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# The Impact of Dental Treatment on the Systemic Health Markers of Dialysis Patients: A Series of Cases

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**Abstract:** Studies have reported a more precarious oral health status, with a higher prevalence of periodontal disease in hemodialysis patients. Also, oral inflammation foci, mainly periodontal disease, are related to systemic inflammation and malnutrition, which have a negative impact on morbidity and mortality in these patients. The aim of this study was to observe the influence of dental treatment on the oral and systemic status of these patients. The study is a series of cases and was conducted in two stages: the initial evaluation and treatment stage and the monitoring stage. The patients included in the study were diagnosed with moderate or severe periodontal disease. The oral status parameters (plaque and gingival bleeding index, pocket depth, attachment level, DMFT and CPITN index) and general status parameters (C-reactive protein, albumin, hemoglobin, calcium phosphate product, calcium and phosphate levels, erythropoietic-stimulating agents) were registered and monitored. Conventional periodontal treatment, dental extractions and endodontic treatments were performed. The evaluation of treatment results was performed on 13 patients. Post-treatment assessment showed a statistically significant improvement in oral parameters, at both 1 month and 3 months post-treatment. The mean values for albumin, C-reactive protein, hemoglobin, calcium phosphate product and calcium levels had a slight improvement, but the difference was not statistically significant.

**Keywords:** oral health; dental treatment; hemodialysis; systemic inflammation; malnutrition; periodontal disease

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## Introduction

During the last decade, scientific studies that explored the oral status of patients with chronic kidney disease (CKD) at different stages of evolution, including those on hemodialysis, reported a more precarious oral health status than in the general population [1–3]. Moreover, the research highlighted the burden of oral

infection, particularly periodontal disease, on the nutrition state and systemic inflammation in hemodialysis patients [4–6]. The prevalence of periodontal disease is higher in patients with advanced CKD and on hemodialysis, and it is associated with systemic inflammation and malnutrition, the latter conditions both being related to morbidity and mortality in those patients [2,4,7,8].

Studies conducted on patients with CKD and dialysis treatment suggest the beneficial effect that the early implementation of dental prophylaxis and treatment may have on these patients [2,4,5]. Removing inflammatory foci from the body is a recommendation of nephrologists for both the prophylaxis of protein–energy malnutrition in patients with CKD in stages 4 and 5 ([9] recommendation III-7), as well as for patients registered for a renal transplant [10].

Research studies that focus on the effects of dental treatment on the general status and the quality of life of patients with CKD and/or hemodialysis patients are few [11,12]. Hopper et al. [13] reported that dental problems are an important risk factor for malnutrition in dialysis patients and observed that dental treatment had a beneficial effect on nutrition status. A Japanese study reported that patients on peritoneal dialysis that benefitted from dental care in the past also had better prognosis factors for their underlying disease [12].

Most studies that have researched the relationship between oral status, particularly periodontal disease, and general status suggest the necessity to perform interventional studies that monitor the effects of dental treatment on the general status and prognosis factors of CKD patients [2,4,5,14,15].

The scope of the present study was to observe the effects of the removal of oral inflammatory foci through dental treatment on the local and general status of hemodialysis patients.

## Materials and Methods

The present study was carried out between January and July 2013, in collaboration with the Nephrology Department at “Carol Davila” University Nephrology Hospital in Bucharest, the “Dr Carol Davila” Fresenius Nephrocare Dialysis Center, Bucharest and the IHS Dialysis Center “Sf. Pantelimon”, Bucharest.

This study is a series of cases. The conditions for inclusion in the study were as follows: the presence of periodontal disease in severe or moderate form and/or odontogenic infections, and the ability to attend the necessary treatment sessions. Patients with diabetes, neoplastic diseases or edentulism were not included in the interventional study.

For the assessment of oral status, the following parameters were registered:

- O’Leary Plaque Index (PI) [16];
- Mühlemann and Son sulcular bleeding index (SBI);
- DMFT index (total number of Decayed, Absent, Filled Teeth) [17];
- Gingival attachment level (CAL) [18];
- Periodontal pocket depth (PPD) [18];
- CPITN Index (community index of the need for periodontal treatment) [19];
- The existing prosthetic treatment;
- The need for prosthetic treatment.

The assessment of the general status [10] included the registration of parameters for the following:

- Nutritional status: serum albumin, cholesterol level, calcium and phosphate levels, calcium phosphate product, body mass index;
- Systemic inflammation status: C-reactive protein;
- Hematological status: hemoglobin, quantity of erythropoietic-stimulating agents (ESAs);
- Dialysis parameters: dialysis vintage (number of years on dialysis).

The general health parameters were registered monthly as part of the dialysis protocol. In order to have a clearer understanding of the inflammation and malnutrition status of the patients, we decided to take into consideration the values of the general health parameters 6 months before and 3 months after dental treatment for analysis. The analysis was performed by comparing the mean values of the general parameters of the months before with the mean values of the post-treatment period.

The study had two stages. The first included the initial assessment and the dental treatment. The second stage consisted of two follow-up assessments of the local status parameters that took place 1 and 3 months after the last treatment session.

The registered and monitored oral and general health parameters can be seen in Table 1.

**Table 1.** Study parameter monitoring chart.

Parameter	Initial Evaluation	Monitored Parameter
Name	X	
Gender	X	
Age	X	
Address	X	
Marital status	X	
Smoking habit	X	
Education	X	
Primary renal disease	X	
DMFT	X	
Plaque index	X	X
Sulcular bleeding index	X	X
CAL	X	X
PPD	X	X
CPITN	X	X
Existing prosthetic treatment	X	
Need for prosthetic treatment	X	
Frequency of toothbrushing	X	
Use of mouthwash	X	
Dental attendance	X	
C-reactive protein	X	X
Albumin	X	X
Hemoglobin	X	X
Calcium phosphate product	X	X
Serum calcium level	X	X
Serum phosphate level	X	X
Erythropoietic-stimulating agents	X	X
Body mass index	X	
Hemodialysis vintage (years)	X	

### ***Treatment Stage***

In the interventional stage, individualized procedures for the removal of oral inflammatory foci were applied according to the patient treatment needs, namely supra and subgingival scaling and debridement, tooth extractions, treatment of caries or pulpal complications. Patients also received instructions for correct oral hygiene habits. All invasive procedures were performed on non-dialysis days according to the individualized medication protocol set-up in collaboration with the nephrologist [20].

Patients attended the clinic for at least 2 initial sessions for documentation and periodontal treatment as follows:

Session 1:

- Registration of demographic data, medical history, dental hygiene habits and dental status;
- Measurement of clinical parameters: PI, SBI, CAL and PPD;
- Indications for the daily use of chlorhexidine digluconate 0.1% mouthwash;
- Individualized oral hygiene instructions.

Session 2:

- Conventional periodontal therapy: scaling and root planning;
- Subgingival irrigation with chlorhexidine digluconate 0.05%;
- Remineralization of dental hard tissues;
- Individualized oral hygiene instructions.

Optional treatment sessions:

- Tooth extractions;
- Dental treatments according to the patient's needs;
- Supplementary remineralization of dental hard tissue.

### ***Monitoring Stage***

Mandatory sessions were scheduled at 4 weeks and 12 weeks, respectively, after the last treatment session and included the following:

- Measurement of clinical parameters;
- Re-evaluation of the clinical markers.

Statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 16.

A paired sample's *T*-test and an analysis of variance (ANOVA test) were used to compare the before and after treatment mean values for oral and general status parameters. A *p*-value lower than 0.05 was considered statistically significant.

The study had the approval of the Ethics Commission of "Carol Davila" University of Medicine and Pharmacy (certificate 04/01.01.2013).

### **Results**

Twenty patients were initially enrolled in the study; they signed the informed consent and started the interventional treatment. Two of the patients refused to continue with the interventional treatment due

to personal reasons and eighteen ended the therapy phase. Among them, five patients did not show up for either of the follow-up evaluations.

Thus, the final evaluation of the impact of dental treatment was carried out for the remaining 13 patients. Of these, eight were men. The patient ages ranged from 43 to 69 years, with only two patients over 65 years of age.

### *Oral Status*

The oral status in terms of periodontal parameters, plaque and bleeding index, and number of functional teeth is detailed in Table 2. Regarding the periodontal status, 10 patients were assessed to have severe and 3 with moderate periodontal disease.

The oral hygiene status was very poor for all 13 participants, as the plaque index values were higher than the acceptable value of 10% or lower (Table 2).

**Table 2.** Oral parameters registered before treatment.

Oral Parameter	Mean $\pm$ SD	Minimal Value	Maximal Value
CAL mean	4.9 $\pm$ 0.9	3.15	6.25
CAL max	8.1 $\pm$ 1.8	5.50	11
PPD mean	3.5 $\pm$ 0.9	2.13	4.82
PPD max	6.4 $\pm$ 2.2	3.50	11
PI	90% $\pm$ 10%	72%	100%
SBI	2.2 $\pm$ 0.5	1.59	3.27
Number of functional teeth	19.31 $\pm$ 6.1	5	30

In terms of existing prosthetic treatment, nine patients had fixed prosthetic reconstructions and four had no prosthetic rehabilitation treatments. Most of the prosthetic treatments had indication for removal and retreatment.

Clinical and X-ray examinations revealed the following pathological aspects:

- Multiple deposits of supra and subgingival tartar;
- Gum inflammation and recess;
- Periodontal pockets;
- Horizontal and vertical bone resorptions;
- Multiple carious lesions at coronal and root levels;
- Tooth wear;
- Tooth mobility.

The following procedures were performed among the 13 patients:

- Conventional periodontal treatment: using piezoelectric ultrasound device and Gracey curettes for all 13 patients;
- Dental extractions: total of 43 tooth extractions for the entire group;
- Endodontic treatments: nine for the entire group;
- Treatment of carious lesions and application of composite fillings: 26 for the entire group.

### *Treatment Effects at the Local Level*

The values of these variables can be seen in Table 3.

**Table 3.** Mean values of oral parameters pre- and post-treatment, and statistical significance for the paired sample *t*-test.

Oral Parameter	Pre-Treatment (Mean ± SD)	1 Month Recall (Mean ± SD)	3 Months Recall (Mean ± SD)	<i>T</i> -Test for (2)–(3) and for (2)–(4)
(1)	(2)	(3)	(4)	(5)
CAL mean	4.9 ± 0.9	4.1 ± 0.8	4.3 ± 0.7	<i>p</i> < 0.05
CAL max	8.1 ± 1.8	6.8 ± 1.5	7.1 ± 1.6	<i>p</i> < 0.001
PPD mean	3.5 ± 0.9	2.8 ± 0.8	3.1 ± 0.7	<i>p</i> < 0.05
PPD max	6.4 ± 2.2	5.0 ± 1.4	5.2 ± 1.4	<i>p</i> < 0.001
PI	0.9 ± 0.08	0.4 ± 0.2	0.7 ± 0.2	<i>p</i> < 0.01
SBI	2.2 ± 0.5	0.6 ± 0.4	1.1 ± 0.7	<i>p</i> < 0.001

A statistically significant decrease was observed between the pre-treatment and post-treatment values. The mean values of the registered parameters decreased after treatment and remained lower at the 1- and 3-month post-treatment recalls, with a slight tendency to increase over time. This translates clinically into a reduction in the CAL index and periodontal pocket depth, as well as a reduction in the amount of plaque and reduction in gingival bleeding. The reduction in the amount of plaque is proof of an improvement in the oral hygiene status. This fact shows a better compliance of the patients to personal oral hygiene habits following the instructions received during the interventional stages.

### *Treatment Impact on the Systemic Status*

An ANOVA analysis of variance revealed slightly improved values for most general parameters, but the difference was not statistically significant. The following values were considered for analysis: mean values of the general parameters during the 6 months before dental treatment and mean values of the parameters during the 3 months of follow-up. These means are listed in Table 4, where the statistical comparison was carried out using the *T*-test for paired samples.

**Table 4.** Comparison between general status parameters before and after dental treatment.

General Parameter	6 Months before Treatment (Mean ± SD)	3 Months post-Treatment (Mean ± SD)	<i>T</i> -Test
Albumin	3.95 ± 0.34	3.89 ± 0.22	<i>p</i> = 0.512
C-reactive protein	11.50 ± 11.07	6.90 ± 7.05	<i>p</i> = 0.121
Hemoglobin	12.16 ± 1.16	12.09 ± 1.08	<i>p</i> = 0.774
Erythropoietic-stimulating agent	15.65 ± 21.20	16.8 ± 19.27	<i>p</i> = 0.458
Serum calcium level	9.34 ± 0.45	9.18 ± 0.66	<i>p</i> = 0.091
Serum phosphate level	5.47 ± 1.11	5.47 ± 1.41	<i>p</i> = 0.999
Calcium phosphate product	50.54 ± 10.53	49.69 ± 14.69	<i>p</i> = 0.772

### Discussion

This study is a case series. The decision to conduct this type of research was made for several reasons. First, carrying out a larger study, such as a randomized control group study, on a larger number of individuals, was not possible given the available human and financial resources. Second, the general status of dialysis patients influenced by the associated comorbidities, which differ from case to case, and the side effects of dialysis treatment would have made it difficult to find a control group calibrated with the study group so that the effects of an interventional treatment at the oral level are visible.

For this study, we also considered that patients with diabetes should be excluded from the interventional study, unlike the study by Wehmeyer et al. [11]. This decision was made taking into account the fact that diabetes is an important predisposing factor for periodontal disease, and we considered that it would have constituted a bias for this research. It should be emphasized that the percentage of people with diabetes and hemodialysis treatment is much lower in Romania compared to the USA. In 2009, the incidence of patients with diabetes starting dialysis treatment was 13% in Romania [21] and 44% in the USA [22].

The effects of the oral therapeutic intervention were evident in the oral cavity, showing an improvement in the values of the periodontal parameters, which was maintained 3 months post-therapeutically. However, the value of periodontal parameters had a tendency to increase toward the third month. This is similar to the observations of Wehmeyer et al. The slight increase in the values of these parameters in the interval between the first and second post-treatment follow-up session can be attributed to the difficulties in maintaining optimal oral hygiene due to both the status of the periodontium (multiple periodontal pockets and gingival retraction) and low motivation of the patients.

The influence of oral treatment on the general parameters of inflammation or malnutrition was not statistically significant. Similar to our results, the study by Wehmeyer et al. [11] did not observe differences in the parameters of inflammation and malnutrition between the treatment and control groups at neither 3 nor 6 months post-intervention. However, it cannot be concluded whether the treatment to remove oral inflammatory foci has implications on the general status due to the following reasons:

- The study group was small. General complications related to the underlying disease led to the withdrawal of almost half of the original subjects. The same phenomenon was also present in the study by Wehmeyer et al. For future studies, the need to initiate research on a sufficiently large group of people should be noted, so that the large number of potential withdrawals from the study does not compromise the results.
- The follow-up period was reduced.
- The general status of the patients in the study was not greatly altered, which proves an effective dialysis and a correct therapeutic approach regarding the treatment of anemia and nutritional status. We believe that under such conditions, the number of participants in the study must be higher for any changes in the parameters to be notable.
- Most of the foci of oral inflammation present in the study group were chronic, and their influence on systemic inflammation (CRP level) was small or not present at all. The study conducted by Shander et al. [23] on the influence of oral inflammatory foci on the kidney transplant rejection rate observes that oral chronic inflammation foci do not have a great influence on the systemic inflammation parameters nor the rejection rate of the organ transplant.

The aspects listed above may constitute limitations of this interventional study.

We believe that although the results of this interventional study were not conclusive in proving or disproving the working hypothesis, it had numerous benefits.

First, the experience gained through the organization and management of the study, including the collaboration with the dialysis patients, the initial consultation at the dialysis bed and the collaboration with the nephrologists in order to establish the treatment protocol, will be indispensable for the design of future research on this topic. In addition, an interdisciplinary team of specialist researchers was formed who proved their ability to collaborate both in the stages of designing the present studies and in the subsequent ones of implementation and observation of the results.

Secondly, the team of dental specialists has accumulated experience related to collaboration with dialysis patients, the medical aspects of this population demographic and their dental treatment.

## Conclusions

1. The oral status, characterized by the measured periodontal parameters, improved visibly and statistically significantly after the dental treatment. The results were also maintained at 3 months post-treatment. However, a slow deterioration of the periodontal clinical aspect was noticeable.
2. The parameters of the general status did not change significantly following the intervention. However, we believe that due to the limitations of this study listed above, the results are not conclusive. As such, studies performed on a larger group of patients and a longer post-therapeutic monitoring period are needed.
3. Education regarding correct oral hygiene habits and the importance of maintaining oral health in dialysis patients was successful in the short term. The long-term benefits can be obtained, however, through a correct monitoring of these patients in terms of oral hygiene habits.

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