


Oral status, quality of life, and anxiety and depression in hemodialysis patients and the effect of the duration of treatment by dialysis on these variables

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Abstract This study aimed is to evaluate the oral health status, quality of life, anxiety and depression among hemodialysis patients and to analyze the effect of the duration of dialysis on these variables. 120 patients on hemodialysis and 120 control subjects underwent oral examination, periodontal evaluation, xerostomia study using a Visual Analogue Scale (VAS), sialometry evaluation; quality of life (QOL) using the OHIP-14 questionnaire and anxiety/depression. Bleeding index, CPTIN, clinical attachment level, and probing depth were significantly higher in the hemodialysis group than the control group ($p < 0.001$). VAS scores were higher in patients on hemodialysis with significant differences in 6 of the 8 domains ($p \leq 0.05$). Unstimulated whole saliva was significantly lower in hemodialysis patients than control subjects ($p < 0.001$). OHIP-14 scores showed significantly poorer QOL in patients on hemodialysis than control subjects ($p = 0.042$). Hemodialysis patients presented greater depression and anxiety than control ($p < 0.001$). Periodontal health was worse among the patients who had been in treatment >10 years, xerostomia and sialorrea was

worse in patients treated for 5–9.9, and >10 years, QOL was worse in patients who had spent <1 year; depression and anxiety was greater among those treated for 1–2.9 years. In conclusion, Oral health, QOL, anxiety and depression are worse in patients on hemodialysis, and oral health deteriorates as the time spent in dialysis lengthens, but patients in treatment for <3 years presented the poorest QOL and the greatest anxiety and depression.

Keywords Hemodialysis · Oral health status · Oral quality of life · Depression · Anxiety

Introduction

Chronic renal failure (CRF) is characterized by progressive and irreversible diminution of renal function containing for longer than 3 months, which may or may not be accompanied by changes to the renal structure or by renal damage with major repercussions for general health [1]. The most common oral manifestations characteristic of renal pathology and its treatment are hypoplasias, enamel demineralization, dental erosion, mycotic infections, elevated pH in saliva (uremia), eruption disorders, drug-induced gingival hyperplasia, periodontal disease, petechiae oral ulceration [2, 3].

In the tissues, periodontal disease produces an increased inflammatory cell load, with intense inflammatory cell infiltrate that can generate a systemic immune response, and so affect the renal system and the prognosis of the chronic renal disorder [2, 4]. In spite of this, some studies have not been able to identify a significant relation between periodontal disease and renal pathology [5, 6].

Patients often complain of a bad odor and a taste of ammonia or a metallic taste in the mouth, which is a

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consequence of high urea content in saliva. Some researchers have found that a considerable number of patients on hemodialysis (HD) suffer simultaneously from thirst, xerostomia, and saliva reduction [7–9].

For CRF patients on HD, the HD becomes a central element of their lives, imposing major time restrictions due to the rigid scheduling of dialysis sessions [10]. In addition, restrictions on diet and the pathology itself, can affect the patient's mental state and reduce the quality of life (QOL). These problems are linked to increased morbidity and mortality among these patients (who may reject treatment, suffer increased inflammatory responses, and decreased immune responses) [11, 12].

Depression is associated with increased morbidity and mortality due to rejection of HD, malnutrition, increased inflammatory response, and immune depression. In the USA, depression among CRF patients increases the probability of suicide by 84% in comparison with the general population [13].

The time spent in treatment by HD will influence oral health status, poorer periodontal indices have been observed among CRF patients on HD for longer than 10 years than among healthy subjects [14]. These data are of vital importance as patients on HD for long periods are potential renal transplant candidates and in this context the possible contribution of periodontitis to the inflammatory burden represents a major risk factor. Meanwhile, the time spent on HD has a direct effect on QOL and anxiety/depression thought to be due to clinical problems arising from CRF and long-term HD. But there is some controversy as to whether QOL and anxiety/depression worsen as a result of the duration of HD treatment or as a result of the associated clinical symptoms, and some authors have observed greater anxiety and depression during the first months on HD [15].

On the basis of these controversial findings, the aims of this study were to evaluate the oral health status, anxiety and depression and quality of life among hemodialysis patients, and to study the effect of the duration of treatment by dialysis on these variables.

Materials and methods

Recruitment and patient characteristics

This cross-sectional study recruited a total of 120 patients with stage 5 CRF treated with HD at two health centers in Murcia managed by Fresenius Medical Care® (Fresenius Medical Care, Bad Homburg, Germany), with a mean age of 69.90 ± 11.61 years, and a control group of 120 healthy subjects (75 men and 45 women), with a mean age of 67.71 ± 8.96 years. Inclusion criteria applied to the CRF

group were as follows: CRF diagnosis according to National Kidney Foundation guidelines [16] with renal lesion continuing for at least 3 months [defined as the presence of structural or functional abnormalities of the kidney, with or without decreases in glomerular infiltrate, manifesting as pathological abnormalities or through markers of renal damage (including alteration to blood or urine composition and/or alterations observed in imaging tests), and reductions in renal function (glomerular filtration <60 mL/min/1.73 m²) continuing for at least 3 months, with or without renal damage]; patients with stage 5 CRF needing dialysis (end-stage renal disease with glomerular filtration <15 mL/min/1.73 m²); patients over 18 years of age; willingness to provide informed consent to take part in the study.

Inclusion criteria for healthy controls group were as follows: subjects free of CRF at any of its five stages; patients over 18 years of age; willingness to provide informed consent to take part in the study. Exclusion criteria for both groups were: presence of physical or functional disabilities that would make it impossible to register the study variables, and unwillingness to sign the informed consent form.

The study protocol was approved by the University of Murcia Ethics Committee and was carried out between July 2015 and February 2016 at three centers: the University Dental Clinic (University of Murcia, Murcia, Spain) where variables were registered for the control group of healthy subjects, and two satellite centers (Murcia, Spain) managed by Fresenius Medical Care® (Fresenius Medical Care, Bad Homburg, Germany) where study variables were registered for the group of CRF patients on HD.

Clinical examination and measurement variables

All patients were examined in detail by one expert clinician from the department of Oral Surgery at the Faculty of Dentistry, University of Murcia (Spain). All examinations were carried out by the same examiner.

Periodontal evaluation was based on the number of remaining teeth and missing teeth, bleeding index, community periodontal index of treatment needs (CPITN), clinical attachment level (CAL), probe depth (PD), number of pockets ≥ 4 mm, number of pockets ≥ 6 mm, and the classification of periodontal disease as either healthy, mild, moderate, or severe.

A validated xerostomy Visual Analogue Scale (VAS) was used to analyze dry mouth [17], with seven items (speech difficulties, swallowing difficulties, lack of saliva in mouth, dry mouth, dry throat, dry lip, dry tongue sensation and level of thirst) and a final item in which the patient gave an overall score for dryness of the mouth. The

patients were instructed to draw a vertical line over a 10-cm horizontal line to represent their level of dry mouth. Values close to 0 are closer to normality and the closer they are to 10, the greater the severity of the xerostomy.

Unstimulated whole saliva (UWS) was collected by spitting into a sterilized millimeter tube via a funnel, following the protocol described by Navazesh (drainage method) [18]. All participants were instructed to abstain from drinking, smoking, tooth brushing, chewing or eating for 1 h before saliva collection. The saliva collection period lasted for 15 min and was conducted in a relaxed surroundings in sessions scheduled between 9 and 11 am to avoid any circadian variations.

Assessment of oral health-related quality of life (OHR-QOL) was performed using the Oral Health Impact Profile (OHIP-14) in its validated Spanish version [19]. This questionnaire consists of 14 items that reflect different aspects of oral function and quality of life. Patients were asked about daily situations, to which they respond according to the frequency of occurrence, giving a score of between 0 (never) and 4 (often) on a Likert scale. The total score was calculated by totally the scores for all items, with the final score ranging from 0 to 56 (higher scores signifying poorer oral quality of life).

Anxiety/depression was assessed by the Hospital Anxiety and Depression Scale (HADS). This has 14 items, seven to determine anxiety status (HADS-A) and seven to determine depression (HADS-D). Each item ranges from 0 (lower anxiety or depression) to 3 (greater anxiety or depression) on a Likert scale, giving a final score of 21 for each subgroup [20].

Lastly, to analyze the effect of the time spent in HD treatment on oral health status, quality of life, and anxiety and depression; the 120 CRF patients were divided into five groups according to treatment duration (<1, 1–2.9, 3–4.9, 5–9.9, and >10 years) as proposed by Cengiz [14].

Statistical analysis

Data were analyzed using SPSS 12.0 statistical software (SPSS® Inc, Chicago, IL, USA). A descriptive study was made of each variable. The Kolmogorov–Smirnov normality test and Levene homogeneity of variance test were applied; the data showed normal distribution and were analyzed using parametric tests. Associations between different qualitative variables were analyzed using Pearson's Chi-squared test. Associations between different quantitative variables were studied using one-way analysis of variance (ANOVA) for more than two samples, and Student's *t* test for two related samples. Statistical significance was established as $p < 0.05$.

Results

The sample was made up of a total of 240 subjects, 157 men (65.42%) and 83 women (34.58%), with a mean age of 59.22 ± 17.69 . Of these, 120 were patients with stage 5 CRF (82 men and 38 women) treated by HD, with a mean age of 69.90 ± 11.61 years, and 120 healthy controls (75 men and 45 women), with a mean age of 67.71 ± 8.96 years. Both groups were homogeneous regarding of demographic characteristics (age $p = 0.103$ and sex $p = 0.342$), educational level ($p = 0.250$), toxic habits (smoking $p = 0.247$ and alcohol consumption $p = 0.282$), and dental hygiene regime ($p = 0.266$).

After oral mucosa and dental health status evaluation, it was noted that in the CRF group, 3 patients (2.50%) presented oral candidiasis, 2 (1.67%) showed enamel hypoplasias and 1 (0.83%) presented erosion of the lingual faces of upper and lower incisors, possibly related to vomiting.

When periodontal characteristics were compared between groups, CRF patients on HD showed lower numbers of teeth and higher bleeding index, CPTIN, CAL, PD, number of pockets ≥ 4 or ≥ 6 mm than healthy control subjects, with statistically significant difference ($p \leq 0.05$). The percentage of patients diagnosed with severe periodontal disease was also higher among CRF patients (16.49%) than control subjects (4.23%) with statistically significant difference ($p < 0.001$) (Table 1).

When the presence of xerostomy was compared between groups, VAS-8 scores were higher among CRF patients, with significant differences for 6 of the 8 domains ($p \leq 0.05$). (Table 2) Likewise, saliva measurement was taken to detect the possible present of sialorrhea (UWS), showed lower quantities in CRF patients (6.11 ± 6.11 mL/15 min) than control subjects (12.51 ± 5.38 mL/15 min), with statistically significant difference ($p < 0.001$) (Table 2).

Total OHIP-14 scores showed worse QOL among CRF patients on HD (10.34 ± 9.09) than control subjects (8.27 ± 6.39), with statistically significant difference ($p = 0.042$) (Table 3).

Lastly, when anxiety and depression were compared between the two groups, CRF patients showed higher degrees of anxiety and depression than control subjects, with a statistically significant difference for depression ($p < 0.001$) (Table 3).

To analyze the effect of the time spent in treatment by HD on oral health status, QOL, and anxiety and depression; the 120 CRF patients on HD were divided into five groups according to the duration treatment: <1 year ($n = 14$ patients), 1–2.9 years ($n = 13$ patients), 3–4.9 years ($n = 27$ patients), 5–9.9 years ($n = 43$ patients) and >10 years ($n = 23$ patients). To avoid the influence of age on results for the five groups, particularly in relation to oral

Table 1 Comparison of periodontal characteristics between study groups (student's *t* test and Pearson's Chi-squared test)

Periodontal characteristics	Patients on hemodialysis (n = 91)	Healthy control group (n = 118)	<i>p</i> value
Number of teeth: mean ± SD	18.25 ± 9.32	25.48 ± 6.18	<0.001
Bleeding index: mean ± SD	33.98 ± 33.28	10.72 ± 16.78	<0.001
CPTIN: mean ± SD	1.43 ± 1.48	0.50 ± 1.02	<0.001
CAL (mm): mean ± SD	1.77 ± 0.81	1.15 ± 0.41	< 0.001
PD (mm): mean ± SD	2.33 ± 1.07	1.76 ± 0.71	< 0.001
Number of pockets ≥4 mm: mean ± SD	2.24 ± 4.62	0.70 ± 2.59	0.003
Number of pockets ≥6 mm: mean ± SD	0.45 ± 1.33	0.07 ± 0.41	0.004
Periodontal disease: <i>n</i> (%)			<0.001
None	34 (37.36)	95 (80.51)	
Mild	24 (26.37)	13 (11.03)	
Moderate	18 (19.78)	5 (4.23)	
Severe	15 (16.49)	5 (4.23)	

SD standard deviation, *CAL* clinical attachment level, *PD* probing depth

Table 2 Comparison of the validated VAS questionnaire (dry mouth scores) and sialometry findings (unstimulated whole saliva) between study groups (student's *t* test)

	Patients on hemodialysis (n = 120) Mean ± SD	Healthy control group (n = 120) Mean ± SD	<i>p</i> value
VAS (cm)			
Speech difficulties	25.78 ± 21.57	18.07 ± 16.69	0.002
Swallowing difficulties	27.03 ± 23.44	17.61 ± 17.26	<0.001
Lack of saliva in mouth	42.75 ± 25.81	38.23 ± 17.17	0.111
Dry mouth sensation	41.88 ± 27.25	28.70 ± 16.55	<0.001
Dry throat sensation	36.43 ± 27.39	30.26 ± 17.89	0.040
Dry lip sensation	38.71 ± 26.76	34.25 ± 19.48	0.141
Dry tongue sensation	38.41 ± 27.58	28.38 ± 16.39	0.001
Level of thirst	54.96 ± 27.02	39.99 ± 19.46	<0.001
Sialometry (mL/15 min)	6.11 ± 6.11	12.51 ± 5.38	<0.001

SD standard deviation

health status, the homogeneity of the groups regarding of subject age was checked; homogeneity was confirmed ($p = 0.283$).

Analyzing the effect of time spent in treatment on periodontal health, CRF patients in treatment for >10 years presented worse periodontal indices and a higher percentage of severe periodontal disease (52.17%), although without statistically significant differences in comparison with the other groups ($p = 0.497$) (Table 4).

Analyzing the presence of xerostomy, CRF patients treated with HD for 5–9.9 years and those treated for >10 years showed higher VAS scores in all 8 domains of the questionnaire, although without statistically significant differences in comparison with the rest of the groups

($p > 0.05$) (Table 5). Likewise, saliva measurement (UWS) showed lower quantities in CRF patients on HD for 5–9.9 years (4.53 ± 5.19 mL/15 min), although without statistically significant differences in comparison with the other groups ($p = 0.080$) (Table 5).

QOL was lower among CRF patients who had spent <1 year on HD (14.00 ± 14.17), although without statistically significant differences in comparison with the other groups ($p = 0.472$) (Table 6).

Lastly, anxiety and depression showed higher levels among CRF patients on HD for 1–2.9 years (9.00 ± 5.35 and $p = 8.15 \pm 4.63$, respectively); although without statistically significant differences in comparison with the other groups ($p = 0.887$ and $p = 0.510$, respectively) (Table 6).

Table 3 Comparison of quality of life, anxiety and depression between study groups (student's *t* test)

	Patients on hemodialysis (<i>n</i> = 120) Mean ± SD	Healthy control group (<i>n</i> = 120) Mean ± SD	<i>p</i> value
OHIP-14			
Functional limitation	1.86 ± 1.81	1.27 ± 1.48	0.007
Physical pain	2.17 ± 2.31	1.29 ± 1.56	0.001
Psychological discomfort	2.08 ± 1.89	2.03 ± 1.88	0.811
Physical disability	1.94 ± 2.14	0.98 ± 1.72	<0.001
Psychological disability	0.88 ± 1.45	0.95 ± 1.32	0.711
Social disability	0.74 ± 1.35	0.90 ± 1.17	0.334
Handicap	0.68 ± 1.38	0.91 ± 1.58	0.242
Total scores	10.34 ± 9.09	8.27 ± 6.39	0.042
HADS			
Depression	7.95 ± 5.36	2.43 ± 2.65	< 0.001
Anxiety	6.39 ± 4.11	5.85 ± 3.61	0.279

SD standard deviation, HADS hospital anxiety-depression scale

Table 4 Influence of dialysis duration on periodontal characteristics (ANOVA and Pearson χ^2)

Periodontal characteristics	<1 year (<i>n</i> = 14)	1–2.9 years (<i>n</i> = 13)	3–4.9 years (<i>n</i> = 27)	5–9.9 years (<i>n</i> = 43)	>10 years (<i>n</i> = 23)	<i>p</i> value
Number of teeth: mean ± SD	18.00 ± 7.18	21.70 ± 6.86	18.70 ± 9.05	16.07 ± 8.12	19.02 ± 15.01	0.656
Bleeding index: mean ± SD	29.82 ± 31.99	24.13 ± 34.91	32.24 ± 33.9	38.07 ± 32.89	38.07 ± 35.93	0.776
CPTIN: mean ± SD	0.75 ± 1.21	0.80 ± 1.47	1.22 ± 1.41	1.82 ± 1.53	1.92 ± 1.44	0.072
CAL (mm): mean ± SD	1.62 ± 0.85	1.46 ± 0.46	1.71 ± 0.83	1.85 ± 0.83	2.05 ± 0.86	0.433
PD (mm): mean ± SD	1.86 ± 1.12	2.08 ± 1.06	2.15 ± 1.03	2.59 ± 1.11	2.61 ± 0.91	0.180
Number of pockets ≥4 mm: mean ± SD	0.58 ± 2.02	1.90 ± 4.53	2.17 ± 5.06	2.33 ± 4.74	3.92 ± 5.31	0.511
Number of pockets ≥6 mm: mean ± SD	0.50 ± 1.73	0.40 ± 1.26	0.26 ± 1.25	0.52 ± 1.25	0.62 ± 1.51	0.945
Periodontal disease: <i>n</i> (%)						0.497
None	7 (50.00)	6 (46.15)	9 (33.34)	9 (20.47)	3 (13.04)	
Mild	3 (21.42)	2 (15.38)	6 (22.22)	12 (27.91)	3 (13.04)	
Moderate	3 (21.42)	3 (23.09)	6 (22.22)	11 (25.81)	5 (21.75)	
Severe	1 (7.16)	2 (15.38)	6 (22.22)	11 (25.81)	12 (52.17)	

SD standard deviation, CAL clinical attachment level, PD probing depth

Discussion

Oral mucosa and dental health status evaluation of CRF patients on HD found that 3 (2.50%) patients presented oral candidiasis. Oral candidiasis in CRF patients is due to diverse factors that influence immune depression, such as nutritional deficiencies, disorders of white blood cell production and function, and the consumption of certain drugs such as corticosteroids, the reduced saliva flow and the high levels of stress that accompany this pathology [21–24].

Two subjects (1.67%) presented enamel hypoplasias. This pathology is often found among CRF patients due to disorders of the calcium and phosphorous metabolism, although this is more common among pediatric renal patients, with some authors reporting percentages over 20% [25]. Another dental phenomenon found among CRF patient is the erosion of the lingual faces of upper and lower incisors, due to regurgitation and vomiting induce by uremia and medication, as well as the HD sessions [22] in the present sample only one case was observed (0.83%).

Table 5 Influence of dialysis duration on VAS questionnaire (dry mouth scores) and sialometry findings (unstimulated whole saliva) (ANOVA test)

	<1 year (<i>n</i> = 14) Mean ± SD	1–2.9 years (<i>n</i> = 13) Mean ± SD	3–4.9 years (<i>n</i> = 27) Mean ± SD	5–9.9 years (<i>n</i> = 43) Mean ± SD	>10 years (<i>n</i> = 23) Mean ± SD	<i>p</i> value
VAS (cm)						
Speech difficulties	19.71 ± 18.79	25.23 ± 21.28	25.74 ± 19.23	24.95 ± 23.01	31.39 ± 23.57	0.610
Swallowing difficulties	15.43 ± 13.83	28.46 ± 18.23	24.78 ± 20.31	28.79 ± 24.69	32.65 ± 29.92	0.260
Lack of saliva in mouth	39.79 ± 21.44	41.54 ± 23.91	43.37 ± 20.85	41.35 ± 28.39	47.13 ± 30.58	0.910
Dry mouth sensation	36.77 ± 27.71	39.46 ± 29.31	41.19 ± 20.76	41.47 ± 29.44	47.74 ± 29.61	0.805
Dry throat sensation	24.00 ± 18.31	34.77 ± 30.03	43.78 ± 28.11	36.58 ± 28.05	36.04 ± 27.71	0.303
Dry lip sensation	37.57 ± 27.27	35.08 ± 28.07	37.22 ± 22.22	39.12 ± 28.65	42.43 ± 28.81	0.940
Dry tongue sensation	36.86 ± 26.34	37.77 ± 29.51	38.78 ± 23.77	38.93 ± 29.62	38.30 ± 29.76	0.999
Level of thirst	55.50 ± 32.99	63.92 ± 17.51	58.89 ± 22.12	51.79 ± 30.46	50.87 ± 26.15	0.543
Sialometry (mL/15 min)	6.85 ± 5.16	8.48 ± 10.29	8.00 ± 5.22	4.53 ± 5.19	5.08 ± 5.54	0.080

SD standard deviation

Table 6 Influence of dialysis duration on quality of life, anxiety and depression (ANOVA test)

	<1 year (<i>n</i> = 14) Mean ± SD	1–2.9 years (<i>n</i> = 13) Mean ± SD	3–4.9 years (<i>n</i> = 27) Mean ± SD	5–9.9 years (<i>n</i> = 43) Mean ± SD	>10 years (<i>n</i> = 23) Mean ± SD	<i>p</i> value
OHIP-14						
Functional limitation	1.57 ± 1.69	2.15 ± 1.91	1.89 ± 1.92	1.84 ± 1.78	1.87 ± 1.89	0.952
Physical pain	2.79 ± 3.19	2.38 ± 2.29	2.22 ± 2.35	1.88 ± 1.97	2.13 ± 2.28	0.782
Psychological discomfort	3.00 ± 2.54	1.85 ± 2.07	2.15 ± 1.65	1.86 ± 1.53	2.00 ± 2.19	0.390
Physical disability	2.86 ± 3.37	1.62 ± 2.06	2.11 ± 1.96	1.81 ± 2.01	1.61 ± 1.67	0.449
Psychological disability	1.43 ± 1.95	1.46 ± 1.76	0.74 ± 1.34	0.70 ± 1.24	0.74 ± 1.38	0.270
Social disability	1.29 ± 1.93	1.15 ± 1.99	0.63 ± 1.18	0.53 ± 0.91	0.70 ± 1.39	0.327
Handicap	1.07 ± 1.38	1.38 ± 2.32	0.22 ± 0.69	0.53 ± 1.12	0.87 ± 1.61	0.077
Total scores	14.00 ± 14.17	12.00 ± 10.34	9.96 ± 8.63	9.12 ± 7.48	9.91 ± 7.87	0.472
HADS						
Depression	6.86 ± 3.52	9.00 ± 5.35	8.15 ± 4.88	8.00 ± 5.81	7.70 ± 6.18	0.887
Anxiety	6.36 ± 4.06	8.15 ± 4.63	6.63 ± 4.15	5.84 ± 3.97	6.17 ± 4.09	0.510

SD standard deviation, *HADS* hospital anxiety-depression scale

Data on the periodontal health status of CRF patients in treatment with HD present some controversy [26]. In the present study, all periodontal indices were significantly higher in the CRF group than the control group ($p < 0.001$), with a significantly higher percentage of patients with severe periodontal disease in the CRF group (16.49%) in comparison with the control group (4.23%) ($p < 0.001$). Brito et al. [27] evaluated plaque index, bleeding index, periodontal pocket depth and insertion loss in a sample of 40 patients on HD, 40 on peritoneal dialysis, 51 patients on predialysis and 67 healthy subjects. They

observed worse periodontal conditions among patients on predialysis and HD, with high percentages of periodontal attachment loss >6 mm (18.5% of patients on predialysis and 13.2% of patients on HD), higher rates of edentulism and chronic and severe periodontitis. Tadakamadla et al. [28] made a study of 74 patients with chronic renal disease at different stages and 150 healthy control subjects, finding that stage 5 patients (25.6% of the sample) presented greater periodontal pocket depth [78.9% community periodontal index (CPI) grade 4]. However, other authors have not observed differences in periodontal health between

CRF patients and healthy control subjects; in a study by Bots et al. [26] of 42 patients on HD and 808 control subjects, the only significant difference identified was the greater presence of tartar among CRF patients. Borawski et al. [29] observed greater presence of severe periodontal disease among patients on HD and predialysis, but the study only enrolled a small sample and lacked a control group.

As for the influence of the time spent in HD treatment on the severity of periodontal disease, periodontal parameters showed that patients on HD for >10 years showed a higher degree of periodontal affectation, although without statistically significant difference in comparison with other groups in treatment for fewer years. These results are similar to those found in other studies [14, 30]. Bayraktar et al. [30] in a study of 66 HD patients and 61 healthy control subjects, divided the 66 HD patients into 2 groups according to the time spent on HD (<3 or >3 years), observing significantly higher gingival indices and significantly worse periodontal disease among patients with CRF treated with HD for over 3 years.

The present study found significant differences in subjective sensations of dry mouth suffered by CRF patients on HD compared with healthy control subjects. Klassen and Krasko [25] described a sample of 147 patients on HD with various oral health problems including dry mouth, finding 96 patients (65.31%) with xerostomy. In the sample studied by Rosa García et al. [3] 44% of CRF patients suffered xerostomy.

In the present study, saliva measurement (UWS) performed to study the possible presence of sialorrhea found lower values in CRF patients on HD than in the control group, with statistically significant difference ($p < 0.001$). Bots et al. [31] in a sample of 94 CRF patients treated with HD, studied stimulated and unstimulated saliva flows; hyposalivation (unstimulated saliva flow <0.15 mL/min) was observed in 36.2% of cases.

As for the influence of the duration of treatment by HD on saliva flow, the present study found that UWS was lower in CRF patients on HD for 5–9.9 years, although without statistically significant differences compared to other treatment durations ($p = 0.080$). In relation to the possible influence of HD treatment duration on saliva flow, Bots et al., [26] made a longitudinal study of 43 patients on HD. They observed an improvement in xerostomy in patients who received a kidney transplant, accompanied by increases in UWS. Meanwhile, patients who continued on HD maintained similar saliva flow values without significant differences.

In the present study, total OHIP-14 scores indicated poorer QOL among patients on HD than control group subjects, with statistically significant difference ($p = 0.042$). These findings were similar to Guzeldemir et al. [32] who also used the OHIP-14 to assess 47 HD patients, identifying

increased affectation of functional limitation (speech, swallowing, eating) and dental and gingival sensitivity. Analyzing the influence of time spent on HD on QOL, CRF patients on HD for <1 year showed a worse QOL, although without statistically significant differences compared with other treatment durations ($p = 0.472$).

Lastly, comparing anxiety and depression between the study groups, CRF patients on HD showed higher levels of anxiety and depression (assessed by the HADS) than healthy control subjects, with a statistically significant difference for depression ($p < 0.001$). Depressive symptoms are the most frequent comorbidities among patients with end-stage renal disease [33]. Analyzing the influence of time spent in HD treatment in anxiety and depression, both were higher among patients on HD for 1–2.9 years, although without statistically significant differences in comparison with other treatment durations ($p = 0.887$ and $p = 0.510$, respectively). Kimmel et al. [15] identified the same pattern, observing an initial increase in anxiety, which decreased later, probably as patients adapted to the treatment regime.

In conclusion, the present study showed that oral health, QOL and anxiety and depression are worse among CRF patients on HD and oral health deteriorates as the time on HD treatment advances. However, patients in treatment for less than 3 years present worse QOL and higher levels of anxiety and depression in patients treated with HD during 1–2.9 years.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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