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Evaluation of Periodontal Status in Patients with Chronic Kidney Disease in Tertiary Care Centre

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ABSTRACT

Background:

Chronic Kidney Disease (CKD) is a progressive disorder associated with chronic systemic inflammation and various oral manifestations, including periodontal disease. Emerging evidence suggests a bidirectional relationship between CKD and periodontal disease, wherein periodontal inflammation may contribute to systemic inflammatory burden and renal dysfunction.

Aim:

To evaluate the periodontal status of patients with Chronic Kidney Disease stages I, II, IIIA, and IIIB and to assess its association with renal function parameters.

Materials and Methods:

A cross-sectional observational study was conducted among 60 patients diagnosed with CKD stages I, II, IIIA, and IIIB attending a tertiary care centre. Periodontal status was assessed using Plaque Index (PI), Gingival Index (GI), Periodontal Probing Depth (PPD), and Clinical Attachment Loss (CAL). Renal function was evaluated using estimated glomerular filtration rate (eGFR) and serum creatinine. Correlation analysis was performed using Spearman's rank correlation coefficient.

Results:

Progressive increase in Periodontal Probing Depth and Clinical Attachment Loss were observed with advancing CKD severity. Mean CAL increased from 3.93 ± 0.86 mm in Stage I to 6.26 ± 0.79 mm in Stage IIIB. Significant negative correlations between CAL and eGFR were observed in Stage IIIA ($r = -0.45$, $p = 0.042$) and Stage IIIB ($r = -0.92$, $p = 0.0001$),

indicating worsening periodontal status with declining renal function. Although serum creatinine values demonstrated variability across CKD stages, eGFR-based staging remained consistent and reliable for disease classification.

Conclusion:

Patients with CKD exhibited a substantial periodontal disease burden, with periodontal deterioration increasing alongside CKD severity. Significant associations between periodontal attachment loss and declining renal function were observed in advanced CKD stages. These findings emphasize the importance of routine periodontal assessment and preventive oral healthcare as part of comprehensive CKD management.

Keywords:

Chronic Kidney Disease; Periodontal Disease; Clinical Attachment Loss; Periodontal Probing Depth; Estimated Glomerular Filtration Rate; Serum Creatinine; Oral Health.

INTRODUCTION

Chronic Kidney Disease (CKD) is a progressive and irreversible disorder characterized by structural or functional abnormalities of the kidneys persisting for more than three months. It is commonly identified by reduced glomerular filtration rate (GFR) and/or evidence of kidney damage such as albuminuria. CKD represents a significant global public health challenge and is associated with substantial morbidity, mortality, and healthcare burden. The most common etiological factors include diabetes mellitus, hypertension, glomerulonephritis, and polycystic kidney disease [1]. Periodontal disease is a chronic multifactorial inflammatory condition initiated by dysbiotic bacterial biofilms, resulting in progressive destruction of the periodontal ligament, alveolar bone, and supporting structures of the teeth [2,3]. Beyond its

local effects, periodontal disease has been increasingly recognized as a contributor to systemic inflammation and has been associated with several chronic conditions including cardiovascular disease, rheumatoid arthritis, chronic obstructive pulmonary disease, metabolic syndrome, and CKD [4–6]. The relationship between CKD and periodontal disease is believed to be bidirectional. Patients with CKD frequently present with oral manifestations such as xerostomia, increased calculus accumulation, gingival inflammation, enamel defects, narrowed pulp chambers, and periodontal destruction [4]. Furthermore, chronic periodontal infection may act as a source of persistent systemic inflammation through the release of bacterial endotoxins, inflammatory mediators, and cytokines into the circulation. Elevated levels of inflammatory markers including C-reactive protein (CRP), interleukin-1 (IL-1), interleukin-6 (IL-6), and tumour necrosis factor-alpha (TNF-α) have been implicated in both periodontal disease and CKD [5–7]. Several studies have reported a higher prevalence and severity of periodontal disease among patients with CKD compared with systemically healthy individuals. Chen et al. reported that approximately 60% of CKD patients exhibited moderate-to-severe periodontal disease [8]. Parkar et al., Kopic et al., and Kim et al. similarly demonstrated increased periodontal destruction, greater clinical attachment loss, and higher inflammatory burden among individuals with renal dysfunction [11–14]. In addition, previous studies have suggested that periodontal therapy may reduce systemic inflammatory markers and improve periodontal outcomes in selected CKD populations [9,18]. Despite growing evidence supporting an association between CKD and periodontal disease, limited data are available regarding periodontal status across the earlier stages of CKD. Most studies have primarily focused on patients with advanced renal disease or those receiving renal replacement therapy. Therefore, evaluation of periodontal health in patients with early and moderate stages of CKD remains clinically relevant. The present cross-sectional

observational study was undertaken to evaluate the periodontal status of patients with CKD stages I, II, IIIA, and IIIB attending a tertiary care centre. Periodontal health was assessed using Plaque Index (PI), Gingival Index (GI), Periodontal Probing Depth (PPD), and Clinical Attachment Loss (CAL). The findings were correlated with renal parameters including estimated glomerular filtration rate (eGFR) and serum creatinine to better understand the relationship between periodontal disease severity and renal dysfunction.

MATERIALS AND METHODS

Study setting and design.

This cross-sectional observational study was conducted at a tertiary care centre at Sawangi (Meghe), Wardha, Maharashtra, India, between June 2022 and August 2022.

Study Population

A total of 60 patients aged between 13 and 80 years diagnosed with Chronic Kidney Disease (CKD) were recruited from the Nephrology Department of the tertiary care centre. Patients were categorized into four groups according to the severity of renal dysfunction: Group I – CKD Stage I, Group II – CKD Stage II, Group III – CKD Stage IIIA,Group IV – CKD Stage IIIB. Patients with CKD stages IV and V were excluded because of severe systemic compromise and associated comorbidities that could potentially affect periodontal assessment and patient participation. Patients with other diagnosed systemic diseases, immunocompromised states, or those receiving immunotherapy were also excluded from the study.

Data Collection

The primary objective of this study was to evaluate periodontal status among patients with CKD and to correlate periodontal findings with renal parameters. All participants underwent comprehensive periodontal examination and laboratory evaluation. To minimize examiner-related bias, all clinical examinations were performed by a single calibrated examiner. Clinical assessment was carried out between June 2022 and August 2022 using a standardized case-recording proforma specifically designed for the study. Periodontal examination was performed under adequate illumination and standard infection-control protocols using a calibrated William's graduated periodontal probe and mouth mirror. The following periodontal parameters were recorded are plaque Index (PI), gingival Index (GI), periodontal Probing Depth (PPD), clinical Attachment Loss (CAL). PPD and CAL measurements were recorded at four surfaces of each tooth excluding third molars. Medical history, duration of CKD, body weight, height, body mass index (BMI), smoking history, and relevant nephrological records were documented. Laboratory investigations included serum creatinine, estimated glomerular filtration rate (eGFR), and C-reactive protein (CRP). Renal function was assessed using serum creatinine and estimated glomerular filtration rate (eGFR). Creatinine clearance rate (CCR) was estimated using the Cockcroft Gault equation "CCR = {(140 – age) × weight} / (72 × serum creatinine)" where age is expressed in years, weight in kilograms, and serum creatinine in mg/dL. Patients were subsequently classified according to CKD stage based on renal function parameters.

Statistical Analysis

Data were analysed using Statistical Package for Social Sciences (SPSS) software version 24.0 (IBM Corp., Armonk, NY, USA).Descriptive statistics were used to summarize the

study variables. Mean and standard deviation were calculated for all periodontal and renal parameters across the four CKD groups.

Spearman's rank correlation coefficient (rho) was used to evaluate the relationship between:

• Clinical Attachment Loss (CAL) and eGFR

• Clinical Attachment Loss (CAL) and serum creatinine

A p-value <0.05 was considered statistically significant.

Ethical Considerations

Written informed consent was obtained from all participants prior to enrolment. Participants were assured of confidentiality, privacy, and voluntary participation throughout the study.

The study protocol was reviewed and approved by the Institutional Ethics Committee (DMIMS(DU)/IEC/2022/1185) and was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

RESULTS

A total of 60 patients diagnosed with CKD stages I, II, IIIA, and IIIB were evaluated for periodontal status and renal parameters. Six clinical parameters were assessed, namely Plaque Index (PI), Gingival Index (GI), Periodontal Probing Depth (PPD), Clinical Attachment Loss (CAL), estimated Glomerular Filtration Rate (eGFR), and serum creatinine.

Plaque Index and Gingival Index

Figure 1 demonstrates the variation in Plaque Index (PI) and Gingival Index (GI) across different CKD stages. No consistent stage-wise trend was observed for either parameter. Spearman's rank correlation analysis between PI and GI demonstrated statistically significant correlations in stages IIIA and IIIB ($p<0.05$), whereas stages I and II did not demonstrate statistically significant associations ($p>0.05$).

Periodontal Probing Depth and Clinical Attachment Loss

Figure 2 illustrates the distribution of Periodontal Probing Depth (PPD) and Clinical Attachment Loss (CAL) across the four CKD stages. A progressive increase in both PPD and CAL was observed with advancing CKD severity, indicating worsening periodontal status in patients with more advanced renal dysfunction. Mean PPD values increased from 3.96 ± 0.85 mm in Stage I to 5.40 ± 0.50 mm in Stage IIIB. Similarly, CAL increased from 3.93 ± 0.86 mm in Stage I to 6.26 ± 0.79 mm in Stage IIIB. The progressive increase in PPD and CAL suggests a potential association between advancing CKD severity and periodontal tissue destruction.

Renal Parameters

Figures 3 and 4 demonstrate the distribution of eGFR and serum creatinine values across different CKD stages. A progressive decline in eGFR was observed with advancing CKD stage, decreasing from 93.73 ± 4.02 mL/min/1.73m² in Stage I to 36.60 ± 4.23 mL/min/1.73m² in Stage IIIB, consistent with expected CKD progression. Although serum creatinine values did not demonstrate a perfectly progressive increase across all CKD stages, patient classification was based primarily on eGFR, which represents the accepted standard for CKD staging. Variability in serum creatinine may reflect differences in age, sex, muscle

mass, body composition, nutritional status, hydration status, and other individual patient characteristics. Therefore, serum creatinine values should be interpreted in conjunction with eGFR rather than as isolated indicators of disease severity.

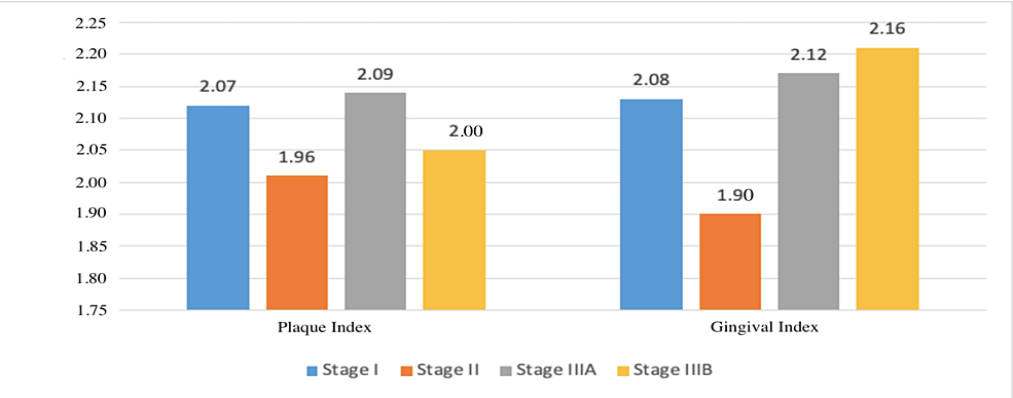

Figure 1: Graphical representation of the variation of PI AND GI according to the different stages of CKD.

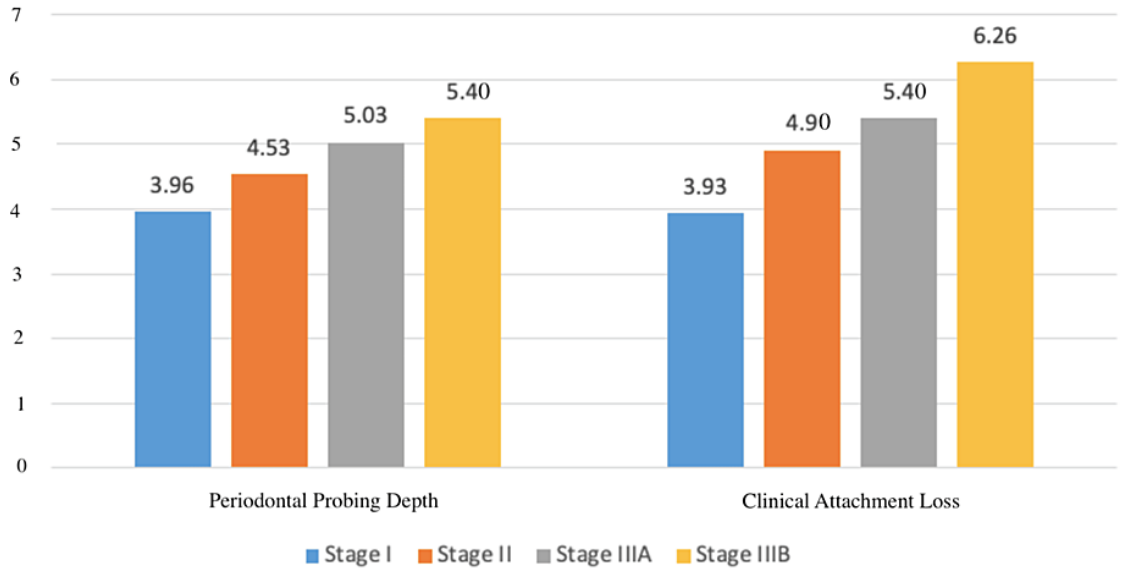

Figure 2: Graphical representation of PPD and CAL values in accordance with different stages of CKD.

(Figures 3 & 4) were used to demonstrate the eGFR levels at the different stages of CKD and the serum creatinine levels at different stages of CKD respectively.

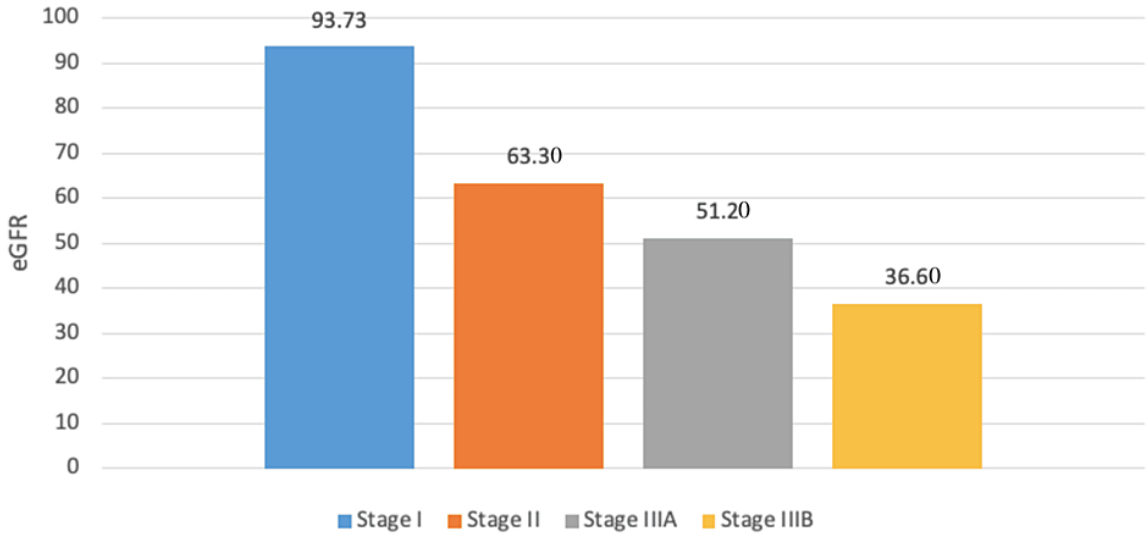

Figure 3: Graphical representation of eGFR values in relation to different stages of CKD.

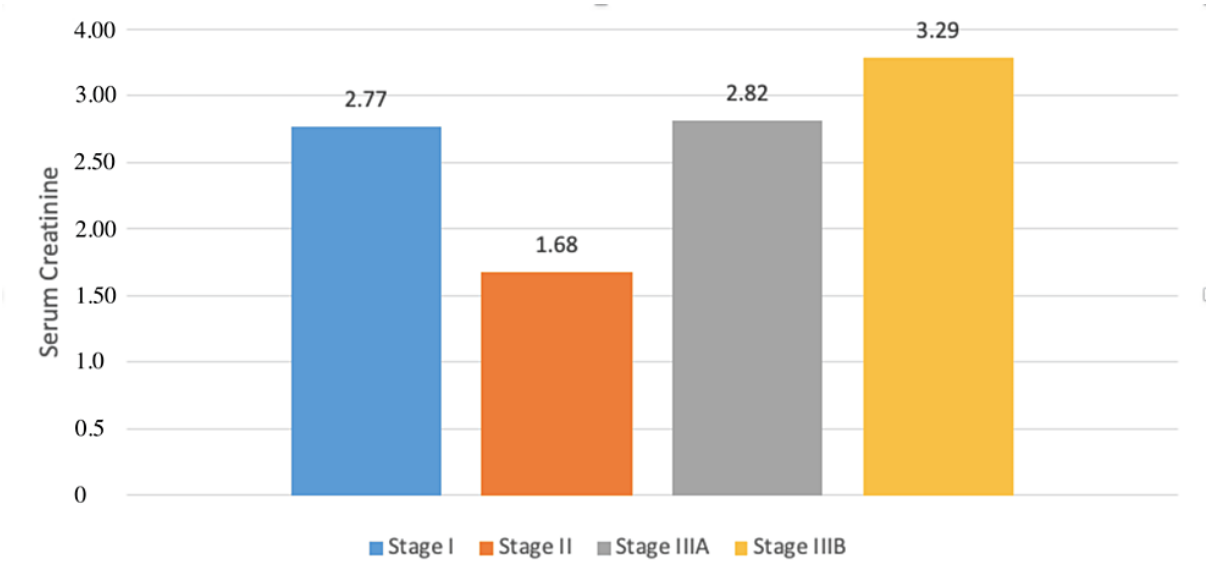

Figure 4: Graphical representation of serum creatinine in values in relation to different stages of CKD.

Table 1: Mean and standard deviation for each parameter for different groups of patients.

Parameter	Stage I	Stage II	Stage IIIA	Stage IIIB
PI	2.07 ± 0.55	1.96 ± 0.62	2.09 ± 0.54	2.20 ± 0.52
GI	2.08 ± 0.47	1.90 ± 0.64	2.12 ± 0.49	2.16 ± 0.55
PPD	3.96 ± 0.85	4.53 ± 0.91	5.03 ± 0.89	5.40 ± 0.50
CAL	3.93 ± 0.86	4.90 ± 0.38	5.40 ± 0.61	6.26 ± 0.79
eGFR	93.73 ± 4.02	63.30 ± 6.71	51.20 ± 5.88	36.60 ± 4.23
Serum Creatinine	2.77 ± 5.21	1.68 ± 0.25	2.82 ± 0.33	3.29 ± 0.27

Table 2: Correlation between CAL and eGFR.

Stage of CKD	Correlation Coefficient	p-value
Stage I	0.02	0.412,NS
Stage II	-0.28	0.543,NS
Stage IIIA	-0.45	0.042,S
Stage IIIB	-0.92	0.0001,S

Correlation analysis between CAL and serum creatinine demonstrated variable associations across CKD stages. No statistically significant correlation was observed in Stage II ($r = 0.11$, $p = 0.684$) or Stage IIIA ($r = 0.40$, $p = 0.206$). A statistically significant negative correlation was observed in Stage IIIB ($r = -0.62$, $p = 0.013$). Although a statistically significant negative correlation was also observed in Stage I ($r = -0.19$, $p = 0.0001$), the magnitude of the correlation was weak and should be interpreted cautiously considering the sample size and potential biological variability.

Table 3: Correlation between CAL and serum creatinine.

Stage of CKD	Correlation Coefficient	p-value
Stage I	-0.19	0.0001,S
Stage II	0.11	0.684,NS
Stage IIIA	0.40	0.206,NS
Stage IIIB	-0.62	0.013,S

None of the participants demonstrated completely healthy periodontal status **(Figures 5-8)**. Representative clinical photographs from different CKD stages demonstrated varying degrees of plaque accumulation, gingival inflammation, periodontal pocketing, and clinical attachment loss, supporting the clinical findings recorded during periodontal examination.

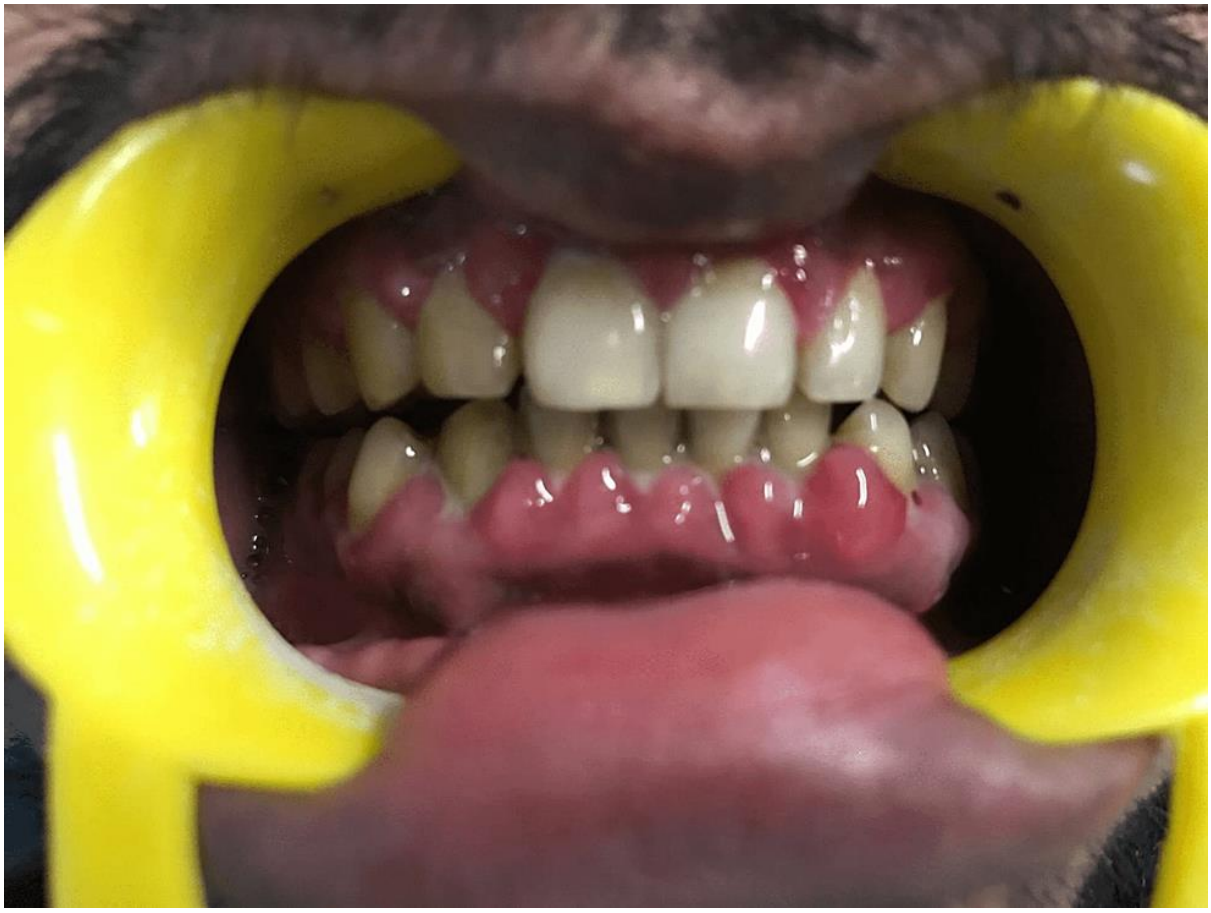

Figure 5: Periodontal status of a stage-ICKD patient.

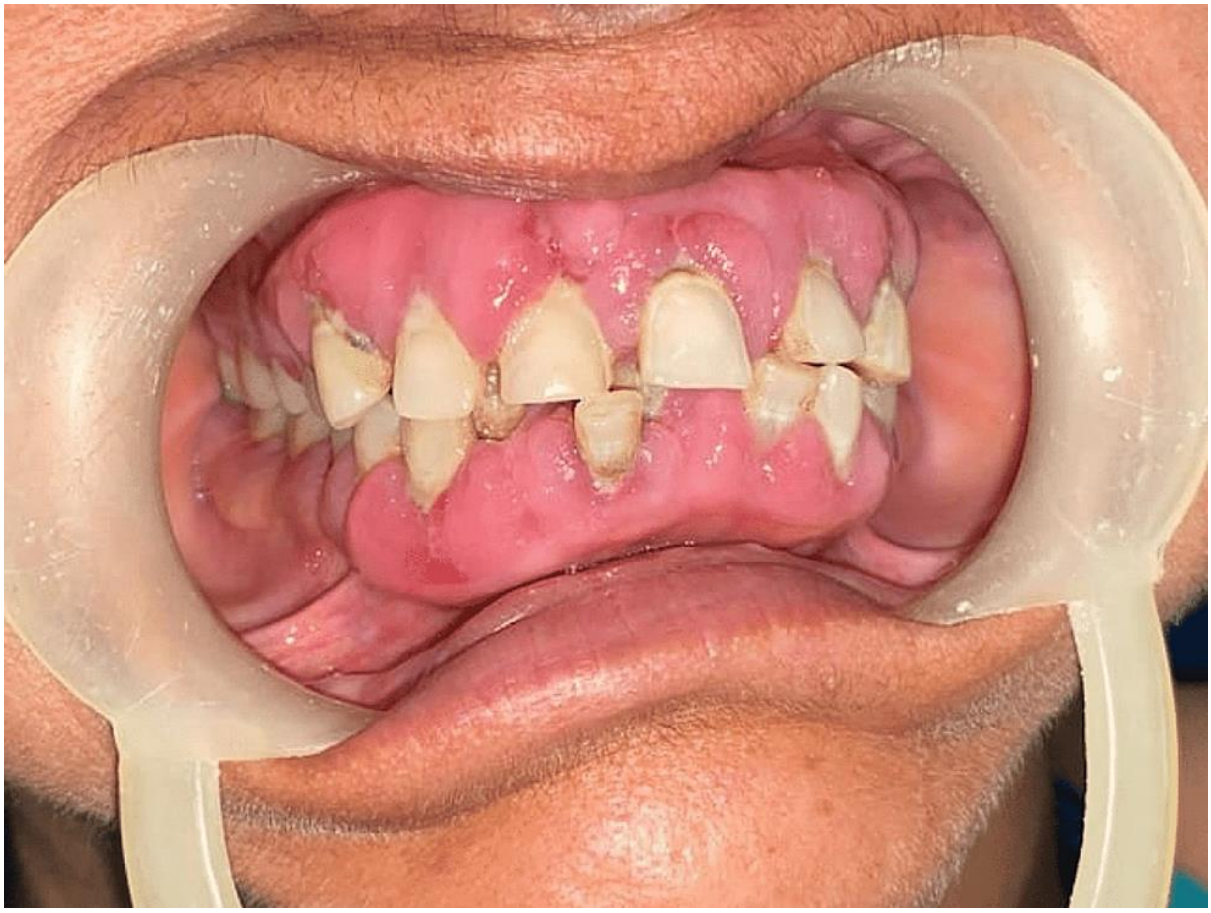

Figure 6: Periodontal status of a stage II CKD patient.

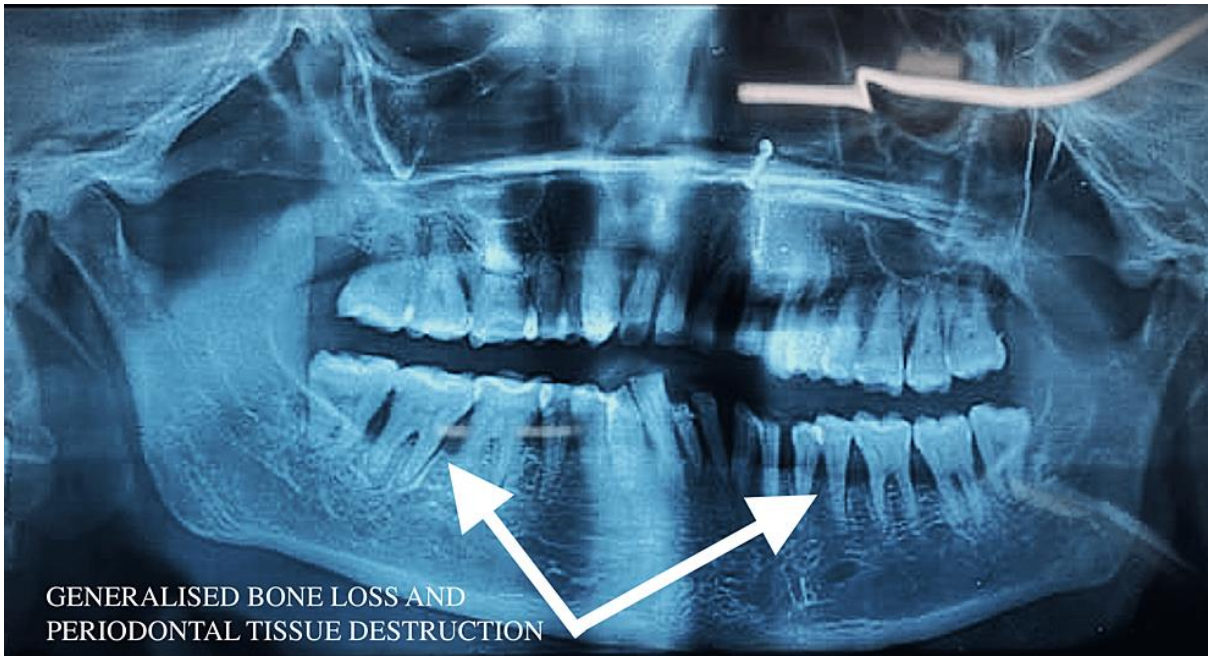

Figure 7: Full mouth radiographic evaluation of a stage II CKD patient.

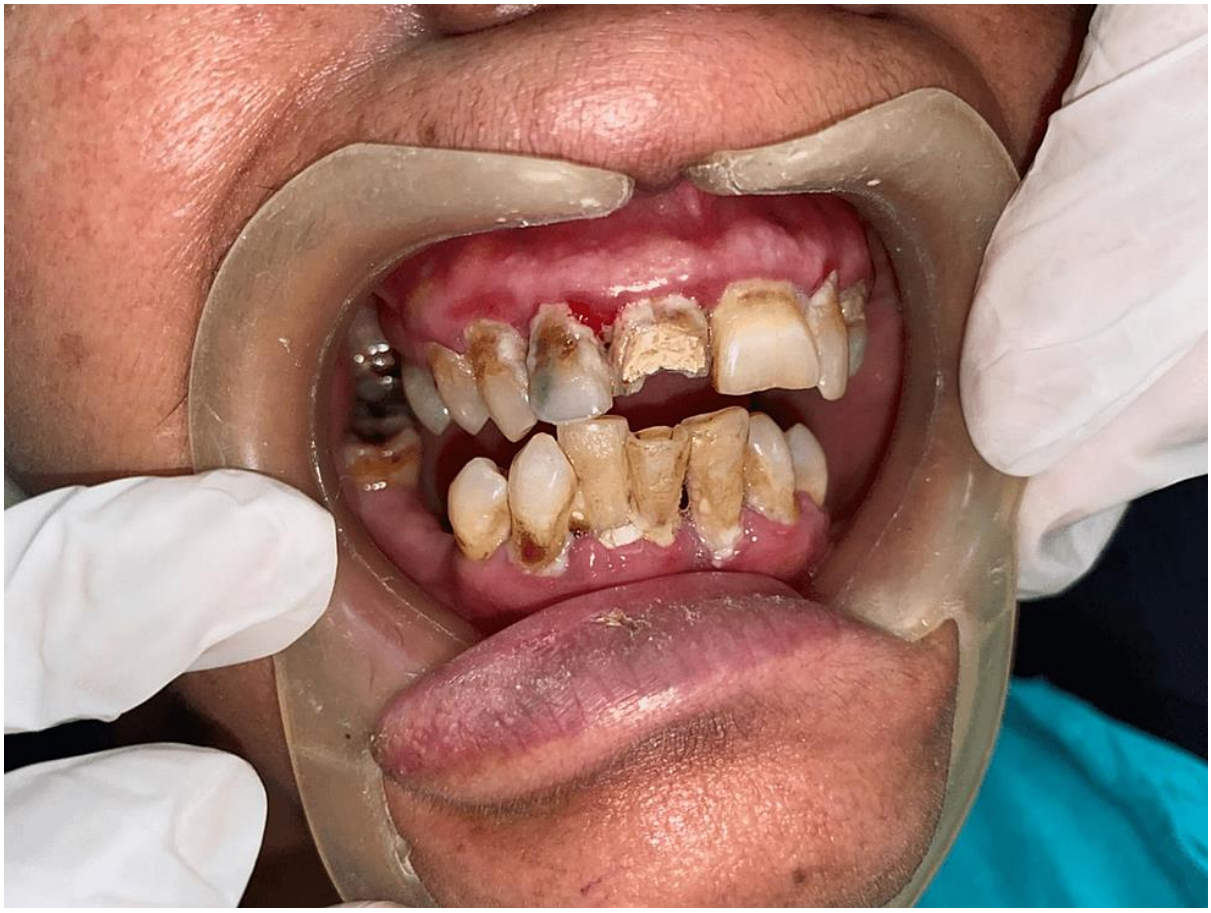

Figure 8: Periodontal status of a stage III CKD patient.

Discussion

Chronic Kidney Disease (CKD) is a progressive disorder characterized by irreversible deterioration of renal function and is frequently associated with chronic systemic inflammation [12]. Increasing evidence suggests a bidirectional relationship between CKD and periodontal disease, wherein periodontal inflammation may contribute to systemic inflammatory burden while renal dysfunction may predispose individuals to poorer periodontal health [13]. The present cross-sectional observational study evaluated periodontal status among patients with CKD stages I, II, IIIA, and IIIB and examined its relationship with

renal parameters including eGFR and serum creatinine. The findings of the present study demonstrated progressive worsening of periodontal parameters with advancing CKD severity. Clinical Attachment Loss (CAL) and Periodontal Probing Depth (PPD) increased consistently from Stage I to Stage IIIB, indicating greater periodontal destruction in patients with more advanced renal dysfunction. These observations support the hypothesis that periodontal disease severity may increase as renal function declines. The observed association may be explained by several biological mechanisms. CKD is associated with chronic low-grade systemic inflammation, immune dysregulation, oxidative stress, altered bone metabolism, nutritional deficiencies, and impaired wound healing. These factors may increase susceptibility to periodontal tissue breakdown and accelerate periodontal disease progression. Furthermore, elevated levels of inflammatory mediators such as C-reactive protein, interleukin-1, interleukin-6, and tumour necrosis factor-alpha have been reported in both CKD and periodontal disease, suggesting overlapping inflammatory pathways. In the present study, eGFR demonstrated a progressive decline with increasing CKD stage, which is consistent with the established natural history of CKD. Correlation analysis revealed significant negative associations between CAL and eGFR in CKD stages IIIA and IIIB. These findings indicate that greater periodontal attachment loss was associated with poorer renal function in the more advanced stages of CKD. Similar observations have been reported by Lertpimonchai et al., Kopic et al., and other investigators who have demonstrated an association between worsening periodontal status and declining renal function[15-17]. An interesting finding of the present study was the variability observed in serum creatinine values across different CKD stages. While eGFR demonstrated the expected stage-wise decline, serum creatinine values did not exhibit a perfectly linear increase. This observation should be interpreted cautiously. Serum creatinine is influenced by multiple factors including

age, sex, muscle mass, body composition, nutritional status, hydration status, and individual metabolic variation. Consequently, serum creatinine alone may not accurately reflect disease severity in every patient. Since CKD staging in the present study was based primarily on eGFR, which is the accepted standard for CKD classification, the observed variation in serum creatinine does not affect the validity of stage allocation. Similar variability in serum creatinine measurements has been reported in nephrology literature and highlights the importance of interpreting serum creatinine in conjunction with eGFR. The present findings are consistent with previous reports in the literature. Chen et al. reported a high prevalence of moderate-to-severe periodontal disease among CKD patients. Parkar et al. demonstrated poorer periodontal status in individuals with renal disease compared with healthy controls[11,12]. Similarly, Kim et al. observed a high burden of periodontal disease among CKD patients and highlighted the potential role of chronic periodontal inflammation in systemic health deterioration. Kopic et al. reported elevated inflammatory cytokine levels among CKD patients and suggested a relationship between inflammatory burden and periodontal destruction[11,12]. The present study also supports observations from previous interventional studies demonstrating the importance of periodontal care in medically compromised individuals. Several investigators have reported improvement in systemic inflammatory markers following periodontal therapy in CKD patients, suggesting that management of periodontal disease may contribute to improved overall health outcomes[12-14]. Although the present study did not evaluate treatment outcomes, the observed periodontal burden highlights the importance of routine periodontal assessment and preventive oral healthcare in this patient population. A notable strength of the present study is the evaluation of periodontal status across multiple early and moderate CKD stages (I–IIIB), providing insight into periodontal changes before the onset of advanced renal failure. Most

available studies have primarily focused on patients with end-stage renal disease or those undergoing dialysis. The current study therefore contributes additional information regarding periodontal health in earlier stages of CKD. However, the findings should be interpreted in light of certain limitations. The study utilized a cross-sectional design, which limits the ability to establish causality between CKD progression and periodontal disease severity. Furthermore, no systemically healthy control group was included for comparison. Potential confounding variables such as diabetes mellitus, hypertension, smoking habits, oral hygiene practices, medication use, socioeconomic status, nutritional status, and duration of renal disease were not controlled through multivariate analysis. Additionally, the relatively small sample size within individual CKD stage subgroups may have influenced the strength and significance of the observed correlations. Therefore, larger prospective studies with appropriate control groups and adjustment for confounding factors are required to further clarify the relationship between CKD and periodontal disease. Despite these limitations, the present study demonstrates a consistent trend toward worsening periodontal status with advancing CKD severity and highlights the importance of integrating periodontal evaluation into the comprehensive management of patients with chronic kidney disease.

LIMITATIONS

The present study has certain limitations that should be considered while interpreting the findings. First, the cross-sectional observational design limits the ability to establish a causal relationship between periodontal disease severity and CKD progression. Second, a systemically healthy control group was not included, thereby restricting direct comparison of periodontal parameters between CKD patients and healthy individuals. Third, potential confounding variables such as diabetes mellitus, hypertension, smoking habits, oral hygiene

practices, medication use, nutritional status, socioeconomic factors, and duration of renal disease were not controlled through multivariate analysis. These factors may independently influence periodontal status and could have contributed to the observed findings. Additionally, the relatively small sample size within individual CKD stage subgroups may have influenced the strength and significance of the correlations observed. Variability in serum creatinine values across CKD stages may also reflect individual differences in age, sex, muscle mass, body composition, nutritional status, and hydration status. Although eGFR-based staging remained consistent and reliable for patient classification, these factors should be considered when interpreting renal parameters. Future longitudinal studies with larger sample sizes, appropriate control groups, and adjustment for potential confounders are recommended to further clarify the relationship between CKD severity and periodontal disease progression.

CONCLUSION

Periodontal disease is a chronic multifactorial inflammatory condition that remains a significant oral health concern in patients with Chronic Kidney Disease. The findings of the present study demonstrate that patients with CKD stages I, II, IIIA, and IIIB exhibit considerable periodontal disease burden, with a progressive increase in periodontal probing depth and clinical attachment loss observed with advancing CKD severity. A significant inverse relationship between Clinical Attachment Loss and eGFR was observed in the more advanced stages of CKD, suggesting that worsening periodontal status may be associated with declining renal function. Although causality cannot be established because of the cross-sectional nature of the study, the findings support the growing body of evidence suggesting an association between periodontal disease and chronic kidney disease. The results highlight

the importance of routine periodontal assessment, preventive oral healthcare, and early intervention in patients with CKD. Integration of periodontal evaluation into the multidisciplinary management of CKD patients may facilitate early identification of periodontal disease and contribute to improved overall health outcomes. Further prospective studies with larger sample sizes and appropriate control groups are required to better elucidate the complex relationship between periodontal disease and renal dysfunction and to determine whether periodontal therapy can positively influence CKD-related outcomes.

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