## PERIODONTAL RESEARCH

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# Extent and severity of chronic periodontitis in chronic kidney disease patients

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*Background and Objectve:* Chronic inflammatory diseases have been investigated as a possible source of inflammation in chronic kidney disease patients; however, there is a shortage of information about the prevalence of periodontitis in such individuals. Therefore, the aim of this cross-sectional study was to determine the extent and severity of periodontitis in chronic kidney disease patients undergoing the following three different treatment modalities: predialysis; continuous ambulatory peritoneal dialysis (CAPD); and hemodialysis (HD); and to compare the findings with those from systemically healthy individuals.

*Material and Methods:* Forty CAPD patients (mean age  $52 \pm 12$  years), 40 HD patients (mean age  $50 \pm 10$  years), 51 predialysis patients (mean age  $54 \pm 11$  years) and 67 healthy individuals (mean age  $50 \pm 7$  years) were examined. The periodontal examination included probing pocket depth, clinical attachment loss, bleeding on probing and presence of plaque. Patients with at least four sites with clinical attachment loss  $\geq 6$  mm were considered to have severe chronic periodontitis, and those with at least 30% of sites with clinical attachment loss  $\geq 4$  mm were considered to have generalized chronic periodontitis.

*Results:* Predialysis and HD patients had significantly more sites with clinical attachment loss  $\geq 6$  mm than healthy individuals. The CAPD patients had similar periodontal condition to healthy subjects. There were significantly more cases of severe chronic periodontitis in predialysis and HD patients.

*Conclusion:* Predialysis and HD are associated with a higher prevalence of severe periodontitis compared with healthy individuals and CAPD patients.

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Periodontitis is a chronic inflammatory disease of infectious origin that leads to destruction of the supporting structures of the teeth, including the periodontal ligament and alveolar bone and, in severe cases, may lead to tooth loss (1). The pathogenesis of periodontitis elicits the production of cytokines, prostaglandins (2) and, in some cases, acute phase reagents, such as C-reactive protein (3–5); therefore, periodontitis may have a systemic negative effect on homeostasis and a negative influence on any ongoing disease.

Chronic kidney disease (CKD) is defined as a progressive decline in renal

function associated with a reduced glomerular filtration rate, as measured clinically by the creatinine clearance rate. The treatment of CKD includes dietary changes, correction of systemic complications, and dialysis or renal graft receipt. In continuous ambulatory peritoneal dialysis (CAPD), the

peritoneal membrane acts as a filter, whereas in hemodialysis (HD), the membrane is within the dialysis machine (6,7). Studies about the oral health of CKD patients have assessed the presence of dental plaque, calculus, gingival bleeding and probing pocket depth (8-13). The presence of chronic periodontitis has been investigated as a potential source of chronic inflammation in patients with CKD treated by HD (14-16), in predialysis and CAPD (13,17-19). The results are somewhat confliting. Gavaldá et al. (8) and Bayraktar et al. (12,13) described that HD patients and healthy subjects had similar periodontal conditions. Borawski et al. (18) showed that predialysis, CAPD and HD patients had higher levels of clinical attachment loss than healthy subjects, while Thorman et al. (17) described that CAPD patients had similar attachment loss compared with healthy subjects. Different methodologies were used and might be not suitable to describe the prevalence of periodontal diseases. Moreover, no study described the extent and severity of periodontal disease. As periodontal disease may adversely affect the survival of patients with HD (20), it is interesting to describe the extent and severity of periodontitis in CKD patients. Therefore, our aim was to determine the extent and severity of periodontitis in CKD patients undergoing predialysis treatments, CAPD or HD, and to compare the findings with those from systemically healthy subjects.

#### Material and methods

# Selection criteria for the CKD patients

Eligibility for this cross-sectional study included the following criteria in CKD patients: (i) age  $\geq$  30 years; (ii) calculated glomerular filtration rate (creatinine clearance)  $\leq$  30 mL/min for the predialysis group [stage 4/5 CKD (21)]; (iii) stable vascular access through a surgically created arteriovenous fistula for HD patients, and a noninflamed peritoneal access (straight Tenckhoff catheter with two cuffs) for CAPD patients; (iv) all patients on HD were on dialysis three times a week on a proportional monitor (Fresenius 4008B or 4008S) with bicarbonate buffer and low-flux polysulphone membranes (Fresenius F7); and (v) all patients on CAPD were in a regime of four daily 2 L dialysis exchanges with a disconnect system (Fresenius Andy-Disk).

#### Subjects

One hundred and ninety-eight subjects participated in the study, including 40 CAPD patients (mean age 52  $\pm$  12 years), 40 HD patients (mean age  $50 \pm 10$  years), 51 predialysis patients (mean  $54 \pm 11$  years) and 67 healthy individuals (mean age  $50 \pm 7$  years). All predialysis individuals were outpatients of the CKD clinic at the Pedro Ernesto University Hospital of the Rio de Janeiro State University (HUPE-UERJ). Patients on CAPD and HD were undergoing treatment at the HUPE-UERJ and at satellite dialysis clinics also in Rio de Janeiro State, Brazil. The participants in the healthy group did not show any clinical signs of ongoing systemic disease, based on answers to a questionnaire, and were family members of the renal patients or patients from the opthalmology department. Edentulous individuals, patients requiring antibiotic prophylaxis before the periodontal examination and pregnant women were excluded from this study. Participants were recruited on a consecutive basis if presenting with an age range from 21 to 76 years, and those enrolled in the study gave written informed consent. The protocol was reviewed and approved by the Committee on Ethics and Research of the HUPE-UERJ.

#### **Clinical data**

A questionnaire covering demographic data, including age, sex and smoking habit was given to the CKD patients and healthy subjects. For CKD patients, the questionnaire also included questions about their medical history, medication used, dialysis parameters, diabetes, arterial hypertension and cardiovascular disease. After the clinical examination, the medical records were reviewed in order to check the information obtained from the patients.

#### Periodontal examination

The clinical examination was performed on all teeth present except for the third molars. Periodontal examination included the following parameters: (i) plaque index, considered as present or absent; (ii) bleeding on probing, considered as present or absent; (iii) probing pocket depth; and (iv) clinical attachment loss. Probing pocket depth and clinical attachment loss were recorded at six sites per tooth (mesiobuccal. buccal. distobuccal. mesiolingual, lingual and distolingual), while plaque index and bleeding on probing were recorded at four sites per tooth (mesiobuccal, buccal, distobuccal and lingual). The clinical evaluation was performed with a manual calibrated pressure probe (PCR 15, DB764R; AESCULAP®, Tuttilige, Germany), with a probing force of 0.20 N. Measurements were approximated to the nearest millimeter. Two periodontists were involved in the examination. For calibration, they measured probing pocket depth and clinical attachment loss in five patients. The interexaminer reproducibility was  $\kappa = 0.972 \ (p < 0.001)$  for the variables analysed. Generalized chronic periodontitis was diagnosed by the presence of > 30% of the sites with clinical attachment loss  $\geq 4 \text{ mm}$  (22), while severe chronic periodontitis was diagnosed by the presence of at least four sites with a clinical attachment  $loss \ge 6 \text{ mm}$  (23).

#### Statistical analysis

A post hoc calculation showed that with a sample size of 67 patients in the healthy group and 38 patients in the HD group, there was an 80% power to detect, at a 0.05 level, a prevalence of 28 and 55% of severe chronic periodontitis in the healthy and HD groups, respectively. Data are expressed as frequencies and means  $(\pm$  SD). The differences between proportions were calculated using the chisquared test and z-test. One-way ANOVA and Tukey's test were used to assess differences of age, number of teeth, percentage of sites with dental plaque, percentage of sites with bleeding on probing, percentage of sites with clinical attachment loss 4–5 mm and clinical attachment loss > 6 mm within the groups. Multivariate adjustments were calculated for sex, race and smoking. Significance was defined as a p < 0.05. All statistical tests were carried out with IBM spss 19.0 for Windows software (SPSS Inc., Chicago, IL, USA).

#### Results

#### **Demographic findings**

The demographic data from CKD patients and healthy individuals are reported in Table 1. There were no significant differences in relation to age and race. The frequency of men was significantly higher in the predialysis and HD patient groups compared with the CAPD and healthy patient groups. The frequency of smokers, diabetics, patients with arterial hypertension and heart disease was similar between the three CKD groups, but significantly higher than the healthy group.

#### **Clinical findings**

Generalized chronic periodontitis (> 30% of the sites with clinical attachment loss  $\ge 4$  mm) was significantly more frequent among predialysis patients, while severe chronic

periodontitis ( $\geq 4$  sites with a clinical attachment loss  $\geq 6$  mm) was significantly more frequent among predialysis and HD patients (Table 2). Multivariate adjustments indicated that sex and race had no effect on the extension and severity of periodontitis among the four analysed groups. Smoking significantly influenced the frequency of generalized higher chronic periodontitis in the predialysis group (p < 0.017); however, smoking had no effect on the higher prevalence of severe chronic periodontitis among the predialysis and HD groups. The number of teeth was similar in all groups studied. Hemodialysis patients had a significantly lower number of sites with dental plaque compared with predialysis and CAPD patients and healthy subjects. Bleeding on probing and the percentage of sites with clinical attachment loss 4-5 mm were significantly higher in predialysis patients. The percentage of sites with clinical attachment loss > 6 mm was significantly higher in predialysis and HD patients compared with healthy subjects and CAPD patients (Table 2).

#### Discussion

The present study showed that predialysis and HD patients had the worst periodontal conditions, expressed as the percentage of sites with clinical attachment loss  $\geq 6$  mm. There were significantly more patients with generalized chronic periodontitis in the predialysis patient group compared with the CAPD and HD patients and the healthy subjects. Moreover, severe periodontitis was significantly more frequent among predialysis and HD patients. No study has previously evaluated the extent and severity of periodontal diseases in CKD patients; therefore, it is difficult to compare our results with others. Bots et al. (11) and Bayraktar et al. (12,13) evaluated periodontal disease by measuring probing pocket depth, either as a partial mouth examination (11) or a full mouth examination (12,13). Their results showed no significant differences in probing pocket depth between HD and CAPD patients compared with healthy groups. However, partial examinations and mean values of probing pocket depth do not properly describe the periodontal conditions, and normally do not reflect the extent and severity of periodontitis, either in individuals or in populations (24). Both bone loss and clinical attachment loss estimate the accumulated exposure to periodontal disease inflammation and seem to reflect the chronic nature of periodontitis (25). Clinical attachment loss was used to measure periodontal disease in some studies. Gavalda et al. (8) did not show significant differences between HD patients and healthy subjects. Borawski et al. (18) presented the results based on the Community Periodontal Index of Treatment Needs and described a higher prevalence of severe

Table 1. Mean  $(\pm SD)$  age, number of months of dialysis and distribution of sex, race, diabetics, smokers, arterial hypertension, heart disease and current smokers in predialysis, continuous ambulatory peritoneal dialysis (CAPD) and hemodialysis (HD) patients and healthy subjects

	Healthy $(n = 67)$	Predialysis $(n = 51)$	$\begin{array}{l} \text{CAPD} \\ (n = 40) \end{array}$	$\begin{array}{l} \text{HD} \\ (n = 40) \end{array}$	
Age (SD) <sup>a</sup>	50 (± 7)	54 (± 11)	52 (± 12)	50 (± 10)	
Sex (% male) <sup>b</sup>	34.3	57*	25	52.5*	
Race (% white) <sup>b</sup>	71.6	51	57.5	70	
Months of dialysis (SD) <sup>a</sup>	-	_	27.2 (± 21.9)	73.4 (± 56.2)‡	
Diabetics (%) <sup>b</sup>	0	13.7†	15†	12.5†	
Arterial hypertension (%) <sup>b</sup>	0	86†‡	52.5†	87.5†‡	
Heart diseases (%) <sup>b</sup>	0	15.7†	37.5†	32.5†	
Current smokers (%) <sup>b</sup>	14.9	41†	40†	52.5†	

<sup>a</sup>One-way ANOVA and Tukey's test.

<sup>b</sup>Chi-squared test and *z*-test.

\* Significantly higher than healthy and CAPD groups (p < 0.05).

† Significantly higher than healthy group (p < 0.05).

‡ Significantly higher than CAPD (p < 0.05).

*Table 2.* Mean (SD) number of teeth, percentage of sites with presence of dental plaque, percentage of sites with bleeding on probing, percentage of sites with clinical attachment loss 4-5 mm and clinical attachment loss 26 mm, and frequency of patients with generalized chronic periodontitis and severe chronic periodontitis

Clinical parameter	Healthy $(n = 67)$	Predialysis $(n = 51)$	$\begin{array}{l} \text{CAPD} \\ (n = 40) \end{array}$	$\begin{array}{l} \text{HD} \\ (n = 40) \end{array}$
Number of teeth <sup>a</sup>	19.6 (6.5)	16.9 (6.4)	17.3 (6.5)	17.7 (6.4)
Presence of plaque $(\%)^a$	51.1 (27.3)‡	52.5 (34.9)‡	40.2 (28.7)‡	21.7 (29.6)
Bleeding on probing $(\%)^a$	25 (21.5)	38.4 (37.7)*	16.9 (20.9)	21.8 (20.6)
Percentage of sites with clinical attachment loss 4–5 mm <sup>a</sup>	15.4 (13.0)	25 (16.6)*	11.0 (8.4)	12.8 (9.8)
Percentage of sites with clinical attachment loss $> 6 \text{ mm}^{a}$	5.8 (9.7)	15.9 (18.5)†	5.7 (12.1)	10.6 (13.2)§
Generalized chronic periodontitis (%) <sup>a</sup>	26.9	56.9*	15	25
Severe chronic periodontitis (%) <sup>a</sup>	28	62.7%†	32.5	55†

<sup>a</sup>One-way ANOVA and Tukey's test.

\* Significantly higher than healthy, CAPD and HD groups (p < 0.05).

† Significantly higher than healthy and CAPD groups (p < 0.05).

‡ Significantly higher than HD group (p < 0.05).

§ Significantly higher than healthy group (p < 0.05).

periodontitis among predialysis, CAPD and HD patients compared with healthy individuals. In agreement with our results, Thorman *et al.* (17) showed that predialysis and HD patients had significantly more attachment loss than CAPD patients and healthy subjects; however, Thorman *et al.* (17) also used partial examinations to describe periodontal disease.

In our study, CAPD patients had similar periodontal condition to healthy subjects. Treatment with CAPD was associated with a lower prevalence of periodontitis. According to our knowledge, there are only three studies which have assessed periodontitis in CKD patients treated by peritoneal dialysis (17-19). Borawski et al. (18) showed that the prevalence of periodontitis was higher in CAPD patients compared with healthy subjects; however, periodontal disease was less severe in CAPD patients compared with predialysis and HD patients. In contrast, similar to our study, Thorman et al. (17) showed that CAPD patients and healthy subjects had similar prevalence of periodontitis. Cengiz et al. (19) described a prevalence of 45.5% of severe periodontitis in CAPD patients. However, there was no healthy group in the study, and the periodontal examination included only six teeth per patient. All three studies used partial examinations, and the results may underestimate the prevalence of periodontal disease in these populations (26). If that is the case,

the differences regarding periodontal attachment loss in predialysis and HD groups compared with the healthy group shown by Thorman et al. (17) could be even higher. Smoking is considered to be a risk factor for periodontal diseases. Although there was no statistically significant difference in the frequency of smokers among the three CKD groups, the healthy group had three times fewer current smokers. The multivariate analyses indicated that smoking influenced only the higher prevalence of generalized chronic periodontitis in the predialysis group. We cannot, however, exclude the possibility that the differences in the number of current smokers between the healthy and diseased groups confounded our findings.

In the present study, the number of teeth was similar among predialysis, CAPD and HD patients and healthy subjects. This is in agreement with Bots et al. (11), Gavalda et al. (8) and Bayraktar et al. (12) in HD and CAPD patients. Borawski et al. (18) showed a significantly higher number of teeth in healthy patients compared with CAPD, HD and predialysis patients. Thorman et al. (17) described a worse dental condition in CKD patients, measured by the index DMFT (decayed, missing, filled teeth) but did not present data for missing teeth. The reason for these different results in terms of number of teeth may be related to different studied populations

and different metabolic health among CKD patients.

A number of limitations should be highlighted. Firstly, our cross-sectional survey was limited to only a small group of individuals with CKD and healthy subjects. We did not perform any matching for those traditional confounders known to affect prevalence of periodontitis (i.e. age, sex, body weight, smoking and socio-economic status). An appropriate casecontrol study should be designed to answer the question of whether CKD is associated with periodontitis. Furthermore, the study design chosen (crosssectional) cannot provide insight into the temporal association between the two disorders (CKD and periodontitis) and provides no information on the causality. Lastly, potential confounders to both chronic diseases that were not measured as part of this study could explain the association found.

In conclusion, our findings are consistent with an association between prevalence of severe periodontitis with predialysis and individuals in hemodialysis compared with CAPD patients and healthy individuals. Further research is needed to understand the impact of treatment modalities for CKD patients on the prevalence of periodontitis.

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