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ORIGINAL ARTICLE

Periodontal Health in End-stage Renal Disease Patients Undergoing Hemodialysis

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Abstract

Aim: The aim of this study is to evaluate periodontal health status of the hemodialysis patients and to examine the relation between Russell periodontal index (RPI) and laboratory and inflammatory markers and nutritional status in this group of patients.

Patients and methods: A cross-sectional study was conducted on a group of patients ($n = 43$, mean age = 51.4 ± 14.9 years) recruited from the Mansoura University Nephrology and Dialysis Unit. Periodontal examination was performed using RPI. Various laboratory and inflammatory markers were recorded, including routine biochemical and hematological data as well as serum parathyroid hormone, ferritin, and highly sensitive C-reactive protein; and nutritional status was evaluated using malnutrition inflammation score.

Results: Periodontitis was frequent in the studied patients where the mean RPI was 3.12 ± 1.55 . There was a statistically significant positive association between periodontitis and patients' ages ($P = 0.006$). Furthermore, a significant positive association between periodontitis and BMI was detected ($P = 0.006$), but not with serum levels of high sensitive C-reactive protein ($P = 0.32$) neither with malnutrition inflammation score ($P = 0.17$). No relation was found between periodontitis and the different laboratory parameters such as calcium, phosphorus, and parathyroid hormone.

Conclusion: Periodontitis is highly prevalent in hemodialysis patients, especially in older patients, and more severe in obese individuals but not related to markers of inflammation or malnutrition.

Keywords: End-stage renal disease, Hemodialysis, Periodontal health

Introduction

Periodontal disease results from a complex interaction between the subgingival biofilm and host-immune system resulting in inflammatory reaction that develops in gingival and periodontal tissues in response to bacteria and their products.¹ It results in clinical attachment loss leading to pocket formation and exposure of the tooth roots.² This has been supported by the finding that chronic periodontitis is associated with increased serum inflammatory biomarkers such as interleukin-6, C-reactive protein (CRP), and prostaglandins.³

Chronic kidney disease is a serious health problem defined by a reduction of glomerular filtration rate to less than $60 \text{ ml/min/1.73 m}^2$ or presence of

kidney damage markers (such as, albuminuria of $\geq 30 \text{ mg/24 h}$, hematuria, or structural abnormalities, e.g., polycystic or dysplastic kidneys), persisting for more than 3 months.

Both periodontitis and chronic kidney disease are considered as major sources of morbidity and independent risk factors for cardiovascular diseases.⁴ In addition, they share common risk factors such as old age, smoking, poorly controlled diabetes, and obesity.⁵ Periodontal pathogens may have a direct effect on the kidney by destroying cells of the nephron unit or the renal vasculature. These pathogens are filtered out of the blood at the glomerulus where they or their products invade capillary endothelium or mesangial cells/matrix.⁶

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The aim of the current study was to evaluate the periodontal health status of the end-stage renal diseases (ESRD) patients undergoing hemodialysis (HD) and to correlate it with nutritional status and the different laboratory biomarkers.

Patients and methods

This cross-sectional study was conducted on 43 HD patients attending the dialysis center of Mansoura University Hospital during the time between January 2020 and March 2021. It was approved by the Ethical Committee of the Faculty of Dentistry, Mansoura University (REC approval code: A07090419).

We approached all the regular HD patients who were maintained on HD at the Nephrology and Dialysis Unit at Mansoura University with an age more than or equal to 15 years old and a history of HD for at least 6 months. Patients with a history of renal transplantation, malignancy, and active hepatitis B were excluded from the current study. All steps were fully explained to the patients who signed a written consent of approval to participate in the research. Forty-three patients were found eligible and they were interviewed and subjected to periodontal examination.

In addition, the patients' body weights, BMI, duration of HD and KT/V (a measurement for efficiency of dialysis) were recorded. The following biomedical and laboratory parameters were evaluated for the included cases: serum levels of albumin, cholesterol, calcium, phosphorous, parathyroid hormone (PTH), serum ferritin, total iron binding capacity (TIBC), and transferrin saturation (calculated by dividing serum iron \times 100/TIBC) as well as complete blood count and erythrocyte sedimentation rate. Malnutritional status was measured using malnutrition inflammation score (MIS).⁷ Mortality was observed during the duration of the study.

Periodontal examination

The periodontal examination was performed for all eligible patients and the periodontal health status was measured by Russell periodontal index (RPI). According to this index, each tooth is examined and scored with one of the following scores (0, 1, 2, 6, and 8). Scorings for each tooth were added and the total is divided over the number of teeth examined.⁸

Malnutrition inflammation score

The score calculation of MIS consists of 10 components which comprise weight change, dietary intake, gastrointestinal symptoms, functional

capacity, comorbidity, subcutaneous fat, signs of muscle wasting, BMI, serum albumin, and TIBC. Each component is assigned a score from 0 (normal) to 3 (very severe). The sum of all compartments lies between 0 (well-nourished) to 30 (severely malnourished).⁷

Statistical analysis

All studied data were collected, double-checked, and tabulated in an SPSS file (IBM SPSS Statistical Package version 25, Chicago, IL). Numerical values are presented as means \pm SD for parametric, and as median (interquartile range) for nonparametric data. For comparing two samples of continuous data the 'two-sample *t* test' was utilized for parametric data and the 'Mann–Whitney test' for non-normally distributed variables. Studying the association of two continuous variables was performed by 'Spearman's correlation test.' ' χ^2 test' studied the distribution of the observation between two or more groups of patients. A '*P* value of less than 0.05 was considered statistically significant.

Results

The studied patients comprised 25 (58.1 %) males and 18 (41.9 %) females with a mean age \pm SD of 51.67 ± 14.7 years, and their mean dialysis duration was 45 ± 37.7 months. About one fifth of the cases were diabetic, 29 % had hepatitis C virus antibody positivity and 86 % of the cases were hypertensive. The clinical data of the cases were summarized in Table 1.

To facilitate the comparison between the different grades of the RPI scores, they were divided into three subgroups (low, intermediate, and high scores), depending on severity of periodontitis where low scores refer to normal, gingivitis or initial

Table 1. Clinical description of the total studied patients.

Sex: males/females	N = 43	n (%)	25/18 (58.1/41.9)
Marital state:	N = 43	n (%)	31/12 (72.1/27.9)
married/single			
or widow			
Age (years)	N = 43	Mean	51.35
		SD	14.94
Body weight (kg)	N = 37	Mean	77.55
		SD	14.84
BMI (kg/m ²)	N = 37	Mean	28.47
		SD	5.03
Hypertension:	N = 41	n (%)	35/6 (85.6/14.6)
yes/no			
Parathyroidectomy:	N = 43	n (%)	2/41 (4.7/95.3)
yes/no			
Mortality: yes/no	N = 43	n (%)	13/30 (30.2/69.8)

stages of periodontitis, intermediate scores refer to established periodontitis, and high scores refer to advanced periodontitis cases.

Statistically significant differences between the three grades of RPI in relation to the age and BMI of the included patients of the current study was detected ($P < 0.05$; Table 2). However, the three groups of RPI show no statistically significant differences in the other clinical and laboratory parameters that were evaluated for the included patients (Table 2).

On comparing the median serum levels of hemoglobin, neutrophils, lymphocytes, serum transferrin saturation, serum ferritin, erythrocyte sedimentation rate, and serum high sensitive C-reactive protein (hsCRP) with RPI, there were no statistically significant differences between the three subdivisions of the RPI ($P > 0.05$). The MIS was recorded for all included cases however, there was no statically significant difference between different groups of RPI (Table 3).

Discussion

The periodontal condition of most of the examined patients, who already suffer from ESRD on HD, was far from optimal. There was a high frequency of established or advanced periodontitis; reflecting the additive suffering of these patients and may have an impact on the mutual pathogenic mechanisms between the oral and renal condition.⁹

The significantly positive association between RPI and the ages of the studied group is in harmony with some previous studies,^{10,11} while it disagrees with the results of Kshirsagar et al.¹² who found no statistically significant association between periodontitis and age when comparing mean ages between mild and severe periodontitis groups. It may be possible that oral hygiene measures and oral care are performed less by older patients than by younger ones. In addition, older people have less capability to visit a dentist for the routine examination compared to younger persons. In fact, the

Table 2. Evaluation of the different clinical and laboratory parameters among the different grades of Russell periodontal index.

	Lower RPI (<2) subgroup	Intermediate RPI (2: <5) subgroup	Higher RPI (≥ 5) subgroup	P value
Age (years)				
N	9	25	9	
Mean	39.11	52.56	60.22	0.006 ^a
SD	11.71	15.63	6.38	
BMI (kg/m ²)				
N	8	22	7	
Mean	23.65	29.86	29.61	0.006 ^a
SD	4.07	4.77	3.62	
Dialysis duration (months)				
N	9	24	8	
Median	36.0	36.0	25.0	0.810
Q1–Q3	11.00–94.00	18.50–57.25	11.25–70.00	
KT/V				
N	9	24	8	
Mean	1.35	1.22	1.43	0.242
SD	0.42	0.23	0.45	
Serum albumin (g/dl)				
N	7	22	7	
Median	3.80	4.10	4.00	0.057
Q1–Q3	3.20–3.90	3.90–4.20	3.70–4.10	
Serum cholesterol (mg/dl)				
N	8	22	7	
Mean	149.13	153.86	145.71	0.918
SD	46.57	50.62	41.55	
Serum calcium (mg/dl)				
N	9	24	8	
Mean	8.42	8.33	8.41	0.948
SD	0.73	0.94	0.68	
Serum phosphorus (mg/dl)				
N	9	24	8	
Mean	4.84	4.66	4.85	0.941
SD	1.84	1.43	2.16	
Serum parathyroid hormone (pg/ml)				
N	9	24	8	0.986

RPI, Russell periodontal index.

^a Statistically significant values.

Table 3. Evaluation of the different biomedical and nutritional parameters among the different grades of Russell periodontal index.

	Lower RPI (<2) subgroup	Intermediate RPI (2: <5) subgroup	Higher RPI (≥5) subgroup	P value
Hemoglobin (g/dl)				
N	9	24	8	
Median	9.90	10.75	9.70	0.195
Q1–Q3	8.70–10.50	9.75–11.78	8.88–11.45	
Neutrophils (× 10⁹/l)				
N	5	19	7	
Median	2.80	3.20	3.50	0.949
Q1–Q3	2.05–6.10	2.80–3.80	2.40–3.80	
Lymphocytes (× 10⁹/l)				
N	5	19	7	
Mean	1.57	1.69	1.44	0.651
SD	0.64	0.67	0.42	
Serum TSAT (%)				
N	9	24	8	
Mean	32.77	36.09	46.88	0.233
SD	11.28	19.87	16.33	
Serum ferritin (ng/ml)				
N	9	24	8	
Median	384.0	216.7	245.5	0.201
Q1–Q3	201.7–664.0	121.35–383.2	100.7–334.8	
ESR (mm)				
N	8	22	6	
Median	35.0	22.5	42.5	0.279
Q1–Q3	7.75–45.00	10.00–45.00	30–46.25	
Serum hsCRP (µg/l)				
N	8	22	6	
Mean	12 437.5	11 859.1	7433.3	0.323
SD	8042.4	6927.8	3003.8	
Malnutrition inflammation score				
N	8	22	7	
Median	9.50	3.50	4.00	0.171
Q1–Q3	3.25–12.75	2.75–6.00	0–6.00	

ESR, erythrocyte sedimentation rate; hsCRP, high sensitive C-reactive protein; RPI, Russell periodontal index; TSAT, transferrin saturation.

relationship between periodontal disease and advancing age has been established in the nonrenal population.¹³ The similarity of the mutual relationship between advancing age and periodontal disease in uremic patients under HD therapy and nonuremic population does not necessarily negate an effect of renal disease on periodontitis but could rather reflect an additive impact of both conditions.

Increased body weight was consistently shown to be associated with periodontal disease in nonrenal disease population.^{14,15} This is in harmony with our finding of a significant positive association between RPI and BMI opposing many previous studies,^{10,16,17} which refuted such a relationship in patients with renal disease. This discrepancy between the present study and the latter studies could be explained considering the lower mean BMI values in those studies (22, 25.2, and 20.7 kg/m², respectively) than that in the current work where the mean BMI value was nearly 29 kg/m²; thus, overweight is more pronounced in the present study. As previously mentioned on discussing the relation between age

and periodontal disease, the lack of difference in the association of overweight and periodontal problem between renal disease and nonrenal disease patients does not necessarily nullify a possible mutual effect of renal disease and periodontitis. Furthermore, there could be a possibility of an aggravating effect, although this needs more detailed comparative studies.

There is no significant relationship between HD duration and periodontitis severity in the current study; a finding that matches that of Chen et al.,¹⁸ Parkar and Ajithkrishnan,¹⁹ and Iwasaki et al.¹⁰ On the contrary, several studies found significant positive association between HD duration and different periodontal indices.^{16,20,21} This controversy could be attributed to different factors such as differences in smoking and dietary habits, and presence or absence of diabetes which can affect the pathogenesis and the progression of periodontal disease in HD patients.

Regarding serum PTH, many previous studies^{16,22–24} were in accordance with the current results

showing no statistically significant association between serum PTH levels and periodontal index. In addition, Frankenthal et al.²² found no significant association between alveolar bone loss, an indicator of severe periodontitis, and PTH levels in HD patients having secondary hyperparathyroidism.

There was no statistically significant association between serum hsCRP and RPI in the current study and this matches with some previous studies on HD patients.^{6,24,25} The absence of relation between RPI and hsCRP is contradictory to logic thinking as the latter is a well-known marker of inflammation. This confusion might be ascribed to possible interference by the presence of a variety of sources of inflammation in HD patients other than periodontitis.

No significant association was noticed between the patient's nutritional status, expressed as MIS and RPI. In contrast to the data of the current study, Chen et al.¹⁶ found a significant correlation between the periodontal status and markers of malnutrition and inflammation. Moreover, Garneata et al.¹⁷ reported that a significantly higher percentage of patients with malnutrition had periodontitis than did those who were well-nourished. The dissimilarity between this finding of the current study and the two aforementioned previous studies could be attributable to the sparsity of malnourished cases in the present study as the mean BMI of the patients of this study was much higher than that in the other two studies. In fact, the BMI of the current study sample could indicate an overweight problem rather than undernutrition, unlike the other studies where the BMI was in the normal range.

The current research failed to show a significant association between mortality and RPI. In contrast, a previous study, conducted over 18 months on 168 HD patients, showed a positive correlation between mortality and the severity of periodontitis in HD patients¹²; an association that was linked to cardiovascular mortality. In another previous prospective study carried out on 253 Taiwanese HD patients, 102 of whom died during a 5-year-follow up period of observation, there was a significant association between the mortality and severity of periodontitis, although it was not linked to the cardiovascular causes.¹⁸

In summary, it is obviously noticed that periodontitis is highly prevalent in ESRD patients undergoing HD where it was more significantly observed in older than in younger adult patients and that it was more associated with higher BMI cases. On the other hand, the current research failed to detect any positive significant association between different inflammatory markers and

periodontitis. Moreover, no significant association was found between periodontitis and MIS.

The current study is unfortunately plagued by some limitations; relying on a single center and including low numbers of patients could have impaired the deductive power of the results. However, it is still clinically relevant as it could direct the attention of periodontists to pay an extra care for patients suffering from ESRD in order to early detect and manage periodontal problems especially in those older in age and heavier in weight. This would definitely decrease their suffering and aid in their wholistic management.

In conclusion, ESRD patients treated by HD are commonly afflicted by periodontitis, which is especially more severe in those who are older and more obese but not related to markers of MIS.

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Conflicts of interest

There are no conflicts of interest.

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