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ORIGINAL RESEARCH

Comparative Evaluation of Periodontal Status of Chronic Renal Failure Patients and Systemically Healthy Individuals

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ABSTRACT

Aim: Periodontitis, a chronic infectious disease, affects most of the population at one time or the other and its expression is a combination of hosts, microbial agents, and environmental factors. Extensive literature exists for the relationship between periodontal disease and diabetes mellitus, cardiovascular diseases, and adverse pregnancy outcomes. Only a few studies performed in a limited number of patients have reported periodontal health status in chronic renal failure patients. Hence, the aim of the present study is to assess and compare the periodontal status of patients with chronic renal failure undergoing dialysis, predialysis with systemically healthy individuals.

Materials and methods: A total of 90 patients were divided into three groups. Group I: 30 renal dialysis patients. Group II: 30 predialysis patients. Control group comprised 30 systemically healthy patients who formed group III. Periodontal examination was carried out using oral hygiene index-simplified (OHI-S), plaque index (PI), gingival index (GI), probing depth, and clinical attachment loss.

Results: The results of the study showed that the periodontal status of patients with chronic renal failure undergoing dialysis (dialysis group) and patients with chronic renal failure not undergoing renal dialysis (predialysis) when compared with systemically healthy subjects showed significantly higher mean scores of OHI-S, PI, and clinical attachment loss.

Conclusion: Thus, patients with chronic renal failure showed poor oral hygiene and higher prevalence of periodontal disease.

Clinical significance: The dental community's awareness of implications of poor health within chronic renal failure patients should be elevated.

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INTRODUCTION

Chronic renal failure is a progressive disease that is characterized by the destruction of the kidney's functional units, nephrons. Primary reasons for the destruction are diabetes, pyelonephritis, glomerulonephritis, nephrosclerosis, polycystic kidney disease, and collagen vascular disease. Nephrons do not regenerate once destroyed, and the kidney attempts to compensate through hypertrophy of the remaining functional nephrons, thereby maintaining renal function until approximately half of the nephrons are destroyed. Loss of renal function arises with the accumulation of metabolic waste products and with the changes in the normal hemostatic mechanisms that control water and electrolyte balance.[1] To prolong life, dialysis as an artificial means of removing nitrogenous and other toxic products of metabolism from the blood is the treatment of choice.[2]

Periodontitis, a chronic infectious disease, affects most of the population at one time or the other and its expression is a combination of hosts, microbial agents, and environmental factors.[3] It does not appear to be a single disease with variations in clinical symptoms, but a group of diseases with overlapping symptomatology.[4] Etiology is complex with many risk factors, of which, few are biological, such as age, systemic conditions, and others are behavioral factors, such as smoking and oral

cleanliness. However, variation in disease severity cannot be explained taking only these factors; the remaining variance may be explained by the importance of psychosocial factors which remain associated with systemic diseases.[5]

Extensive literature exists for the relationship between periodontal disease and diabetes mellitus, cardiovascular diseases, and adverse pregnancy outcomes. Recently, studies have been published in the literature, providing evidence for an increased prevalence of periodontal disease in patients with renal disease, especially in dialysis patients and renal transplant recipients.[6,7]

Chronic renal failure has been shown to affect not only general health of the patient but also oral and periodontal health. Literature on research has shown that the number of patients undergoing dialysis is increasing rapidly and these patients frequently complain of number of symptoms related to oral cavity. Patients presenting with chronic renal failure are at high risk of developing oral health complications, such as narrowing of pulp chamber, enamel abnormalities, xerostomia, premature tooth loss, increased prevalence of calculus, and periodontal disease, when compared with the general population.[8] In addition, renal disease causes a complex of bone changes termed renal osteodystrophy embracing fibrous dysplasia, hyperostosis, osteosclerosis, delayed growth, and osteoporosis. Moreover, comparison of the periodontal status between dialysis, predialysis patients, and healthy individuals has not been described so far. Therefore, the purpose of this study was to assess and compare periodontal status among groups of patients with chronic renal failure undergoing renal dialysis, predialysis patients, and systemically healthy subjects.

MATERIALS AND METHODS

A descriptive cross-sectional study was conducted in patients with chronic renal failure undergoing renal dialysis and those with chronic renal failure not undergoing renal dialysis (predialysis) and was compared with age- and gender-matched systemically healthy subjects. A total of 90 patients (age group 18–70 years) were included in the study. Study group comprised 60 patients with chronic renal failure who reported to Sharda Hospital, Greater Noida, and St. Stephens Hospital, Delhi. These patients were divided into two groups:

- Group I: 30 patients with chronic renal failure undergoing renal dialysis, which was further divided into:
  - Group I1: Duration of renal dialysis <1 year
  - Group I2: Duration of renal dialysis from 1 year to 2 years
  - Group I3: Duration of renal dialysis more than 2 years.
- Group II: 30 predialysis patients

Control group comprised 30 patients who formed group III. Control group was selected randomly from the Department of Periodontology, School of Dental Sciences, Greater Noida, and was otherwise systemically healthy.

Inclusion Criteria

Inclusion criteria included patients with age group 18 to 70 years with chronic renal failure undergoing dialysis for more than 1 month for group I and patients with age group 18 to 70 years with chronic renal failure and no previous renal dialysis for group II.

Exclusion Criteria

Exclusion criteria included children and individuals <18 years and individuals more than 70 years. Patients with uncontrolled diabetes mellitus and patients who refused consent were excluded from the study.

Verbal and written consent was obtained from the patients fulfilling the inclusion and exclusion criteria. Institutional ethical clearance was obtained.

Periodontal examination was carried out using the following indices: OHI-S (Greene and Vermillion 1964), PI (Silness and Loe 1964), GI (Loe and Silness 1963), and probing depth at six sites per tooth (mesio-mid-distal lingual and mesio-mid-distal buccal) by graduated Williams' periodontal probe. The probe was inserted parallel to the long axis of the tooth gently, till resistance was noted and reading was recorded to the nearest millimeter from the gingival margin to the base of gingival sulcus/pocket. Clinical attachment loss was measured at six sites per tooth (mesio-mid-distal lingual and mesio-mid-distal buccal) by graduated Williams' periodontal probe.

Venous blood was drawn from the patients and was sent to the laboratory for the various investigations, such as blood urea nitrogen (BUN) done by urease ultraviolet kinetic method. The reference value of BUN ranged from 5 to 21 mg/dL. Serum creatinine analysis was done by Jaffe's assay. The reference range of serum creatinine is 0.51 to 0.95 mg/dL, fasting blood glucose was determined by hexokinase (rate of reaction) method. The reference range is 70.00 to 100.00 mg/dL.

Statistical Analysis

Statistical software used was Statistical Package for the Social Sciences version and Microsoft Excel. Statistical tests used were Shapiro–Wilk test, parametric test of significance, *post hoc* Tukey's test, and Student's t-test.

RESULTS

After statistical analysis, the periodontal status of all the groups was compared and the following results were

obtained. In our study, group I comprised 22 males and 8 females, while groups II and III had 19 males and 11 females each.

Mean age was highest in group II (44.13 ± 13.53; age 20–68 years) followed by group I (43.23–12.06; age 22–67 years) and group III (35.27–8.60; age 21–51 years).

Mean OHI-S score was highest in group I (3.75 ± 1.18). Test of significance of these mean values showed that there was significant difference in the mean values between groups I and II ($p < 0.001$), and groups I and III ($p < 0.001$) (Table 1). When intragroup comparisons were made, mean OHI-S score was highest in group I2 (3.86 ± 1.42). Test of significance of these mean values showed that there was no significant difference in the mean values between any of the groups (Table 2).

Mean PI score was highest in group I (1.43 ± 0.38). Test of significance of these mean values showed that there was significant difference in the mean values between groups I and III ($p < 0.001$; Table 1). When intragroup comparisons were made, mean PI score was highest in group I2 (1.61 ± 0.45). Test of significance of these mean values showed that there was no significant difference in the mean values between any of the groups (Table 2).

Mean GI score was highest in group III (0.75 ± 0.59). Test of significance of these mean values showed that there was significant difference in the mean values between groups I and III ($p = 0.001$), groups II and III ($p = 0.003$; Table 1). When intragroup comparisons were made, mean GI score was highest in group I1 (0.41 ± 0.42). Test of significance of these mean values showed that there was no significant difference in the mean values between any of the groups (Table 2).

Mean probing depth score was highest in group I (2.58 ± 0.74). Test of significance of these mean values showed that there was no significant difference in the mean values between groups I and II ($p = 0.08$), groups I and III ($p = 0.29$), and groups II and III ($p = 0.77$; Table 1). Within group I, mean probing depth score was highest in group I3 (2.81 ± 0.61). Test of significance of these mean values showed that there was no significant difference in the mean values between any of the groups (Table 2).

Mean clinical attachment level (CAL) score was highest in group I (2.26 ± 1.73). Test of significance of these mean values showed that there was significant difference in the mean values between groups I and III ($p = 0.02$), and groups II and III ($p < 0.001$; Table 1). Within group I, mean CAL score was highest in group I3 (3.54 ± 1.26). Test of significance of these mean values showed that there was significant difference in the mean values between groups I1 and I2 ($p = 0.01$) and groups I1 and I3 ($p < 0.001$). However, no significant difference was seen between groups I2 and I3 ($p = 0.22$) (Table 2).

Table 1: Intragroup comparison of periodontal parameters

	OHI-S		*PI*		*GI*		*Probing depth*		*Clinical attachment loss*		*BUN*		*Serum creatinine*	
Group	*Mean*	*Post hoc pairwise comparison*	*Mean ± SD*	*Post hoc pairwise comparison*	*Mean ± SD*	*Post hoc pairwise comparison*	*Mean ± SD*	*Post hoc pairwise comparison*	*Mean ± SD*	*Post hoc pairwise comparison*	*Mean ± SD*	*Post hoc pairwise comparison*	*Mean ± SD*	*Post hoc pairwise comparison*
I	3.75 ± 1.18	p-value[a] <0.001, S	1.43 ± 0.38	p-value[a] <0.001, S	0.30 ± 0.30	p-value[a] 0.001, S	2.58 ± 0.74	p-value[a] 0.088, NS	2.26 ± 1.73	p-value[a] <0.001, S	43.04 ± 13.41	p-value[a] <0.001, S	4.76 ± 4.16	p-value[a] <0.001, S
II	2.41 ± 1.16	p-values[b] I*II <0.001, S	1.24 ± 0.23	p-values[b] I*II 0.061, NS	0.34 ± 0.48	p-values[b] I*II 0.939, NS	2.16 ± 0.76	p-values[b] I*II 0.08, NS	1.77 ± 1.24	p-values[b] I*II 0.3, NS	49.98 ± 22.32	p-values[b] I*II 0.18, NS	6.32 ± 3.23	p-values[b] I*II 0.12, NS
III	1.69 ± 1.21	I*III <0.001, S II*III 0.053, NS	1.11 ± 0.31	I*III <0.001, S II*III 0.221, NS	0.75 ± 0.59	I*III 0.001, S II*III 0.003, S	2.29 ± 0.73	I*III 0.29, NS I*III 0.77, NS	0.77 ± 1.25	I*III 0.02, S II*III <0.001, S	11.17 ± 2.54	I*III <0.001, S II*III <0.001, S	0.80 ± 0.13	I*III <0.001, S II*III <0.001, S

P[a] one-way analysis of variance test; P[b] *post hoc* Tukey's test; SD: Standard deviation

Table 2: Intergroup comparison of periodontal parameters

Duration of dialysis	*OHI-S*		*PI*		*GI*		*Probing depth*		*Clinical attachment loss*	
	Mean ± SD	*Post hoc pairwise comparison*	*Mean ± SD*	*Post hoc pairwise comparison*	*Mean ± SD*	*Post hoc pairwise comparison*	*Mean ± SD*	*Post hoc pairwise comparison*	*Mean ± SD*	*Post hoc pairwise comparison*
I1. <1 year	3.65 ± 1.06	p-value[a] = 0.929, NS	1.26 ± 0.16	p-value[a] = 0.117, NS	0.41 ± 0.42	p-value[a] = 0.291, NS	2.65 ± 0.97	p-value[a] = 0.265, NS	0.71 ± 0.58	p-value[a] = <0.001, S
I2. 1–2 years	3.86 ± 1.42	p-values[b] = I1*I2 0.923	1.61 ± 0.45	p-values[b] = I1*I2 0.09	0.30 ± 0.23	p-values[b] = I1*I2 0.70	2.27 ± 0.54	p-values[b] = I1*I2 0.49	2.54 ± 1.78	p-values[b] = I1<I2, I3
I3. >2 years	3.74 ± 1.14	I1*I3 0.984 I2*I3 0.976	1.43 ± 0.42	I1*I3 0.52 I2*I3 0.54	0.19 ± 0.15	I1*I3 0.26 I2*I3 0.70	2.81 ± 0.61	I1*I3 0.88 I2*I3 0.25	3.54 ± 1.26	I1*I2 0.01 I1*I3 <0.001 I2*I3 0.22

P[a] one-way analysis of variance test; P[b] *post hoc* Tukey's test. SD: Standard deviation; S: Significant; NS: Not significant

The mean value of BUN in group I (dialysis group) was 43.04 ± 13.41, group II (predialysis group) was 49.98 ± 22.32, and group III (control group) was 11.17 ± 2.54. Mean BUN value was highest in group II (49.98 ± 22.32); test of significance of these mean values showed that there was significant difference in the mean values between groups I and III ($p < 0.001$) and groups II and III ($p < 0.001$). However, no significant difference was seen between groups I and II ($p = 0.18$) (Table 1).

The mean value of serum creatinine in group I (dialysis group) was 4.76 ± 4.16, group II (predialysis group) was 6.32 ± 3.23, and group III (control group) was 0.80 ± 0.13. Mean serum creatinine was highest in group II (6.32 ± 3.23); test of significance of these mean values showed that there was significant difference in the mean values between groups I and III ($p < 0.001$) and groups II and III ($p < 0.001$). However, no significant difference was seen between groups I and II ($p = 0.12$) (Table 1).

DISCUSSION

Chronic renal failure is characterized by progressive loss of nephrons and simultaneous progressive loss of renal function. The disease goes through five stages: A preclinical stage and four clinical stages of progressive renal failure from mild-to-moderate-to-severe which ultimately ends in uremia. Chronic renal failure refers to decline in the glomerular filtration rate caused by variety of diseases, such as diabetes, hypertension, glomerulonephritis, and polycystic kidney disease. Patients with chronic renal failure have high prevalence of hypertension. Chronic renal failure may be categorized as mild (glomerular filtration rate of 60–89 mL/min/1.73 m^2), moderate (glomerular filtration rate of 30–59 mL/min/1.73 m^2), severe (glomerular filtration rate 15–29 mL/min/1.73 m^2), or end-stage renal disease when glomerular filtration rate falls to <15 mL/min/1.73 m^2. In these patients, hemodialysis or peritoneal dialysis is initiated.[9]

Impairment of excretory function of kidney results in an elevation in BUN, creatinine, and various other metabolic products. Impairment of systemic function results in a decrease in production of erythropoietin (causing anemia) and active vitamin D3 (causing hypocalcemia, secondary hypoparathyroidism, hyperphosphatasia, and renal osteodystrophy). Impairment in systemic function also results in reduction in acid, potassium, salt, and water excretion (causing acidosis, hypertension, hyperkalemia, and edema) and results in platelet dysfunction leading to increased bleeding tendencies.[10]

Chronic renal failure is often complicated by multiple infections. This increased susceptibility to infections is due to impairments in both specific and nonspecific host defenses. The incidence of a variety of dental conditions, such as periodontal disease, narrowing of pulp chamber,

enamel abnormalities, premature tooth loss, and xerostomia seems greater among dialysis patients. These problems may be related to a variety of factors, such as a relative state of immunosuppression, medications, bone loss, and restriction of oral fluid intake.[11]

This descriptive cross-sectional study was conducted to determine and compare the periodontal status of patients with chronic renal failure and systemically healthy subjects. Group I comprised 22 males and 8 females while groups II and III had 19 males and 11 females each. Mean age was highest in group II (44.13 ± 13.53) followed by groups I (43.23–12.06) and III (35.27–8.60).

The OHI-S was compared between three groups. Mean OHI-S of dialysis group was found to be significantly higher compared with both predialysis group and control group. This is in accordance with the study done by Mandalunis et al who reported that renal patients have more plaque and calculus than controls. Increased calculus accumulation in dialysis patients may be due to insufficiently oral hygiene and imbalance of calcium to phosphate ratio resulting in changes in salivary composition. High urea levels may be a factor in heavy calculus formation and should be a consideration in determining of regularity of periodontal maintenance therapy.[12]

The high values of OHI-S indicated that individuals in the study group have poor oral hygiene and would benefit from professionally delivered self-care instruction. These findings support Bottomley et al[13] who advocated that an intensive bacterial plaque control program for individuals on renal dialysis is fundamental and mandatory. Many patients receiving renal dialysis are victims of oral neglect. Renal dialysis is time-consuming and often leaves individuals with lowered self-esteem. Consequently, individuals on renal dialysis do not spend much time taking care of them and may ignore other potential problems.

Full mouth PI was recorded in all the groups. Disclosing agent was painted over gingival areas of patients' teeth and plaque scores were assessed. Mean PI of dialysis (group I) was found to be significantly higher compared with control group III. The mean PI of dialysis group was higher compared with group II (predialysis group), but this difference failed to reach the level of statistical significance. Plague index is unique among the indices used for the assessment of plaque because it ignores the coronal extents of plaque on the tooth surface and assesses only thickness of plaque at the gingival areas of tooth. Higher values of PI in patients with chronic renal failure undergoing renal dialysis and those not undergoing dialysis could be related to existence of chronic disease and its influence on the lifestyle and prolonged hospitalization. The results are in accordance with the study conducted by Davidovich et al[14] where plaque scores were higher in dialysis and predialysis group.

Mean GI of dialysis group and predialysis group was found to be significantly lower as compared with control group. The results suggest that the tissue response was modified during uremia. The result of our study is in accordance with the study by Tollefsen and Johansen where patients on hemodialysis and immunosuppression showed significantly fewer gingival bleeding points than their respective controls in spite of abundant dental plaque.[15]

The result also agrees with those of Been and Engel.[16] They are also in line with earlier histological observation done by Tollefson et al,[17] where it was found that gingival specimens from patients with uremia showed significantly ($p = –0.05$) fewer inflammatory cells than corresponding biopsies from systemically healthy patients. The result supports the view that chronic renal failure also modulates the gingival response to dental plaque.

Since gingivitis may be considered a defense reaction, a compromised immune system might well mask an ongoing destruction of periodontal attachments. Therefore, pocket probing depth and clinical attachment loss were measured in all three groups using a graduated Williams' periodontal probe.

Probing depth and CAL were evaluated for all maxillary and mandibular teeth at six sites (mesio-mid-distal lingual and mesio-mid-distal buccal) by graduated Williams' probe. Intergroup comparison of mean probing depth showed no statistically significant difference between the three groups. The results are in accordance with the study by Rahman et al[18] where no significant difference was observed between hemodialysis group and corresponding healthy controls.

Similar results were also observed in a study by Marakoglu et al,[1] where host factors, such as systemic diseases, genetic polymorphism, or drug pathogenesis of periodontal disease by modifying the host response to periodontal infection or altering the susceptibility to infection by periodontal organism.

Mean CAL of dialysis group and predialysis group was found to be significantly higher compared with control group signifying the severity of periodontal destruction. It can also be justified that poor oral hygiene and its cumulative effect over the years might have caused increased periodontal attachment loss in these patients. Frequent evaluation of oral cavity in a longitudinal study, right from the beginning of dialysis therapy could give more meaningful and conclusive results.

Duration of dialysis indicates the extent period of end-stage renal failure, the most severe kidney damage with all the derived complications. In our study, the dialysis patients (group I) were further divided into three subgroups based on the duration of dialysis (1, 1–2, and

2 years) and comparisons were done to evaluate the periodontal status between the three groups. No significant effect of duration of dialysis on the severity of gingivitis or periodontitis was seen. The results are in accordance with the study done by Klassen and Krasko[11] and Naugle et al[9] findings that lead to the conclusion that the renal dialysis population regardless of length of time on dialysis are in need of comprehensive professional oral care and self-care instructions.

The findings of the present study are limited by combination of confounding factors, such as diet, improper oral hygiene maintenance, improper home care, and medications which were not controlled.

The test most commonly used to evaluate renal function is the measurement of serum creatinine. Normally, no major changes occur in creatinine levels (0.5–1.4 mg/dL) because it depends on stable skeletal muscle mass. When levels rise above 1.5 mg/dL, it is an indication of decreased renal function. Also, BUN is an indication of renal disease. Normal values range from 1.8 to 7.1 mmol/L. Invariably, patients undergoing dialysis had increased BUN and serum creatinine value. Renal function depends on glomerular filtration rate. Moreover, BUN will not be increased until glomerular filtration rate is decreased by 50%. Dialysis and predialysis patients show higher value of BUN and serum creatinine than controls as expected.

Our findings may be limited because only the physical measurement of periodontal disease was made, and not the effect of biochemical markers (serum creatinine and serum phosphorus) on periodontitis was made. There may be important difference in the host response to bacterial challenges.

To conclude, the periodontal status was poor among the chronic renal failure patients compared with healthy controls. The results suggest that the higher prevalence of periodontal disease in chronic renal failure patients is mainly due to the negligence of oral hygiene in chronic renal failure population. Oral prophylaxis and early dental care should be intensified in chronic renal failure patients; this may have a beneficial impact on their general health status. A larger series of patients and longitudinal studies are needed to confirm our findings and validate the hypothesis.

CONCLUSION

Within the limits of the present study, it can be concluded that:

- The periodontal status of patients with chronic renal failure undergoing dialysis (dialysis group) when compared with systemically healthy subjects showed significantly higher mean scores of OHI-S, PI, GI, and clinical attachment loss.
- The periodontal status of patients with chronic renal failure not undergoing renal dialysis (predialysis) when compared with systemically healthy subjects showed significantly higher mean scores of OHI-S, PI, GI, and clinical attachment loss.
- Duration of dialysis therapy did not show any influence on periodontal status of chronic renal failure patients. Invariably, patients undergoing dialysis had increased BUN and serum creatinine.

Thus, patients with chronic renal failure showed poor oral hygiene and higher prevalence of periodontal disease. Lack of awareness and negligence toward oral health care was noted. These patients do not visit the dentist on a regular basis. Since these patients aspire to receive transplants, it becomes mandatory for them to undergo extensive oral and dental therapy to remove probable source of infection, which may lead to failure of transplant. The dental community's awareness of implications of poor health within this population should be elevated.

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