

The impact of periodontal disease on physical and psychological domains in long-term hemodialysis patients: a cross-sectional study

Gabriel Veisa¹ · Alexandra Tasmoc^{2,3} · Ionut Nistor¹ · Liviu Segall¹ ·
Dimitrie Siriopol¹ · Sorina Mihaela Solomon⁴ · Mihaela Dora Donciu¹ ·
Luminita Voroneanu¹ · Andra Nastasa¹ · Adrian Covic¹

Received: 12 December 2016 / Accepted: 11 March 2017 / Published online: 18 March 2017
© Springer Science+Business Media Dordrecht 2017

Abstract

Purpose Periodontal disease is a chronic infectious disease. Individuals with end-stage kidney disease (ESKD) experience impaired quality of life (QoL) and low oral health. This is the first comprehensive study which aimed to explore the link between periodontal disease and quality of life, assessed with the Short Form 36-Item Health Survey in hemodialysis patients.

Methods In total, 101 patients (57 females) with ESKD were recruited from two Romanian dialysis centers. Periodontal disease assessment included the measurement of periodontal disease index, with its three components: the gingival and periodontal index (GP), the bacterial plaque index (PI) and the calculus index (CI). For assessing QoL, we used the Short Form 36-Item Health Survey (SF-36), with its two components: physical component (PCS) and mental component (MCS).

Results The mean age was 52.5 ± 14.3 years. The dialysis vintage was 6.7 ± 5.6 years. According to periodontal status,

the mean value of GP was 4.0 ± 1.3 , mean PI was 1.8 ± 0.9 , and mean CI was 1.3 ± 0.7 . Regarding the QoL, the means for PCS and MCS were 38.0 ± 17.3 and 45.0 ± 16.3 , respectively. In univariate analysis, the physical and mental components of QoL were significantly associated with the gingival and periodontal index, the bacterial plaque index and the calculus index. In the multivariable linear regression, only the gingival and periodontal index remained significantly associated with physical component ($\beta = -3.26$, $p = 0.04$, 95% CI -6.39 to -0.13) and mental component ($\beta = -5.57$, $p = 0.001$, 95% CI -8.74 to -2.41) of QoL.

Conclusion Our study shows a high prevalence and severity of periodontal disease. The gingival and periodontal index was associated with low QoL, both on physical and on mental components.

Keywords End-stage kidney disease · Periodontal disease · Quality of life · Hemodialysis

Gabriel Veisa and Alexandra Tasmoc have contributed equally to this work.

✉ Alexandra Tasmoc
alexandra_tash@yahoo.com

¹ Nephrology Department, Faculty of Medicine, University of Medicine and Pharmacy “Gr. T. Popa”, Iasi, Romania

² Dialysis and Renal Transplantation Center, “Dr. C. I. Parhon” University Hospital, Iasi, Romania

³ Medical Deontology and Bioethics Department, Faculty of Medicine, University of Medicine and Pharmacy “Gr. T. Popa”, Iasi, Romania

⁴ Periodontology Department, Faculty of Dental Medicine, University of Medicine and Pharmacy “Gr. T. Popa”, Iasi, Romania

Introduction

Poor oral health is a major public health problem, and despite improvements in prevention and treatment, severe periodontitis is found in 5–20% of most adult populations worldwide [1].

Periodontal disease (PoD) is a chronic infectious disease that results in the inflammation of specialized tissues surrounding and supporting the teeth. It can lead to a progressive loss of connective tissue attachment of alveolar bone. This tissue destruction is characterized by formation of periodontal pockets which act as reservoirs for bacterial colonization of the dentogingival environment [2, 3].

Chronic inflammation contributes to both coronary heart disease and chronic kidney disease progression [4].

Epidemiological studies have linked poor oral health with a variety of conditions, such as cardiovascular disease, diabetes, adverse pregnancy outcomes, respiratory disease, stroke, rheumatoid arthritis, malignant disease and obesity [5–7].

Chronic kidney disease (CKD) has also been reported to affect the oral mucosa [8], bone [9], periodontium [10], salivary glands [11] and tongue [12]. CKD has been associated with higher plaque and calculus indices [13] and with oral burning [14, 15].

Some observational evidence suggests that PoD adversely affects the survival of patients with end-stage kidney disease (ESKD) who are on dialysis [16]. Furthermore, moderate-to-severe PoD increases the risk of cardiovascular mortality in dialysis patients [17].

Although hemodialysis (HD) has greatly increased the life expectancy of ESKD patients, low quality of life (QoL) among these patients is frequently reported, especially in physical domain [18, 19].

The objective of this study was to evaluate the prevalence and severity of periodontal disease and its relationship with QoL in a cohort of HD patients.

Materials and methods

Patients

We conducted an observational cross-sectional study, which included only patients on chronic HD for at least 6 months. The patients were recruited between March 2013 and October 2015 from two dialysis units from Iasi, Romania. The exclusion criteria were age under 18 years, terminal illness and psychiatric cognitive disorders that might have affected the understanding of the questionnaires used in the study. All included subjects gave informed consent before participating in the study. The study was approved by the Hospital's Ethical Committee and was performed in agreement with Declaration of Helsinki for human rights.

Demographic characteristics, medical history, laboratory and dialysis parameters were obtained from the patients' medical records. All patients received HD 4 h per session, three times per week. Patients were treated with the Fresenius 4008 and 5008 s CorDiax machine, on high-flux HD or hemodiafiltration. Anemia medication, calcium and non-calcium phosphate binders were used based on monthly assessment. Laboratory measurements were taken using blood samples drawn before dialysis sessions.

Periodontal disease assessment

The patients were referred to a stomatologist for an oral clinical examination, which included periodontal probing and the assessment of periodontal disease index (PDI) (Ramfjord), with its three components: the gingival and periodontal index (GP), the bacterial plaque index (PI) and the calculus index (CI) [20].

The type of edentulous ridge was recorded according to the Kennedy classification. GP scores higher than 3 are suggestive of the presence of periodontitis. Data about oral hygiene habits, diet, smoking and the presence or absence of xerostomia were collected for each patient by the investigators [21].

Quality of life assessment

To assess the QOL, we used the Short Form 36-Item Health Survey (SF-36), a generic instrument, translated and validated in Romanian patients with ESKD [22].

This instrument is divided into 8 dimensions: physical functioning, physical role functioning, pain, general health, vitality, social role functioning, emotional role functioning and mental health. The results vary on scales from 0 to 100 (i.e., from worse to best possible status). The physical and mental components of the 8 dimensions were combined into a physical component summary (PCS) and a mental component summary (MCS), respectively.

Statistical analysis

The descriptive variables are presented as mean \pm standard deviation (SD) or as percentages, as appropriate. Normality of the distribution was assessed with the Shapiro–Wilk test. Logarithmic conversion was performed for non-normally distributed variables. Pearson's and point biserial correlation coefficients were used to determine correlations between paired variables. All the univariable associates ($p < 0.05$) were included in a backward stepwise multivariate regression analysis in order to assess the predictors for both the physical and mental components of QoL.

We tested in univariate analysis the association between the two components of QoL (physical component and mental component) with the following parameters in our database: albumin, serum ferritin, transferrin saturation (TSAT), C-reactive protein (CRP), tumor necrosis factor-alpha (TNF- α), interleukin-6 (IL-6), serum phosphate (P), serum i-PTH, magnesium (Mg), calcium (Ca), comorbidities (diabetes, neurological impairment, hypertension, atrial fibrillation, cardiac failure, ischemic cardiomyopathy, angina

pectoris), body mass index, fat tissue, lean tissue, use of phosphate binders, calcimimetics, proton pump inhibitors, iron supplements, diuretics, statins, nitrate, alpha centrals blockers, alpha beta blockers.

The analysis was performed using the SPSS 20.0 statistical standard package for Windows. A p value <0.05 was considered statistically significant.

Results

In this prospective study, a total of 150 individuals were assessed for eligibility (see “Materials and methods”). In the final analysis, 101 patients (57 females) were included as 49 subjects failed to meet the eligibility criteria (Fig. 1). The mean age was 52.5 ± 14.3 years and the mean dialysis vintage 6.7 ± 5.6 years. Detailed biochemical parameters are presented in Table 1. 59.4% of patients were on phosphate-binding therapy. Twelve patients presented concurrent neurological impairment (previously diagnosed hemorrhagic/ischemic stroke, lacunar brain infarcts), while 31 patients had cardiovascular-associated conditions (heart failure, coronary artery disease, permanent rhythm disorders, peripheral arterial disease) (Table 1). 47.5% patients were treated with high-flux hemodialysis, while 52.5% were treated with hemodiafiltration and 3×4 h sessions per week in all patients.

We identified 76 patients (75.2%) with GP scores higher than 3.00, suggesting the presence of periodontitis. According to periodontal status, the mean value of

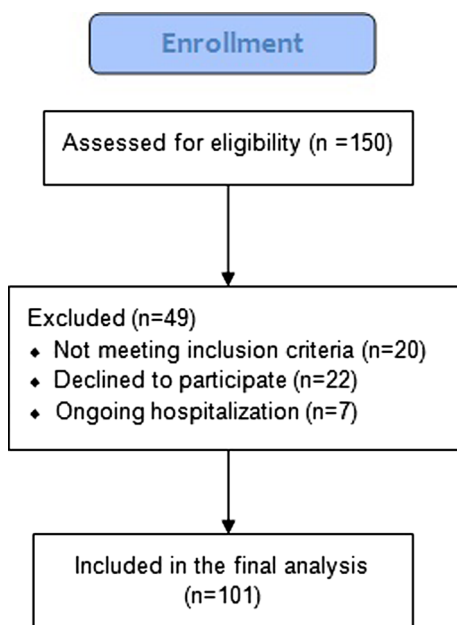


Fig. 1 Flowchart of the patient selection process

Table 1 Baseline general characteristics of the study sample (mean \pm SD and N , % as appropriate)

	Total ($N = 101$)
<i>Sociodemographic</i>	
Age (years)	52.5 ± 14.3
Women, N (%)	57 (43.7)
Dialysis vintage (years)	6.74 ± 5.64
<i>Laboratory data</i>	
Hemoglobin (g/dL)	11.72 ± 1.65
Albumin (g/dL)	4.29 ± 0.42
CRP (mg/L)	9.29 ± 15.21
Serum ferritin (ng/mL)	942.57 ± 712.75
<i>Clinical measures</i>	
Kt/v	1.41 ± 0.25
SBP	148.50 ± 103.12
DBP	73.22 ± 12.07
<i>Comorbidity</i>	
Diabetes mellitus, N (%)	6 (5.9)
Cardiovascular disease (%)	($N = 31$) 30.6%
Neurological impairment	($N = 12$) 5.9%
<i>Smoking status</i>	
Yes, N (%)	14 (13.9)
<i>Dental consultation</i>	
Never went	($N = 14$) 13.3%
When needed	($N = 84$) 83.2%
Once/year	($N = 2$) 2.0%
Once every 6 months	($N = 1$) 1%
Xerostomia	($N = 53$) 52.5%
<i>Place of living</i>	
Rural	($N = 52$) 51.5%

SBP systolic blood pressure, DBP diastolic blood pressure

Table 2 Mean and standard deviation of QoL and periodontal parameters in hemodialysis patients ($N = 101$)

Quality of life components	
Physical component summary (PCS) score	38.00 ± 17.29
Mental component summary (MCS) score	45.04 ± 16.30
Periodontal evaluation	
GP	4.02 ± 1.28
PI	1.76 ± 0.90
CI	1.33 ± 0.72

GP gingival and periodontal index, PI bacterial plaque index, CI calculus index

GP was 4.0 ± 1.3 , mean PI was 1.8 ± 0.9 , and mean CI was 1.3 ± 0.7 . Xerostomia was experienced by 52.5% of patients. 13.3% of patients reported that they never underwent a dental consultation before, while 83.3% were seen by a dentist only in case of emergency (Table 2).

Table 3 Baseline characteristics of clinical parameters and QoL components scores in subgroup without periodontitis and group with periodontitis

	Group 1 (<i>N</i> = 25) GP—rank 0–3	Group 2 (<i>N</i> = 76) GP—rank 3–6	<i>p</i>
Age	42.16 ± 17.13	55.83 ± 11.51	<0.001
Mg	2.92 ± 0.48	2.66 ± 0.43	0.014
Mental component summary (MCS) score	56.36 ± 18.65	41.80 ± 13.77	<0.001
Physical component summary (PCS) score	48.28 ± 19.54	34.61 ± 15.15	<0.001

Mg magnesium, GP gingival and periodontal index, rank 0–3 absence of periodontitis, rank 3–6 presence of periodontitis

We performed a comparison between patients with no periodontitis (GP score 0–3) and with periodontitis (GP score 3–6). Patients with higher GP scores were older, had a low level of Mg and had low scores at both QoL components (Table 3).

Analyzing the two components of the QoL questionnaire, the means for PCS and MCS were 38.0 ± 17.3 and 45.0 ± 16.3 , respectively. The mean scores and standard deviation of the two domains of the SF-36 and of the three components of periodontal disease are shown in Table 2.

Univariate analysis showed a significant association between the two QoL components with the following parameters: C-reactive protein, magnesium, atrial fibrillation, cardiac failure, ischemic cardiomyopathy, angina pectoris, diabetes, fat tissue, body mass index. For all the other parameters tested in the univariate analysis, the results were not significant (Tables 4, 5). The physical and mental components of QoL were significantly associated with the gingival and periodontal index, the bacterial plaque index and the calculus index (Tables 4, 5).

In the multivariable linear regression, only the gingival and periodontal index remained significantly associated with both physical (Table 6) and mental (Table 7) components of QoL.

Table 4 Univariate associates of physical component of QoL in hemodialysis patients (*N* = 101)

Variables	Coefficient	<i>p</i>
Age (years)	−0.49	<0.001
GP	−0.27	0.006
PI	−0.21	0.034
CI	−0.25	0.01
Log GP	−0.34	0.001
Log CI	−0.24	0.02
BMI (kg/m ²)	−0.19	0.04
Log CRP	−0.25	0.01
Log magnesium (mg/dL)	0.19	0.04
Atrial fibrillation, 0—no; 1—yes	−0.37	<0.001
Cardiac failure, 0—no; 1—yes	−0.22	0.03
Ischemic cardiomyopathy, 0—no; 1—yes	−0.32	0.001
Diabetes, 0—no; 1—yes	−0.22	0.03

GP gingival and periodontal index, PI bacterial plaque index, CI calculus index, BMI body mass index, CRP C-reactive protein

Table 5 Univariate associates of mental component of QoL in hemodialysis patients (*N* = 101)

Variables	Coefficient	<i>p</i>
Age (years)	−0.37	<0.001
GP	−0.37	<0.001
PI	−0.21	0.03
CI	−0.25	0.01
Log GP	−0.45	<0.001
Log CI	−0.24	0.02
Fat tissue (kg)	0.22	0.03
BMI (kg/m ²)	−0.22	0.03
Angina pectoris, 0—no; 1—yes	−0.21	0.04

GP gingival and periodontal index, PI bacterial plaque index, CI calculus index, BMI body mass index

Table 6 Determinants of mental component of QoL in hemodialysis patients (*N* = 101)—*R*² = 0.25

Variables	Backward stepwise multiple regression		
	Coefficient	95% CI	<i>p</i>
Age (years)	−0.28	−0.50 to −0.06	0.01
Log GP, per 1 SD increase	−5.57	−8.74 to −2.41	0.001

GP gingival and periodontal index

Table 7 Determinants of physical component of QoL in hemodialysis patients (*N* = 101)—*R*² = 0.33

Variables	Backward stepwise multiple regression		
	Coefficient	95% CI	<i>p</i>
Age (years)	−0.45	−0.69 to −0.21	<0.001
Log GP, per 1 SD increase	−3.26	−6.39 to −0.13	0.04
Atrial fibrillation, 0—no; 1—yes	−10.73	−20.14 to −1.32	0.03

GP gingival and periodontal index

Discussion

This pilot study examined in a cohort of 101 HD patients, for the first time, the relationship between periodontal disease index (as assessed by its three components: gingival and periodontal index, bacterial plaque index and calculus

index), and quality of life, including two summary scores: the physical component and mental component. We found that increasing PoD values were negatively associated with poorer QoL scores. We identified 75.2% of the included patients with GP scores higher than 3.00, suggesting the presence of periodontitis. Regarding the QoL, we found a low level, especially in the physical domain.

Periodontal disease progresses toward teeth loss with consecutive masticatory function impairment in a body systemically affected and with risk of malnutrition. Also, in the general population, periodontal disease is significantly associated with psychological discomfort and physical disability [23].

Due to decreased saliva flow and to local and systemic ionic imbalance, hemodialysis patients have a higher rate of calculus buildup, thus favouring bacterial adherence and more calculus buildup. Periodontal disease has been previously associated, in CKD patients, with older age, low annual income, less high school education, less dental care visits, smoking, and preexisting CVD and diabetes [16].

In another study, aimed to assess the periodontal health status, in a group of 115 HD patients, high level of periodontal parameters were associated with higher dialysis vintage [24].

Our study did not find any statistically correlation between dialysis vintage and periodontal parameters.

Franek et al. [25] reported that progressing chronic periodontitis was associated with increased serum CRP concentration and with increased intima-media thickness of the carotid artery in hemodialysis patients.

As regards the plaque index, the mean value (1.76 ± 0.90) was found to be slightly lower among our studied patients compared to other reports [26–28].

Compared to general population, end-stage kidney disease patients have increased salivary pH and salivary urea concentration [29] and significantly higher plaque and calculus indices [30].

Xerostomia, as a result of the restriction in fluid intake, drugs side effects, possible salivary gland alteration, and oral breathing secondary to lung perfusion problems, was recorded in 52.5% of our included patients. Overall, our data are consistent with other previous reports in the same study population, in terms of poor oral hygiene and periodontal status.

Among our included patients, 5.9% have diabetes mellitus. This result is quite common in the Romanian dialysis population. We have found a low prevalence of diabetes mellitus in other studies as well [31–33].

Mean PCS and mean mental MCS in our population were consistent with a low QoL, although we included a younger population (mean age 52.45 ± 14.31), with a mean dialysis vintage of approximately 7 years. Our findings are not singular in suggesting lower QoL in various HD populations [18, 19, 34].

Our study has several strengths and limitations. To our knowledge, there has never been a comprehensive study to assess a link between periodontal disease and quality of life, assessed with the Short Form 36-Item Health Survey. The study limitations include a small sample size and lack of dental radiographic examination for a more accurate periodontal diagnosis. Being a cross-sectional study, no causal relationship could be explored. We need further longitudinal studies to highlight the predictive relationship between PoD and QoL. Another limitation was the fact that we were not able to explore the etiology of PoD.

The results of the present study show a greater prevalence and severity of periodontal disease in a young HD population. Our HD patients presented weak attitudes and negligence toward oral health. Also, we found that the more severe the periodontal disease, the lower the quality of life in our patients. The gingival and periodontal index was considered a strong predictor for low QoL, with impact on both physical and mental components. Although previous reports have revealed similar results concerning QoL or PoD, no other studies analyzed the impact of PoD on health-related quality of life, using an objective tool—the SF-36 questionnaire for HD patients. Future studies should assess the relative impact of QoL and PoD on patient' survival and cardiovascular morbidity.

Acknowledgements This paper was published under the frame of European Social Fund, Human Resources Development Operational Programme 2007–2013, project no. POSDRU/159/1.5/136893 and by the University of Medicine and Pharmacy “Gr. T. Popa,” Iasi (Grants No. 29235/01.01.2014).

Compliance with ethical standards

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

Ethical approval The study was approved by the Hospital's Ethical Committee and was performed in agreement with Helsinki's declaration of human rights.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

1. Global oral health data bank. Geneva: World Health Organization; 2004
2. Flemmig TF (1999) Periodontitis. *Ann Periodontol* 4:32–38
3. Shub A, Swain JR, Newnham JP (2006) Periodontal disease and adverse pregnancy outcomes. *J Matern Fetal Neonatal Med* 19:521–528
4. Segall L, Mardare NG, Ungureanu S, Busuioc M, Nistor I, Enache R, Marian S, Covic A (2009) Nutritional status

- evaluation and survival in haemodialysis patients in one centre from Romania. *Nephrol Dial Transplant* 24:2536–2540
5. Taylor GW (2001) Bidirectional interrelationships between diabetes and periodontal diseases: an epidemiologic perspective. *Ann Periodontol* 6:99–112
 6. Kinane D, Bouchard P, Group E of the European Workshop on Periodontology (2008) Periodontal diseases and health: consensus report of the sixth European workshop on periodontology. *J Clin Periodontol* 35(8):333–337
 7. Tonetti MS, Van Dyke TE, Working group 1 of the joint EFPAAPw (2013) Periodontitis and atherosclerotic cardiovascular disease: consensus report of the Joint EFP/AAP Workshop on Periodontitis and Systemic Diseases. *J Periodontol* 84:24–29
 8. Summers SA, Tilakaratne WM, Fortune F, Ashman N (2007) Renal disease and the mouth. *Am J Med* 120:568–573
 9. Klassen JT, Krasko BM (2002) The dental health status of dialysis patients. *J Can Dent Assoc* 68:34–38
 10. Gavalda C, Bagan J, Scully C, Silvestre F, Milian M, Jimenez Y (1999) Renal hemodialysis patients: oral, salivary, dental and periodontal findings in 105 adult cases. *Oral Dis* 5:299–302
 11. Proctor R, Kumar N, Stein A, Moles D, Porter S (2005) Oral and dental aspects of chronic renal failure. *J Dent Res* 84:199–208
 12. Anuradha BR, Katta S, Kode VS, Praveena C, Sath N, Sandeep N, Penumarty S (2015) Oral and salivary changes in patients with chronic kidney disease: a clinical and biochemical study. *J Indian Soc Periodontol* 19(3):297–301
 13. Bots CP, Poorterman JH, Brand HS, Kalsbeek H, vanAmerongen BM, Veerman EC, Nieuw Amerongen AV (2006) The oral health status of dentate patients with chronic renal failure undergoing dialysis therapy. *Oral Dis* 12:176–180
 14. Dirschnabel A, Martins A, Dantas S et al (2011) Clinical oral findings in dialysis and kidney-transplant patients. *Quintessence Int* 42:127–133
 15. de la Rosa GE, Mondragon PA, Aranda RS et al (2006) Oral mucosa symptoms, signs and lesions, in end stage renal disease and non-end stage renal disease diabetic patients. *Med Oral Patol Oral Cir Bucal* 11:467–473
 16. Ricardo AC, Athavale A, Chen J, Hampole H, Garside D, Marucha P, Lash JP (2015) Periodontal disease, chronic kidney disease and mortality: results from the third national health and nutrition examination survey. *BMC Nephrol* 16:97
 17. Kshirsagar AV, Craig RG, Moss KL et al (2009) Periodontal disease adversely affects the survival of patients with end-stage renal disease. *Kidney Int* 75:746–751
 18. Lessan-Pezeshki M, Rostami Z (2009) Contributing factors in health-related quality of life assessment of ESRD patients: a single center study. *Int J Nephrol Urol* 1:129–136
 19. Yusop NB, Yoke Mun C, Shariff ZM, Beng Huat C (2013) Factors associated with quality of life among hemodialysis patients in Malaysia. *PLoS ONE* 8(12):841–852
 20. Ramfjord SP (1959) Indices for prevalence and incidence of periodontal disease. *J Periodontol* 30:51–59
 21. Kennedy E (1951) *Partial Dental Construction*, 2nd edn. Dental Items of Interest Publishing Company, Brooklyn
 22. Seica A, Segall L, Verzan C, Vaduva N, Madincea M, Rusoiu S, Cristea S, Stefan M, Serbanescu D, Morosanu P, Grajdeanu L, Andronache R, Nechita M, Dragos D, Dronca A, Gusbeth-Tatomir P, Mircescu G, Covic A (2009) Factors affecting the quality of life of haemodialysis patients from Romania: a multicentric study. *Nephrol Dial Transplant* 24:626–629
 23. Palma PV, Caetano PL, Leite ICG (2013) Impact of periodontal diseases on health-related quality of life of users of the Brazilian unified health system. *Int J Dent* 2013:1–6
 24. Bayraktar G, Kurtulus I, Duraduryan A, Cintan S, Kazancioglu R, Yildiz A, Bural C, Bozfakioglu S, Besler M, Trablus S, Issever H (2007) Dental and periodontal findings in hemodialysis patients. *Oral Dis* 13:393–397
 25. Franek E, Blaschkyk R, Kolonko A, Mazur-Psonka L, Langowska-Adamczyk H, Kokot F, Wiecek A (2006) Chronic periodontitis in hemodialysis patients with chronic kidney disease is associated with elevated serum C-reactive protein concentration and greater intima-media thickness of the carotid artery. *J Nephrol* 19:346–351
 26. Hamissi J, Porsamimi J, Naseh MR et al (2009) Oral hygiene and periodontal status of hemodialyzed patients with chronic renal failure in Qazvin, Iran. *East Afr J Public Health* 6:108–111
 27. Jnabian N, Mirsaed AMG, Ehsani H, Kiakojoji A (2013) Periodontal status of patient' underwent hemodialysis therapy. *Casp J Intern Med* 4(2):658–661
 28. Borawski J, Wilczynska-Borawska M, Stokowska W, Mysliwiec M (2007) The periodontal status of pre-dialysis chronic kidney disease and maintenance dialysis patients. *Nephrol Dial Transplant* 22:457–464
 29. Frankenthal S et al (2002) The effect of secondary hyperparathyroidism and hemodialysis therapy on alveolar bone and periodontium. *J Clin Periodontol* 29:479–483
 30. Gavalda C et al (1999) Renal hemodialysis patients: oral, salivary, dental and periodontal findings in 105 adult cases. *Oral Dis* 5:299–302
 31. Onofriescu M et al (2015) Overhydration, cardiac function and survival in hemodialysis patients. *PLoS ONE* 10(8):e0135691
 32. Garneata L, Slusanschi O, Preoteasa E, CorbuStancu A, Mircescu G (2015) Periodontal status, inflammation, and malnutrition in hemodialysis patients—is there a link? *J Ren Nutr* 25:67–74
 33. Tasmoc A, Donciu MD, Veisa G, Nistor I, Covic A (2016) Increased arterial stiffness predicts cognitive impairment in hemodialysis patients. *Hemodial Int* 20(3):463–472
 34. Ayoub AM, Hijjazi KH (2013) Quality of life in dialysis patients from the United Arab Emirates. *J Family Community Med* 20:106–112