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ORIGINAL ARTICLE

The effect of the duration of the dialysis in hemodialysis patients on dental and periodontal findings

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OBJECTIVE: The purpose of this study was to investigate the dental and periodontal health status of patients on regular hemodialysis (HD) maintenance therapy, and the effect of duration of HD on oral status.

STUDY DESIGN: Sixty-eight HD patients and 41 controls were examined. Decayed, Missing or Filled Teeth (DMFT index), plague index (PI), gingival index (GI), Probing pocket depth (PPD) and loss of periodontal attachment (LPA) were examined.

RESULTS: Except DMFT index, significant differences were found in the other index values between patients and controls ($P < 0.01$). Dialysis duration significantly correlated not with DMFT but with the others. Also, DMFT values showed no significant differences between the five HD subgroups. For the PI, GI and PPD values, the first 5-year period revealed no significant variation, whereas the second 5-year period included significant increases. After 10 years, a much more significant increase was observed. The LPA values did not show any significant differences between the HD subgroups, but after 10 years a significant progressive increase can be observed.

CONCLUSIONS: The dental and periodontal health is poor in HD patients and becomes worse with time on dialysis. Thus, oral health maintenance is of utmost importance in this patient group.
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Keywords: oral health assessment; hemodialysis; periodontal condition

Introduction

Despite significant technical advances, annual mortality in chronic dialysis patients is as high as 20% with cardiovascular disease and infection, which are leading causes of death (Kotanko, 2008). Chronic inflammation is highly prevalent in dialysis patients and chronic renal failure (CRF) *per se* is a pro-inflammatory state (Zimmermann *et al*, 1999; Kaysen, 2001).

Recently, periodontal disease has been recognized as another potential source of chronic inflammation in CRF patients. Several strands of epidemiological evidence indicate that the prevalence of periodontal disease is increased in CRF patients (Naugle *et al*, 1998; Bots *et al*, 2006; Chen *et al*, 2006; Cengiz *et al*, 2007).

Most recent studies, focusing on the periodontal health of CRF patients on hemodialysis (HD) maintenance therapy, have reported the presence of poor oral hygiene and attendant gingival inflammation. Increased levels of plaque have been reported for HD populations from several countries, including Brazil (Souza *et al*, 2005), Canada (Klassen and Krasko, 2002), Jordan (Al-Wahadni and Al-Omari, 2003), Israel (Davidovich *et al*, 2005), Spain (Gavalda *et al*, 1999; Castillo *et al*, 2007), Taiwan (Chen *et al*, 2006), Turkey (Duran and Erdemir,2004; Bayraktar *et al*, 2007; Cengiz *et al*, 2007) and the United States (Naugle *et al*, 1998).

Associated with increased plaque in CRF populations on HD maintenance therapy was increased calculus formation and attendant gingival inflammation (Naugle *et al*, 1998; Gavalda *et al*, 1999; Klassen and Krasko, 2002; Al-Wahadni and Al-Omari, 2003; Duran and Erdemir, 2004; Davidovich *et al*, 2005; Souza *et al*, 2005; Chen *et al*, 2006; Cengiz *et al*, 2007).

Several possible reasons have been forwarded to account for the almost universally reported increased levels of plaque, calculus formation and gingival inflammation in renal HD populations. Most prominently, CRF patients on HD are in a state of CRF resulting in uremic syndrome, and uremia has been associated with immune dysfunction including defects in lymphocyte and monocyte function (Cengiz *et al*, 1988; Cohen *et al*, 1997). Therefore, if uremia is responsible for the increased gingival inflammation observed in this population, increased dialysis vintage maintenance therapy should be associated with increased gingival inflammation, and periondotitis has been reported in association

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with increased dialysis vintage in several (Duran and Erdemir, 2004; Davidovich *et al*, 2005; Chen *et al*, 2006; Bayraktar *et al*,2007) but not all (Naugle *et al*, 1998; Al-Wahadni and Al-Omari,2003; Marakoğlu *et al*, 2003; Bots *et al*, 2006) studies.

Of interest, one study directly assessed the effect of uremia on the gingival inflammatory response to increasing bacterial plaque load using the experimental gingivitis protocol of Löe. At 28 days after the cessation of oral hygiene, the authors reported no difference in gingival indices between a group of six HD patients and a group of six age and sex-matched non-uremic controls (Kitsou *et al*, 2000).

Periodontitis is a disease characterized by inflammation of gingiva that results in periodontal pocket formation with loss of the supporting periodontal ligament and alveolar bone around the teeth (Novak, 2002). Naugle *et al* (1998) reported severe gingivitis and periodontitis in HD patients, but they had no records from a healthy control group. In other studies evaluating the level of periodontal and gingival diseases in HD patients, it was reported that gingival and periodontal diseases were prevalent in these HD populations (Klassen and Krasko, 2002; Al-Wahadni and Al-Omari,2003). Duran and Erdemir (2004) found a significant positive relationship between the periodontal index scores and age and time on dialysis among 342 HD subjects. On the contrary, there are also studies reporting low values for the periodontal indices in this group of patients (Jaffe *et al*, 1986; Nunn *et al*, 2000; Marakoğlu *et al*, 2003; Bots *et al*, 2006). There are also rare and conflicting data in the periodontal health status and duration of dialysis (Naugle *et al*, 1998; Al-Wahadni and Al-Omari, 2003; Ertuğrul *et al*, 2003; Marakoğlu *et al*, 2003; Bayraktar *et al*, 2007).

On the basis of these controversial findings, we aimed to analyze and compare the dental and periodontal health status of HD patients with healthy controls. And also, we tried to determine the effect of the duration of HD therapy on dental and periodontal health status.

Materials and methods

The subjects of this study were 77 individuals undergoing HD. All the patients were undergoing 4 h of HD thrice a week. HD was prescribed in these patients with single-use hollow-fiber dialyzers equipped with modified cellulose-based or polysulfone membranes. The dialysate used was a standard ionic composition and bicarbonate-based buffer in all cases. Individuals undergoing renal dialysis were asked to sign an informed consent detailing the purpose of the study, appointment procedures, risks and benefits. After explaining the experimental design, written informed consent was obtained from all the participants. All the patients agreed to participate. Nine of the patients on HD were excluded due to being either edentulous or reluctant to participate in this study. A total of 68 patients on HD for chronic renal failure (CRF) (37 males and 31 females; mean age 47.85 ± 14.61 years) were studied, together with 41 healthy people age and sex-matched controls not receiving medication (21 males and 20 females; mean age 44.80 ± 10.22 years). Patients and control groups were classified as either current smokers, i.e. those who regularly smoke 10 cigarettes a day (25 patients and 15 healthy subject), or non-smokers, i.e. who had never smoked (43 patients and 26 healthy subjects). All smokers were cigarette smokers. The mean ages of current smokers and non-smokers were 44.41 ± 7.8 and 46.94 ± 6.07 years, respectively. The age differences between smoking groups were not statistically significant ($P > 0.05$). Control patients attending the Dental Faculty of Ondokuz Mayıs University regularly were included in the study. The study was performed at the dialysis center at Ondokuz Mayıs University. The patients were enrolled between February 2006 and March 2007. None of the patients had diabetes. None of the patients had received periodontal and general dental care within the 6 months prior to the study. Smoking behavior and use of drugs, including statins and aspirin, that influenced inflammatory state were also recorded. All the patients included in this study group were using the same drugs. No difference in age, sex and smoking habits were found among patients in both groups (Table 1).

Table 1 The distribution of age, gender and smoking habits among HD and control groups

	HD group (n = *68*)	*C group* (n = *41*)	P-*value*
Mean age (years)	47.85 ± 14.61	44.80 ± 10.22	> 0.05*
Gender (male/female)	37/31	21/20	> 0.05
Smoking (yes/no)	25/43	15/26	> 0.05

HD, group with patients on hemodialysis; C, control group with healthy controls.
*Not significant.

Clinical examination and indices

Prior to clinical examination, a medical history was taken from each subject. All the patients were examined in detail by experts from the departments of Oral Diagnosis, Periodontology and Prosthetic Dentistry from Ondokuz Mayıs University, Dentistry Faculty. All examinations were carried out by one author. However, before regarding the clinical data, the examiner and another author, who is a specialist in periodontology (MIC), calibrated the clinical examination. The examiner could not be blind to the subjects' general systemic condition, as they were either examined in a hospital or in a regular clinic. On the other hand, the examiner was 'blind' to the subgroup of renal failure.

Dental health status was determined by visual examination using a probe and dental mirror. Decayed, Missing and Filled Teeth (DMFT) were documented and also the dental health status was calculated using the DMFT index (Schuller and Holst, 2001). Periodontal indices were performed using dental mirror, explorer and a periodontal probe with William's markings. For assessing the thickness of plaque at the gingival area of the tooth, the plaque index (PI) of Silness and Löe

Table 2 The mean values of DMFT, PI, GI, LPA and measurement for PPD for both hemodialysis and control groups (mean ± s.d.)

	HD group (n = 68)	*C group (41)*	P-*value*
DMFT	12.7 ± 8.1	11.7 ± 5.5	>0.05*
PI	2.1 ± 0.5	1.7 ± 0.7	<0.01
GI	1.9 ± 0.3	1.1 ± 0.2	<0.01
LPA (mm)	3.1 ± 1.5	2.4 ± 1.4	<0.01
PPD (mm)	2.3 ± 0.6	1.6 ± 0.6	<0.01

HD, group with patients on HD therapy; C, control group with healthy controls; DMFT, index for decayed, missing, and filled teeth; PI, plaque index; GI, gingival index; LPA, loss of periodontal attachment; PPD, probing pocket depth.
*Not significant.

Table 3 The Spearman correlation coefficients between age, HD duration and measurement of PPD and indices for DMFT, PI, GI and LPA in HD group

	DMFT	*PI*	*GI*	*LPA (mm)*	*PPD (mm)*
Time on HD					
r	0.027	0.58	0.60	0.47	0.52
P	>0.05*	<0.001	<0.001	<0.001	<0.001
Age (years)					
r	−0.005	0.155	−0.126	0.167	−0.005
P	>0.05*	>0.05*	>0.05*	<0.05	>0.05*

HD, group receiving HD therapy; *r*, correlation coeffciency; DMFT, index for decayed, missing, and filled teeth; PI, plaque index; GI, gingival index; LPA, Loss of periodontal attachment; PPD, periodontal probing pocket depth.
*Not significant.

(1964) was used. After the teeth were dried, the microbial dental plaque was scraped by dental explorer and evaluated by the unaided eye. Gingival status was evaluated by using the gingival index (GI) of Löe and Silness (1963). A blunt instrument, such as a periodontal pocket probe, was used to assess the bleeding potential of the tissues in this index.

The periodontal condition was examined using the probing pocket depth (PPD) to measure the distance between the bottom of the pocket and the margin of the gingiva from the six sites of each tooth (mesiovestibule, midvestibule, distovestibule, distolinqual, midlinqual and mesiolinqual). The mean PPD values from the six sites of each tooth and finally the mean values of all

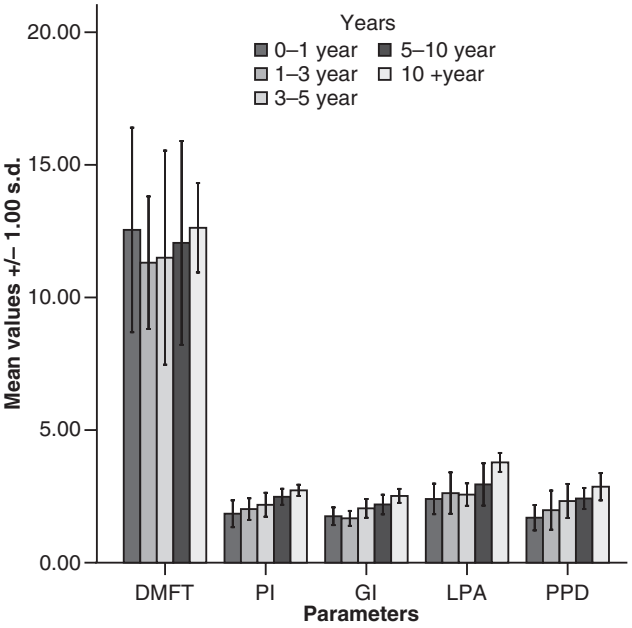

Figure 1 Mean values for DMFT, PI, GI, LPA and PPD levels for the hemodialysis duration groups

teeth were calculated in both HD and control groups and are shown in Table 2. Loss of periodontal attachment (LPA) was measured by calculating the total recession of tooth present within the oral cavity and dividing by the total number of points explored (six sites per tooth) according to World Health Organisation, 1997.

To determine the effect of the duration of HD therapy on dental and periodontal health status, two studies were carried out; first, the duration of all the HD patients was correlated with the dental and periodontal parameters (Table 3). Second, the HD group was further divided into five subgroups and their effects on dental and periodontal parameters were examined and shown (Table 4; Figure 1). Non-manipulated independent variables – the five subgroups of the population studied – were included:

1 those who had been on renal dialysis for less than 1 year (11 patients);
2 those who had been on renal dialysis for 1–3 years (1–2.9 years; 13 patients);

Table 4 The mean values and standard deviations of age, DMFT, PI, GI, LPA and PPD in HD patients and their significance tests for the dialysis duration groups

Dialysis duration groups	n	*Age (years) (mean ± s.d.; min–max)*	*DMFT*	*PI*	*GI*	*LPA (mm)*	*PPD (mm)*
<1 year	11	49.7 ± 8.9 (35–59)	12.5 ± 3.8^{a}	1.8 ± 0.5^{a}	1.8 ± 0.3^{a}	2.4 ± 0.6^{a}	1.7 ± 0.5^{a}
1–2.9 years	13	45.0 ± 8.7 (26–54)	11.3 ± 2.5^{a}	2.0 ± 0.4^{a}	1.7 ± 0.3^{a}	2.6 ± 0.8^{a}	2.0 ± 0.7^{ab}
3–4.9 years	18	48.8 ± 13.2 (24–60)	11.5 ± 4^{a}	2.2 ± 0.4^{ab}	2.0 ± 0.3^{ab}	2.6 ± 0.4^{a}	2.3 ± 0.6^{abc}
5–9.9 years	18	47.5 ± 16.8 (20–70)	12 ± 3.8^{a}	2.5 ± 0.3^{bc}	2.2 ± 0.4^{bc}	2.9 ± 0.8^{a}	2.4 ± 0.4^{bc}
>10 years	8	48.0 ± 12.3 (28–56)	12.6 ± 1.7^{a}	2.7 ± 0.2^{c}	2.5 ± 0.3^{c}	3.8 ± 0.3^{b}	2.9 ± 0.5^{c}

The groups having the same letters have no difference from each other ($P > 0.05$).

3 those who had been on renal dialysis for 3–5 years (3–4.9 years; 18 patients);
4 those who had been on renal dialysis for 5–10 years (5–9.9 years; 18 patients);
5 those who had been on renal dialysis for longer than 10 years (eight patients).

Statistical analysis

To analyze the difference in demographic and clinical parameters of HD and control groups, student's *t*-test was used. The Pearson's chi-squared test was performed if there was a difference in the distribution of sex and smoking habits between the HD and control groups. Mann–Whitney *U*-test was used to determine the significant difference in all clinical parameters to compare the groups. The difference among more than two groups was evaluated using analysis of variance (Kruskal–Wallis one-way ANOVA) and then Bonferroni adjusted Mann–Whitney *U*-test was used to the compare the groups pairwise. The spearman Pearson's correlation coefficients were calculated to evaluate the relationship between the dialysis duration and the clinical parameter values. The level of significance was accepted as $P < 0.05$. For statistical analysis, SPSS ver. 10.0 for Windows was used (SPSS Inc, Chicago, IL, USA).

Results

No significant differences were found regarding age, sex and smoking habits among both the HD and control groups (Table 1; $P > 0.05$). The mean values of DMFT, PI, GI, LPA and PPD for both HD and control groups are shown in Table 2. DMFT index scores in HD group were slightly higher than that in the control group, but this difference was not statistically significant ($P > 0.05$). A highly significant difference was found in the indices for PI, GI, LPA and PPD between both groups (Table 2; $P < 0.01$).

Dialysis duration significantly correlated with PI ($r = 0.46$; $P < 0.01$), GI ($r = 0.46$; $P < 0.01$), LPA ($r = 0.33$; $P < 0.01$) and PPD ($r = 0.38$; $P < 0.01$). But, there was not any statistically significant correlation between dialysis duration and DMFT index values ($r = 0.037$; $P > 0.05$; Table 3). Also, DMFT values show no significant differences between the five HD subgroups. Moreover, there was a weak correlation between age and LPA ($r = 0.24$; $P < 0.05$). But there was no statistically significant correlation between individuals ages and the other parameters (DMFT, PI, GI and PPD; $P > 0.05$; Table 3). PI and GI values display such a behavior for HD subgroups up to 5 years. After 5 years, an increase in the values was observed with the values increasing remarkably after 10 years. LPA values show no significant differences between the five HD subgroups, but after 10 years a significant progressive increase can be observed. For the PPD values, the first 5-year period reveals no variation, whereas the second 5-year period includes significant increases and after 10 years a much more significant increase is observed (Table 4; Figure 1).

Discussion

The dental and periodontal health status of 68 HD patients were analyzed and compared with that of 41 healthy controls in this study. DMFT index values were all comparable in the HD and control groups (Table 2). This is in agreement with the results reported by Bots *et al* (2006); Marakoğlu *et al* (2003); Yamalik *et al* (1991); Tollefsen and Johansen (1985) and Bayraktar *et al* (2007), who support the suggestion that although uremic condition causes an immunosuppressed state, the host is still able to react against a bacterial load. Similar findings were also reported in other uncontrolled studies (Nunn *et al*, 2000; Klassen and Krasko, 2002; Duran and Erdemir, 2004). Furthermore, the authors stated that severe periodontal disease was uncommon in these patients, but the degree of periodontal destruction increased with the time on dialysis (Duran and Erdemir, 2004). In this study, more plaque and bleeding on the probing were found in the HD than in the control group and highly significant difference was found in the indices for PI, GI, LPA and PPD between both groups (Table 2; $P < 0,01$).

Several possible reasons have been forwarded to account for the almost universally reported increased levels of plaque, calculus and gingival inflammation in renal HD populations (Naugle *et al*, 1998; Gavalda *et al*, 1999; Klassen and Krasko, 2002; Al-Wahadni and Al-Omari, 2003; Duran and Erdemir, 2004; Davidovich *et al*, 2005; Souza *et al*, 2005; Chen *et al*, 2006; Bayraktar *et al*, 2007; Castillo *et al*, 2007). Most prominently, CRF patients on HD are in a state of CRF resulting in the uremic syndrome, and uremia has been associated with immune dysfunction, including defects in lymphocyte and monocyte function (Cengiz *et al*, 1988; Cohen *et al*, 1997). Therefore, if uremia is responsible for the increased gingival inflammation observed in this population, increased dialysis vintage maintenance therapy should be associated with increased gingival inflammation and periodontitis incidence and severity. Increased gingival inflammation and periodontitis has been reported in association with increased dialysis vintage in several (Duran and Erdemir, 2004; Davidovich *et al*, 2005; Chen *et al*, 2006; Bayraktar *et al*, 2007) but not all (Naugle *et al*, 1998; Al-Wahadni and Al-Omari, 2003; Marakoğlu *et al*, 2003) studies. Of interest, furthermore Kitsou *et al* (2000) were able to induce experimental gingivitis in CRF patients and concluded that chronic uremia has no effect on the defense of periodontal tissue against microbial plaque.

In view of the nearly universal reports of increased plaque, calculus and gingival inflammation, an increased incidence and severity of periodontitis would be expected in CRF patient populations on HD therapy. However, conflicting results on the status and severity of periodontitis have been reported for CRF populations. Using loss of attachment as a criterion for periodontitis, no increase in periodontitis was found in a study of 38 patients in the United Kingdom, 11 of whom were receiving HD; however, enamel defects and gingival hyperplasia were reported (Nunn *et al*, 2000). A study of 36 adult CRF

patients receiving HD reported no increase in periodontitis when compared with control subjects; however, the controls were drawn from a dental school periodontal clinic population who were presumably seeking periodontal care (Marakoğlu *et al*, 2003). A recent study from Spain assessed the periodontal status of 52 CRF patients receiving HD and found no increase in periodontal indices when compared with the controls. The authors did note that the HD group had greater numbers of periodontopathic bacterial species than the control (Castillo *et al*, 2007). Finally, a study from the Netherlands CRF patients receiving HD did not find an increased loss of attachment when compared with the controls (Bots *et al*, 2006).In contrast, studies on CRF patients receiving HD reported increased attachment loss when compared with the controls (Duran and Erdemir, 2004; Chuang *et al*, 2005; Davidovich *et al*, 2005). Our study supports these findings.

In the literature, to determine the effect of the duration of HD therapy on dental and periodontal health status, the HD group has been further divided into 2–3 subgroups (Al-Wahadni and Al-Omari, 2003; Ertuğrul *et al*, 2003; Marakoğlu *et al*, 2003; Bayraktar *et al*, 2007) as described by Naugle *et al*, 1998;. Also, there are rare and conflicting data on the periodontal health status and duration of dialysis (Naugle *et al*, 1998; Al-Wahadni and Al-Omari, 2003; Ertuğrul *et al*, 2003; Marakoğlu *et al*, 2003; Duran and Erdemir, 2004; Bayraktar *et al*, 2007).

The prevalence of CRF is increasing and when coupled with improved rates of survival for renal replacement therapies, it is evident that patients with CRF will comprise an enlarging proportion of the dental patient population in the future. In addition, CRF and periodontitis can have significant, reciprocal effects (Craig, 2008). CRF and renal replacement therapy can affect oral tissues and can greatly influence the dental management of the renal patient, while recent studies suggest that chronic adult periodontitis can contribute to overall systemic inflammatory burden and may, therefore, have consequences in the management of the CRF patient on HD maintenance therapy. Recently, the patients on dialysis have been living much longer than before. Because of these, much more complications that depend on dialysis have been observed (Craig, 2008). Therefore, in this study, to determine the effect of the duration of HD therapy on dental and periodontal health status, two studies were carried out; first, the duration of HD therapy on dental and periodontal parameters were analyzed, and are shown in Table 3. In this study, a high positive correlation was found between time on dialysis and the parameters, indices for PI, GI, LPA and PPD. But there was no correlation between time on dialysis and DMFT index scores (Table 3). This finding is supported by other studies (Peterson *et al*, 1985; Al Nowaiser *et al*, 2003; Duran and Erdemir, 2004; Bayraktar *et al*, 2007), although there are also studies that found no effect of the duration of dialysis treatment to oral health (Naugle *et al*, 1998; Marakoğlu *et al*, 2003). The second part of this study; DMFT values did not show any significant differences between the five HD subgroups. The PI, GI and PPD values display that the first 5-year period revealed no significant variation, whereas the second 5-year period included significant increase, and after 10 years a much more significant increase was observed. Also, LPA values show no significant differences between the five HD subgroups, but after 10 years a significant progressive increase can be observed (Table 4; Figure 1). According to our knowledge, this part of our study is the first of its kind in the literature.

As mentioned by Craig (2008), although it cannot be concluded that periodontitis is more prevalent and severe in CRF patients on HD therapy from the results of the above studies, it may be important to note that reports of positive associations examined larger renal HD populations. The inclusion of large numbers of subjects is critical in epidemiologic studies of populations that present with multiple potential confounding variables such as the medically complex CRF population. Potential confounding variables in the CRF population include: the high prevalence of diabetes mellitus, smoking, dialysis vintage, age, degree of medical managemant of renal failure complications, potential ethnic/racial or demographic variables that may influence access to dental care, and the selection of appropriate control population. Because of these confounding variables, patients with diabetes mellitus were excluded from this study. To determine the effect of the duration of HD therapy on dental and periodontal health status, the HD group was further divided into five subgroups. However, no data exist to suggest that the prevalence in the CRF population is less than the 14% prevalence of moderate and severe periodontitis reporter for the general population (Brown *et al*, 1996) but may in fact be substantially greater.

In conclusion, in the light of the fact that all CRF patients on HD maintenance therapy are potential renal transplant candidates and the possible contribution of periodontitis to the inflammatory burden in the CRF population, it appears important to assess and maintain the periodontal health of these at risk population. Although periodontal disease is moving into the focus of nephrologist caring for CRF patients, prevention, diagnosis and treatment of periodontal disease have not yet received the prominent attention they deserve, in the major national and international CRF guidelines. All dialysis patients should receive initial oral examinations with follow-up care, including periodontal therapy and restorative treatment within 6 months of their initial dialysis treatment. Besides, they should also receive periodical supportive periodontal therapy. The oral health maintenance program for patients receiving dialysis should be reinforced by the dialysis team and the dentists. Otherwise oral pathologies and infections could jeopardize the opportunity to receive a successful kidney transplant (Bots *et al*, 2006).

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Conflict of interest

None declared.

Author contributions

All of the authors had significant contribution to our study.

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