathogen bacteria in combination with bacterial components such as lipopolysaccharide and endotoxin has been shown in studies on the pathophysiology of periodontal disease. These components can trigger an immunological inflammatory response characterized by the release of inflammatory mediators, which are important factors associated with the degeneration of periodontal tissue. One of the potential risk factors for the fatalities of hemodialysis patients was evaluated to be periodontal disease [16-18].
However, there is strong evidence that chronic inflammation has a major impact on the levels of nutritional and inflammatory indicators in hemodialysis patients, including serum albumin, C-reactive protein, and other biomarkers [19]. A high CRP level is a strong predictor of cardiovascular events and adverse outcomes, denotes an inflammatory state, and is commonly associated with chronic disease [20].
Furthermore, research is still being conducted on systemic disease variables, which are one of the primary factors impacting periodontal disease [21]. Low blood levels of high-density lipoprotein (HDL) have been identified as a risk factor for cardiovascular disease in several previous epidemiological studies [22]. Choi et al. [23], Nepomuceno et al. [24], and Abraham et al. [25] also discovered a significant correlation between periodontitis and triglyceride levels, HDL-cholesterol (HDL-C), and low HDL-C, respectively.
Accordingly, this study aimed to examine the association between serum biomarkers, including hemoglobin (Hb), creatinine, urea, uric acid, triglycerides, random blood sugar (RBS), CRP, and periodontal disease in hemodialysis patients at Gharyan Teaching Hospital (GTH), with a focus on understanding their potential impact on systemic inflammation and disease management.

Methods

Study design, population, and criteria

This study was carried out at GTH, Gharyan, Libya, and was planned as a longitudinal, observational, and comparative inquiry. The study population consisted of adult patients with end-stage renal disease (ESRD) receiving continuous hemodialysis at GTH during the study period. 99 individuals, ages 25 to 80, were enrolled in the current study; 63 of them were males and 36 were females. Individuals diagnosed with end-stage renal disease and receiving regular hemodialysis for at least six months with no history of recent periodontal treatment within the last three months were included in this study. On the other hand, patients with systemic conditions known to independently affect periodontal health (e.g., diabetes mellitus, autoimmune diseases), those who have used antibiotics or anti-inflammatory medications in the last 2 weeks, who have an active cancer, or have had periodontal therapy during the last six months, and pregnant women were excluded.

Data collection and examinations

Demographic and clinical data were collected through structured interviews (with a specially formulated questionnaire) and review of medical records, including Age, gender, and duration of hemodialysis. Hemodialysis bed patients underwent supine clinical examinations. This comprises a comprehensive examination of the gums and mouth to determine the gingival health and the degree of periodontal inflammation, in accordance with the current classification of periodontal diseases and peri-implant disorders (2017). Recession was categorized using Miller's classification, and tooth mobility was categorized using the Loe and Silness indices. The PI was then calculated by measuring the buccal, lingual, mesial, and distal regions of each tooth, yielding a score ranging from 0 to 3. The Loe and Silness Gingival Index was used to measure gingival inflammation, and results ranged from 0 to 3. The presence or absence of bleeding following probing was indicated by the BOP index, which was calculated as a percentage. Venous blood

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samples for biomedical parameters measurement were collected under aseptic conditions before the dialysis session to avoid dilutional effects.

Ethical considerations and statistical analysis

The study received ethical approval from the Postgraduate Academy's scientific committee. Written informed consent was obtained from each participant prior to clinical and laboratory research. Throughout the study, participants' confidentiality and privacy were strictly maintained. The data was determined to be normally distributed based on the findings of the Kolmogorov-Smirnov test. The association between serum biomarkers and the degree of periodontal disease was assessed using Spearman's correlation and Pearson's correlation. Logistic regression analysis. For intergroup comparisons between the variables, the Student's t-test and chi-square test were employed, with a significance level set at $\alpha < 0.05$. A 95% confidence interval was also computed for the odds ratio. For statistical analysis, SPSS software (version 22, Chicago, IL, USA) was utilized.

Results

The study comprised 99 hemodialysis patients from GTH, with a gender distribution skewed toward males, who made up 63.6% (n=63) of the participants, and females, who made up 36.3% (n=36), according to the results in (Table 1). This male preponderance is in line with more general epidemiological trends that are frequently seen in ESRD patients, where CKD is more common in the male population. The average age of male participants was 51.6 years (±11.4), which was marginally older than the average age of female participants, which was 48.6 years (±12.8).

Table 1. Total number of participants and mean/ ± SD of age.

Gender	Participants no.	Percent %	Age	
Male	63	63.6 %	Mean	51.6
			± SD	11.4
Female	36	36.3 %	Mean	48.6
			± SD	12.8

The data presented in Table 2 provide a clear breakdown of the distribution of male and female hemodialysis patients at GTH according to the duration of dialysis treatment, measured in years. This is a critical demographic and clinical variable in the context of the current study, as the duration of hemodialysis has direct implications for both systemic health status and periodontal condition.

Table 2. Frequency and percent of males and females according to the duration of hemodialysis/years.

Duration of hemodialysis/years	Male Frequency/percent %	Female Frequency/percent
< one year	4 (6.3%)	4 (11.1%)
1-3 years	18 (28.5%)	13 (36.1%)
3-5 years	27 (42.8%)	17 (47.2%)
> 5 years	14 (22.2%)	2 (38.8%)
Total	63 (100%)	36 (100%)

Figure 1 displays the prevalence of self-reported symptoms of periodontal disease in both male and female hemodialysis patients at GTH. The common clinical signs of periodontitis, a chronic inflammatory disease that damages the tissues that support teeth, are among these symptoms. Analyzing the distribution of these symptoms is essential to achieving the study's objectives, particularly those related to estimating the incidence of periodontal disease and its inflammatory effects in connection with CKD.

According to the findings, both male and female patients have a high prevalence of periodontal issues, underscoring the substantial burden of dental illness in this demographic. At 87.3% for men and 91.6% for women, persistent bad breath (halitosis) was the most reported symptom. Halitosis is a powerful marker of persistent periodontal disease since it is frequently linked to bacterial buildup, gingival inflammation, and plaque-related biofilm. Furthermore, a sizable portion of participants—50% of women and 58.7% of men reported tooth movement, which is an indication of severe periodontal disease, specifically the loss of attachment and resorption of alveolar bone.

Additionally, with 22.2% of men and 36.1% of women having swollen or sore gums, as well as a comparable percentage reporting gum recession, these conditions were also often observed. Additionally, although less common, chewing pain and pus formation were clinically significant. While only one male patient (1.5%)

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reported pus discharge, which suggests an active infection or an abscess, 12.6% of males and 13.8% of females reported pain during mastication, indicating acute or severe inflammation. Furthermore, none of the female participants were symptom-free, and just three males (4.7%) reported having no periodontal symptoms.

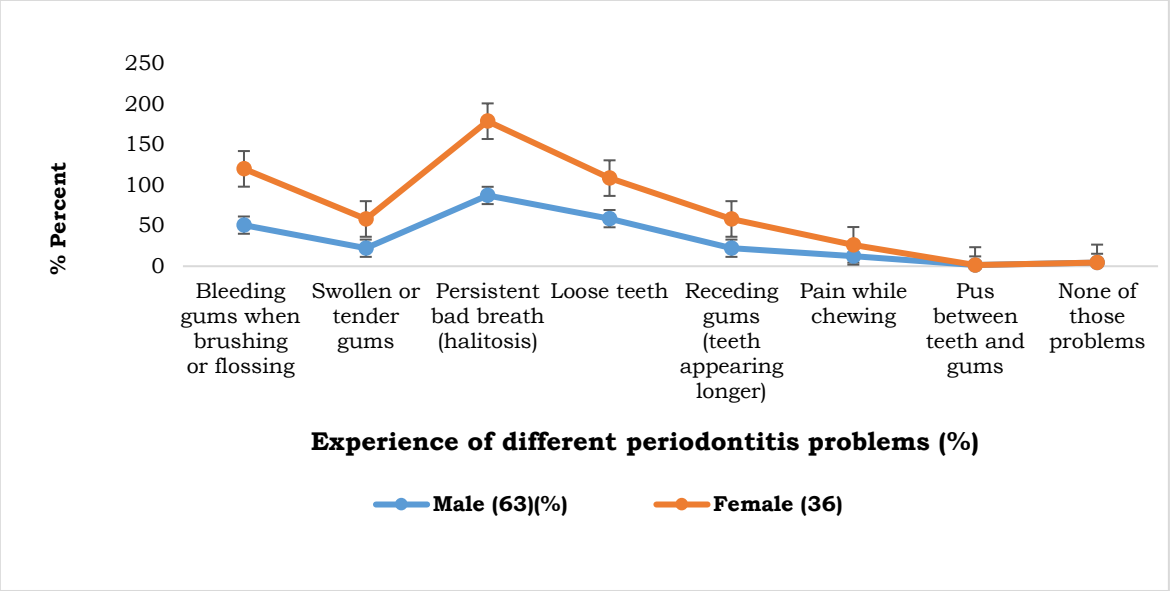

Figure 1. Frequency and percent of the participants (male and female) depending on the experience of different periodontitis problems.

Regarding laboratory investigations of different blood biomarkers for hemodialysis patients who participated in this study, in the first month, the mean Hb concentration in males was 9.57 g/dl (±2.16), indicating moderate anemia, as normal levels in adult males are generally considered to be ≥13 g/dl. Conversely, by Month 2, the mean Hb rose slightly to 10.2 g/dl (±1.68) and remained stable in Month 3 at 10.2 g/dl (±1.67). Regarding female participants, in month 1, females had a slightly higher mean Hb concentration of 9.9 g/dl (±2.1), like the male range and consistent with anemia (normal in adult females is ≥12 g/dl). In month 2, an unusual spike in mean Hb was observed, reaching 13.25 g/dl, but with a very high standard deviation (±17.6). The CRP levels, a focus of this study, may be indirectly influenced by low hemoglobin levels, as anemia of chronic disease is tightly associated with inflammatory states. Additionally, while female participants initially demonstrated slightly higher mean Hb, the large variation in Month 2 complicates direct comparison. By Month 3, male and female values converged, with males at 10.2 g/dl and females at 10.58 g/dl, showing no substantial gender disparity in the anemic status by the end of the observation period.

The levels of urea, a crucial metabolic waste product, are a biochemical indicator of protein metabolism, renal function, and the efficacy of dialysis therapy; in the first month, males had a mean urea level of 156.9 mg/dl (±51.5). By Month 2, levels increased to 162.7 mg/dl (±44.6), and slightly more in Month 3, reaching 163.9 mg/dl (±50.3). On the other hand, females started with a mean of 158.9 mg/dl (±52.1) in Month 1, which slightly declined to 153.3 mg/dl (±52.18) in Month 2, before rising again to 157.3 mg/dl (±52.2) in Month 3. Unlike males, females did not show a steady increase, but rather fluctuated mildly within a similar range, suggesting relative stability in urea levels.

CRP is a well-known indicator of systemic inflammation, and it is frequently linked to cardiovascular risk, CKD, and (most critically for this study) periodontitis. Accordingly, after three months of hemodialysis, male participants had a mean CRP level of 48.4 mg/L (±59.8). This is markedly elevated, considering that the normal CRP range is typically <5 mg/L in healthy individuals. The high standard deviation suggests considerable variability among male patients, indicating that while some had moderately elevated CRP, others may have had very high inflammatory levels, possibly due to coexisting infections, comorbidities (like diabetes), or severe periodontal disease. In contrast to male patients, female patients had a dramatically higher mean CRP level of 158.9 mg/L (±52.15).

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Table 3. Mean value and standard deviation of different biomarkers investigated in the blood samples of study participants during three months of hemodialysis.

Time of Invest.	Sex	Mean (± SD)							
		Hb	Urea	Alb.	Crea.	RBS	TG	UA	CRP
1st month	M	9.57 (2.16)	156.9 (51.5)	3.6 (0.6)	13.9 (5.1)	105.3 (23.8)	171.3 (56.9)	7.4 (1)	
	F	9.9 (2.1)	158.9 (52.1)	3.7 (0.4)	14.7 (4.4)	109.4 (35.3)	202.5 (93.5)	7.4 (1.3)	
2nd month	M	10.2 (1.6)	162.7 (44.6)	3.6 (0.5)	13.3 (4.3)	105.2 (23.8)	163.9 (59.1)	7.19 (0.8)	
	F	13.2 (1.6)	153.3 (52.1)	3.6 (0.4)	14.6 (4.4)	110.4 (15.9)	184.8 (77.5)	7.5 (1.3)	
3rd month	M	10.2 (1.6)	163.9 (50.3)	3.7 (1.4)	13.6 (5.2)	105.1 (20.7)	174.2 (52)	7.2 (0.9)	48.4 (5.9)
	F	10.5 (1.5)	157.3 (52.2)	3.7 (0.5)	14.6 (4.1)	112.8 (11.9)	187.4 (69.8)	7.5 (1.1)	158.9 (5.1)

SD: Standard Deviation; Hb: Hemoglobin; Alb.: Albumin; Crea.: Creatinine; RBS: Random Blood Sugar; TG: Triglycerides; UA: Uric Acid; CRP: C-Reactive Protein.

For individuals with CKD, serum albumin is a crucial indicator of inflammation, nutritional status, and general health. Malnutrition-inflammation complex syndrome (MICS), which is prevalent in hemodialysis patients and markedly raises the risk of morbidity and death, is closely linked to low albumin levels. Dependently, across all three months, both male and female patients maintained relatively stable albumin levels ranging between 3.6 and 3.7 g/dl. These values fall within the lower end of the normal range (typically 3.5–5.0 g/dl), suggesting that while gross hypoalbuminemia is not present, the cohort is still at risk of mild protein-energy wasting or chronic inflammation.

On the other hand, among male participants, the mean creatinine level in the first month was 13.9 mg/dl with a SD of ±5.19. In the second month, the mean slightly decreased to 13.3 mg/dl (±4.39), followed by a modest increase to 13.6 mg/dl (±5.2) in the third month. For female participants, the mean creatinine levels were consistently higher than those of males in each of the three months. The mean in the first month was 14.7 mg/dl with an SD of ±4.4, followed by a slight dip to 14.6 mg/dl (±4.4) in the second month, and a similar value of 14.6 mg/dl (±4.1) in the third month.

The RBS levels in male participants remained nearly unchanged throughout the study. Female participants, on the other hand, demonstrated slightly higher RBS levels compared to males across all three months. Additionally, the triglyceride levels exhibited slight fluctuations. In the first month, the mean value was 171.3 mg/dl with a standard deviation (SD) of ±56.9. This level slightly decreased to 163.9 mg/dl (±59.19) in the second month, followed by a modest rise in the third month to 174.2 mg/dl (±52.04). In contrast, female participants exhibited consistently higher triglyceride levels throughout the study. During the first month, the mean was 202.5 mg/dl (±93.5), which decreased to 184.8 mg/dl (±77.5) in the second month, and slightly increased again to 187.4 mg/dl (±69.8) by the third month.

The evaluation of uric acid levels in male and female hemodialysis patients over three months demonstrates a generally stable biochemical profile across time and between genders, with minor fluctuations. In male participants, the mean uric acid level in the first month was 7.4 mg/dl with a standard deviation (SD) of ±1.05. For female participants, the initial mean uric acid level was also 7.4 mg/dl (±1.3) in the first month, which increased slightly to 7.5 mg/dl (±1.3) in the second month, and remained unchanged in the third month at 7.5 mg/dl, with a slightly lower SD of ±1.14.

Table 4. Correlations between Periodontal Markers and Biochemical Parameters.

Periodontal Marker	RBS r (p-value)	Hemoglobin r (p-value)	Urea r (p-value)	Creatinine r (p-value)	Triglyceride r (p-value)	Albumin r (p-value)	Uric Acid r (p-value)	CRP r (p-value)
Bleeding on Probing	-.090 (.377)	-.105 (.301)	-.087 (.390)	-.013 (.897)	-.110 (.279)	-.019 (.852)	-.007 (.947)	-.033 (.748)
Tooth Mobility Category	.064 (.532)	-.098 (.336)	-.074 (.466)	.115 (.257)	-.089 (.380)	-.024 (.815)	.003 (.976)	.175 (.084)
PPD Category	.066 (.517)	.104 (.304)	-.059 (.564)	.195 (.053)	-.013 (.895)	-.208 (.038)*	-.111 (.275)	.144 (.155)
GR Category	.059 (.562)	-.139 (.169)	-.039 (.703)	.078 (.443)	-.136 (.180)	-.161 (.110)	-.112 (.270)	.123 (.224)

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CAL Category	.066 (.517)	.104 (.304)	-.059 (.564)	.195 (.053)	-.013 (.895)	-.208 (.038)*	-.111 (.275)	.144 (.155)
Plaque Index Category	-.052 (.607)	-.095 (.352)	-.017 (.869)	-.202 (.045)*	.069 (.498)	.002 (.986)	-.071 (.484)	-.282 (.05)*
Gingival Index Category	.059 (.559)	.094 (.354)	-.030 (.771)	.204 (.043)*	-.087 (.394)	-.108 (.288)	.063 (.533)	.418 (<.001)*

*r = Spearman correlation coefficient, * Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed*).

Several noteworthy trends were found in this study's associations between biochemical parameters and periodontal indicators in hemodialysis patients (Table 4). All biochemical variables had modest, non-significant associations with BOP (r values close to zero, $p > 0.05$), indicating that systemic influences had no discernible impact on BOP. Although there was a minor trend toward greater mobility with higher systemic inflammation, tooth mobility also showed weak, non-significant relationships with CRP ($r = 0.175$, $p = 0.084$). For PPD, there was a significant negative correlation with serum albumin ($r = –0.208$, $p = 0.038$), implying that lower albumin levels—commonly associated with malnutrition or inflammation in chronic kidney disease—were linked to deeper periodontal pockets. A borderline positive correlation was observed between PPD and creatinine ($r = 0.195$, $p = 0.053$), suggesting a potential but not statistically confirmed association between worsening renal function and increased periodontal pocketing. CAL followed the same pattern as PPD, with a significant negative correlation with albumin ($r = –0.208$, $p = 0.038$). In contrast, the GI displayed the strongest and most clinically relevant associations, showing a positive correlation with creatinine ($r = 0.204$, $p = 0.043$) and a robust positive correlation with CRP ($r = 0.418$, $p < 0.001$). These results indicate that worsening gingival inflammation was closely associated with both renal dysfunction and systemic inflammation.

Discussion

Results of the current study revealed that the data were in line with a typical adult hemodialysis population; many participants (63.6%) were male, and the mean age of the males and females was roughly 51.6 and 48.6 years, respectively. Most patients had been receiving hemodialysis for one to five years, while the length of time varied greatly. The systemic biochemical milieu and observed periodontal health are probably influenced by this long-term exposure to dialysis treatment. Low-grade chronic inflammation is the hallmark of the inflammatory response linked to Parkinson's disease (PD), and higher levels of inflammatory biomarkers, such as serum C-reactive protein, have been linked to systemic effects [26,27]. Inflammatory biomarker levels will decrease as periodontal health improves [28,29].

The correlations between periodontal markers and biochemical parameters in hemodialysis patients at Gharyan Teaching Hospital provide valuable insight into the relationship between oral health and systemic inflammation in chronic kidney disease (CKD). The strong positive correlation between the gingival index (GI) and C-reactive protein (CRP) ($r = 0.418$, $p < 0.001$) indicates that greater gingival inflammation is associated with elevated systemic inflammation. This supports previous evidence suggesting that periodontal disease contributes to the systemic inflammatory burden in CKD populations [30,31]. Elevated CRP is an established predictor of cardiovascular complications and mortality among dialysis patients [32], making this finding particularly relevant to systemic disease management. Additionally, the positive association between GI and creatinine ($r = 0.204$, $p = 0.043$) suggests that declining renal function may worsen gingival health, creating a possible feedback loop between periodontal inflammation and CKD progression.

The negative correlations between probing pocket depth (PPD) and serum albumin ($r = –0.208$, $p = 0.038$), mirrored by clinical attachment loss (CAL), emphasize the interplay between malnutrition-inflammation complex syndrome in CKD and periodontal tissue destruction. Hypoalbuminemia, frequently seen in hemodialysis patients, has been previously linked to poor periodontal status [33,34], underscoring the importance of monitoring nutritional and inflammatory markers when evaluating periodontal health.

In contrast, bleeding on probing (BOP) and gingival recession (GR) showed no significant associations, suggesting they may be less sensitive indicators of systemic inflammation or renal dysfunction in this population. Similarly, tooth mobility demonstrated only a weak, non-significant trend toward correlation with CRP ($r = 0.175$, $p = 0.084$), which may indicate that mobility reflects more advanced or chronic periodontal destruction rather than early inflammatory changes [35].

An unexpected result was the negative correlation between plaque index (PI) and both creatinine ($r = –0.202$, $p = 0.045$) and CRP ($r = –0.282$, $p = 0.050$). This finding contradicts previous studies reporting that higher plaque levels are associated with increased systemic inflammation [36]. One possible explanation is that patients with more advanced CKD may have received better oral hygiene counseling or altered dietary

patterns, leading to reduced plaque despite worse systemic status. Sampling variability or unmeasured confounders may also have contributed to this discrepancy, suggesting the need for larger studies to clarify these relationships.

Generally, these findings align with the concept that periodontal health and systemic inflammation are bidirectionally linked in CKD. The significant associations, particularly between GI and CRP, support the inclusion of periodontal evaluation and care in the comprehensive management of hemodialysis patients [37]. Integrating dental and medical care may help mitigate systemic inflammation, reduce cardiovascular risk, and improve quality of life for these patients.

Conclusion

With an emphasis on the connection between serum biomarkers and periodontal disease, this study offers important new information about the biochemical and systemic milieu of hemodialysis patients at Gharyan Teaching Hospital. The findings indicate that male and female patients exhibit distinct patterns in serum biomarker levels, including triglycerides, uric acid, creatinine, urea, hemoglobin, albumin, and random blood sugar. These variations not only reflect the complex metabolic alterations inherent to chronic kidney disease and dialysis but also appear linked to systemic inflammatory processes potentially exacerbated by periodontal disease. Moreover, this study underscores the multifactorial and interconnected disturbances in metabolic, nutritional, and inflammatory parameters among hemodialysis patients, with marked gender differences and temporal variations. These findings highlight the critical need for comprehensive, multidisciplinary management approaches addressing not only renal replacement therapy but also periodontal health, metabolic control, nutritional support, and inflammation reduction to improve clinical outcomes and quality of life for these vulnerable patients.

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Conflicts of Interest

The authors declare no conflicts of interest.

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