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Research Article

Effect of Individualized Dietary Counseling Improve Hyperphosphatemia among Hemodialysis Patients

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Abstract

Rationale: Hyperphosphatemia is a significant health problem in end-stage renal disease (ESRD) patients on hemodialysis (HD). It can lead to cardiovascular, bone, and other disorders, as well as secondary hyperparathyroidism, and is also associated with an increased prevalence of mortality in HD patients. The aim of the present study was to evaluate the effect of nutrition counseling and dietetic intervention on hyperphosphatemia management.

Methods: The study was organized at big dialysis centers in Khartoum for six months. ESRD patients (n = 145) on regular HD (three times weekly for the duration of three hours each session), dialyzed for at least 3 months, were included in the study. They were divided into a test group (n = 83) and a control group (n = 62). All participants (in both the test and control groups) were similar in everything, including their dialysis time and durations. In the same age group, all were adults above 18 years old, following the same medications with specific doses as prescribed and followed by their physician (erythropoietin intravenous injection, iron, active vitamin D, phosphorus binders, B-complex vitamins, folic acid, and vitamin E). and only differ in their dietary regimens. The test group received nutritional counseling and consumed individualized diets (restricted in phosphate intake) for a period of 6 months. The study was organized at big dialysis centers in Khartoum for six months. ESRD patients (n = 145) on regular HD (three times weekly for the duration of three hours each session), dialyzed for at least 3 months, were included in the study. They were divided into a test group (n = 83) and a control group (n = 62). All participants (in both the test and control groups) were similar in everything, including their dialysis times and durations. In the same age group, all were adults above 18 years old, following the same medications with specific doses as prescribed and followed by their physician (erythropoietin intravenous injection, iron, active vitamin D, phosphorus binders, B-complex vitamins, folic acid, and vitamin E). and only differ in their dietary regimens. The test group received nutritional counseling and consumed individualized diets (restricted in phosphate intake) for a period of 6 months. The control group consumed the usual diet. Serum phosphorus levels were measured at baseline and 2, 4, and 6 months after the start of the study.

Results: Serum phosphorus levels decreased significantly from 5.6 mg/dL to at baseline 4.8, 4.2 and 3.8 mg/dL 2, 4, and 6 months after the onset of the study in the test group. In the control group, the decrease was mild and insignificant (5.0, 5.0, 4.7, and 4.3 mg/dL at baseline, 2, 4, and 6 months). Significant differences between groups were apparent in months 4 and 6 ($p < 0.05$).

Conclusions: The study demonstrated that effective nutritional counseling was effective in controlling and improving serum phosphorus levels among HD patients. Therefore, nutritional counseling by qualified dietitians should be mandatory in renal units as part of the medical therapy management to reduce the incidence of hyperphosphatemia in HD.

Keywords: Serum Phosphorus; Hemodialysis; Hyperphosphatemia; Dietary Counseling

Introduction

Hyperphosphatemia is a significant health problem in end-stage renal disease (ESRD) patients on hemodialysis (HD). It is defined as an elevated level of phosphate in the blood. Normal values may vary from laboratory to laboratory. For chronic kidney disease (CKD) patients, the National Kidney Foundation Kidney Disease Outcome Quality Initiative (K/DOQI) clinical practice guidelines target phosphorus control of 3.5-5.5 mg/dL for CKD stage 5, including dialysis patients [1].

Hyperphosphatemia in CKD patients is a potentially life-altering condition. It has been shown that for every 1 mg/dL increase in phosphorus, there is a 10% to 62% increase in risk [2]. It's more common in people with ESRD, especially those on HD. Studies

found that more than 60-70% of patients on HD face high serum phosphorus levels and suffer from hyperphosphatemia compared with the healthy population [3]. It can lead to cardiovascular [4], bone, and other disorders, as well as secondary hyperparathyroidism, and is also associated with an increased prevalence of mortality and an increasing risk of death among patients on HD [5-7].

Beside other medical causes, hyperphosphatemia can result from increased phosphate intake due to the inability of the kidneys to excrete the excess dietary intake. And it is very necessary to consider managing phosphorous intake to achieve and control serum phosphorus concentrations within a normal reference range, as it is highly recommended by K/DOQI to adjust the dietary phosphorus intake amount in adults with CKD stage 3-5D (on dialysis) to maintain serum phosphate levels in the normal range [8]. For successful management of hyperphosphatemia in ESRD patients, it is important to combine both medical and dietary treatment. The primary treatment of hyperphosphatemia among HD patients usually includes eating a restricted phosphate diet and taking phosphate binder medications such as calcium carbonate. To control and restrict eating high phosphorus foods, a good and complete dietary consultation is needed. And to ensure the following of the dietary plan, individualized meal planning is highly recommended to make sure that patient needs are all included based on the patient's general condition.

Guidelines advised by the K/DOQI Clinical Practice Guidelines for Bone Metabolism and Disease in CKD are to control phosphorous dietary intake to less than 800-1000 mg/day. To manage serum phosphorus levels and prevent hyperphosphatemia in HD patients (8). This usually should be implemented with full nutritional education, explaining all the necessary information about the dietary content of phosphorus and the dietary sources of phosphorus in foods, as well as the hidden phosphorus content, especially in canned foods and food additives [8,9].

Hyperphosphatemia is highly present among ESRD patients treated with HD, which still needs more work and efforts by the medical team, especially dietitians and nephrologists, to manage serum phosphorus levels. And this is the main reason for this research paper. The aim of the present study was to evaluate the effect of nutrition counseling and dietetic intervention on hyperphosphatemia management.

Materials and Methods

Patients and study design

Our study is an interventional study to evaluate the effect of nutrition counseling and dietetic intervention on hyperphosphatemia management. with CKD patients on HD. The study was organized at big dialysis centers for six months. Adult (more than 18 years of age) ESRD patients (n = 145) on regular HD (two-three times weekly), dialyzed four hours per session for at least 3 months, were enrolled in the study (both male and female). Consent given for participation in the study. They were divided into a test group (n = 83) and a control group (n = 62). The test group received nutritional counseling and consumed individualized diets (restricted in phosphate according to the National Kidney Foundation) for a period of 6 months. The control group consumed the usual diet. Serum phosphorus levels were measured at baseline and 2, 4, and 6 months after the start of the study.

Method of data collection

With this study, data was collected three times: at baseline, during the study period, and after intervention.

For the review of patients' medical histories, all the participants (test group and control group) medical records were checked to understand the medical condition (and the association of other diseases) such as hypertension, diabetes, ischemic heart disease, and hepatitis profile, See the medication list that was followed by patients in addition to the duration of the problem, treatment, duration on dialysis (per month), number of dialysis sessions per week, and duration of dialysis in hours. Medical records were reviewed at baseline and every 2 months for biochemical results of serum phosphate levels.

To collect demographic characteristic data and a few medical information, direct individual interviews with all participants in the study (during baseline) were done by the researcher using a structured questionnaire that was filled out during their dialysis session.

Intervention

The test group (83 patients) received conventional nutritional counseling and an individual meal plan to achieve adequate phosphate intake. Follow-up and monitoring were done during the six months of the study. The individual meal plan was designed for each participant and explained to the patient and their families in multiple ways to make sure that they understood it. It was provided as an educational lecture presented by the researcher followed by the distribution of a diet sheet (handout) including the summary of the presentation to all test groups during their dialysis session by using a data-show to educate the patients and their families on the nutritional needs to provide appropriate food with adequate restricted phosphorus intake to the patients. In addition to all the important information needed to be known by ESRD patients on HD, It was concentrated on the renal diet with restricted phosphate intake and including other nutrients needed, such as calories and protein, fluid limitation, and intake of sodium, potassium, and phosphorus in foods, to complete the balance of the renal diet. Information was

provided in a simple way and explained with pictures for better understanding. Then individualized meal plans were designed individually for all intervention group participants after analysis of the full information that helped the researcher conduct the meal plan. The meal plan was based on the patient's economic status, medical history, diet history, likes and dislikes, chewing and swallowing status, food allergies, blood investigation results, age, weight, height, and sex. (A food exchange list was used to help patients find food substitutes if they were unable to follow the meal prescribed according to likes and dislikes or socio-economic reasons.) After calculation of all nutrients needed by each participant, an individual meal plan for the whole week was designed by the researcher, typed, organized, color printed, and given to the participant with a full explanation of its uses. The meals planned were designed only for intervention patients, whereas control patients continued to receive their usual care.

Biochemical parameters

Blood samples were drawn from the participants under fasting conditions just before the beginning of a dialysis session and measured for serum phosphorous at baseline and every two months during the intervention period until the end of the study for all participants. The following parameters were determined: serum phosphorus, with normal values ranging from 2.7 to 4.5 pg/ml.

Biochemical parameter data were recorded over a six-month period. Test done by using the following methods [10]:

Test principle, Molybdate UV.

Inorganic phosphate forms an ammonium phosphomolybdate complex having the formula (NH4)3[po4(MoO3)12] with ammonium molybdate in the presence of sulfuric acid.

Phosphate + ammonium molybdate → H_2SO_4 ammonium phosphomolybdate

Medications

All the participants in the study from both groups (the test and control groups) continued taking their medications that were prescribed and recommended by their physicians during the study period. (Such as erythropoietin intravenous injection, iron, active vitamin D, phosphorus binders, B-complex vitamins, folic acid, and vitamin E).

Statistical analysis

The SPSS statistical software package (version 17.0 for Windows; SPSS Inc., Chicago, IL, USA) was used to do all the statistical analyses. The results are presented as frequencies and percentages for categorical variables, and the mean [+ or -] standard deviation (SD) was calculated for all continuous variables. For comparison and differences between means, data were analyzed using the 't' test and the (χ2) qui squire test. The statistical significance level of $p < 0.05$ was adopted.

Results

Demographic characteristics of the study sample

For the demographic characteristics of the study participants (test and control), males represented a higher percentage than females. The age group distribution of the subjects shows that most of the patients (46.3%) were in the active age group of 30-45 years (49.4% test and 42.1% control). The majority (31.3%) had higher secondary school education (29.9% test and 33.3% control), followed by 17.9% university graduates (23.4% test and 10.5% control); the rest were illiterate or with low educational level.

Medical profile of the participants

The medical characteristics of the study participants show that 53.7% of the participants had hypertension (61.0% test and 43.9% control), while only 3.0% had diabetes mellitus and hypertension (1.3% test and 5.3% control), and the rest (43.3%) did not have any comorbid disease (37.7% test and 50.9% control). The mean durations of dialysis periods were 57.08 ± 36.16 months for both groups (61.77 ± 38.84 test and 50.75 ± 31.42 control group).

Biochemical evaluation of the study patients (Serum phosphorus (po4))

The study shows that at baseline, there was no significant difference in the biochemical markers (serum phosphorus) between the two study groups. ($p = .153$). The changes in serum phosphorus levels in the study before and after the intervention with both studied groups (test and control) are shown in figure 1 and table 1. The study shows a significant control in serum phosphorus levels among the intervention group during the study period compared with the control group. Serum phosphorus levels decreased significantly from 5.6 mg/dL at baseline to 4.8, 4.2, and 3.8 mg/dL 2, 4, and 6 months after the onset of the study in the test group. In the control group, the decrease was mild and insignificant (5.0, 5.0, 4.7, and 4.3 mg/dL at baseline, 2, 4, and 6 months). Significant differences between groups were apparent in months 4 and 6 ($p < 0.05$).

Discussion

International guidelines suggest that all patients on chronic dialysis receive frequent nutrition counseling. Our study demonstrates a significant improvement in the nutritional status of hemodialysis patients who followed active nutritional counseling during the study according to serum phosphorus levels. Hyperphosphatemia increases patients' mortality and morbidity among hemodialysis patients; accordingly, the management of this risk factor in dialysis patients is very important.

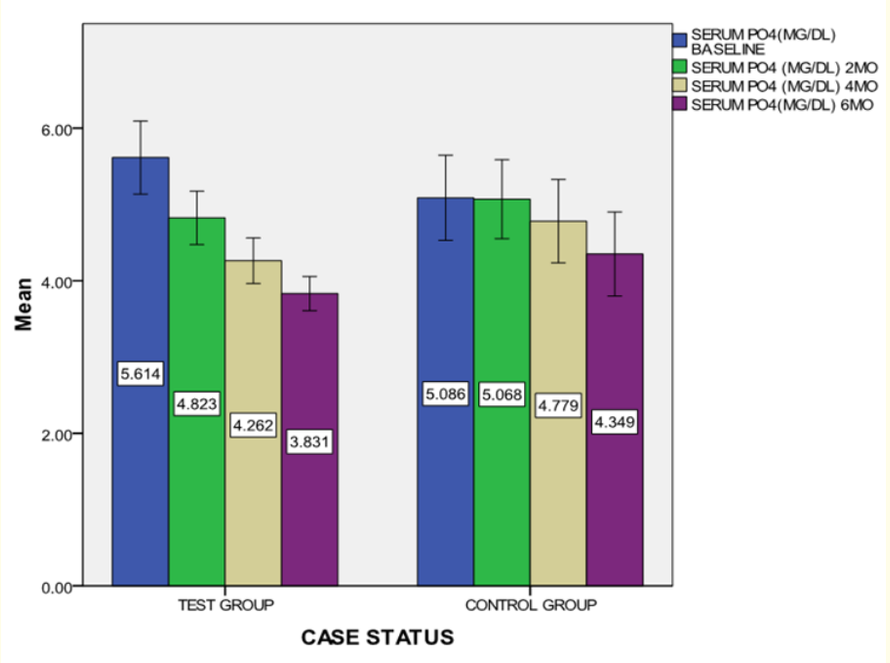

Figure 1: Changes in serum phosphorus levels in the study patients throughout the study (n = 134).

Parameter	Test (n = 77)	Control (n = 57)	P value
Serum phosphorus (PO4) level (mg/dl)			
Serum PO4 (mg/dl) baseline	5.61 ± 2.10	5.08 ± 2.10	0.153
Serum PO4 (mg/dl) after 2mo	4.82 ± 1.53	5.06 ± 1.94	0.418
Serum PO4 (mg/dl) after 4mo	4.26 ± 1.30	4.77 ± 2.06	0.079
Serum PO4 (mg/dl) after 6mo	3.83 ± 0.98	4.34 ± 2.08	0.058

Table 1: Biochemical measurement for the study patients (n = 134).

The renal team, who work in dialysis centers, routinely advises patients to restrict phosphorus intake in their diet to prevent elevation of serum phosphorus and manage hyperphosphatemia [11]. Elevated phosphorus levels can lead to many medical problems because they are associated with an increased death risk in long-term hemodialysis patients [8,12].

Elevated serum phosphorus is common among patients on hemodialysis. Studies found that more than 60% of hemodialysis patients in the United States have higher phosphate levels in their blood (above the normal reference range) [13] which affect their nutritional and health status as Elevated serum phosphorus is a strong independent risk factor for mortality in maintenance hemodialysis (MHD) patients. Studies done to evaluate nutritional status with hemodialysis patients show that nutritional status predicts mortality in patients with end-stage renal disease on hemodialysis [14]. In this study, serum phosphorus levels were found to be higher in both study groups at baseline (phosphorus with normal values ranging from 2.7 to 4.5 pg/ml), which agreed with other international studies.

Our study shows a significantly decreased serum phosphorus level from 5.6 mg/dL at baseline to 4.8, 4.2, and 3.8 mg/dL 2, 4, and 6 months after the onset of the study in the test group. In the control group, the decrease was mild and insignificant (5.0, 5.0, 4.7, and 4.3 mg/dL at baseline, 2, 4, and 6 months). Significant differences between groups were apparent in months 4 and 6 ($p < 0.05$).

Elevated serum phosphate levels usually lead to hyperphosphatemia [15] and need more attention from the medical renal team, especially dietitians and nephrologists, to control serum phosphorus levels.

Dialysis patients also tend to have high levels of phosphorus, so controlling serum phosphorus levels is a priority [8,16]. Like other nutrients, phosphorus is found in many otherwise healthy foods. These foods need to be eaten sparingly because the high phosphorus content pulls calcium from the bones, causing permanent bone weakness. (17). This study was done to control serum phosphorus

levels and manage hyperphosphatemia in ESRD patients on HD. In our study, the intervention group received the recommended intake of phosphorus. We use a phosphate restriction diet of 800-1000 mg/dL/day from phosphate intake as recommended by the National Kidney Foundation [8,18], which is equivalent to 17 mg/kg/day as recommended by the ADA, and the result shows good improvement after intervention with the test group.

Serum phosphorus is probably still the most commonly used chemical biomarker in clinical practice [19], as hyperphosphatemia is considered to be one of the most high-risk factors and a strong predictor of death among hemodialysis patients [20]. High serum phosphate levels are due to high intakes of food containing phosphate, resulting in an elevation of serum phosphorus [18].

A phosphate-controlled diet has a role in an integrated therapeutic approach to hyperphosphatemia and positive calcium-phosphorus balance in hemodialysis patients. The increase in serum phosphorus in Sudanese patients may be due to food habits; most of the Sudanese population depends mainly on beans (foul) and peas (tameea), which are foods with the highest phosphorous content.

The metabolism of calcium and phosphorus is abnormal in patients with CKD and is associated with the development of bone disease. Phosphate retention occurs as GFR declines. Both hyperphosphatemia and a reduction in the active form of vitamin D (1.25-dihydroxycholecalciferol) lead to hypocalcemia. As attempts are made to normalize the serum calcium level, secondary hyperparathyroidism can develop, causing significant bone damage [21]. In a study done by Zammrawi., *et al*. in Sudan, the results found that the ranges of phosphorous were 2.1 to 11.3 mg/dl between hemodialysis patients [22]. Our study disagrees with that found by Abu-Almakarem in his study in Saudi Arabia, which found only 1.6% of the patients showed serum phosphorus of >1.94 mmol/L [23]

In this study the Serum phosphorus (mg/dl) was found higher from 2.7 to 4.2 (mg/dl)) in both study groups from base line and till the four months of study. The phosphorus level is significantly controlled in patients who followed the individual meal plan compared with controls ($p < 0.05$). A study done in Turkey found a high prevalence of hyperphosphatemia in HD patients (66.4%) [14]. Another study also found that a renal diet restricted in phosphate intake is a good medical nutrition therapy to control nutrition status and serum phosphate levels among renal patients [13].

Another study in concern with dietary phosphate restriction as a management tool to control nutrition status was done in Europe and shows that it is a key element for successful management among this category of patients [14]. Which were all in agreement with our study, as the result of the current study shows a good decrease in serum phosphorus in the test group compared with controls throughout the study. (Phosphorus with normal values ranging from 2.5 to 4.5 mg/dl).

Our study demonstrates significant improvement in nutritional status by providing active nutritional counseling in the form of a simple, balanced individual meal plan program and by improving important nutritional and clinical parameters consisting of: The serum phosphorus levels were quickly controlled in patients who followed the individual meal plan containing the recommended amount of phosphorus needed per day, compared with the control group. This indicates that individual meal plans helped control serum phosphorus levels among hemodialysis patients.

The study showed that proper nutritional counseling by a dietitian to HD patients on the intake of phosphate and an individualized meal plan can result in a better nutritional status, control serum phosphate levels, and prevent hyperphosphatemia. Other studies also found a strong relationship between dietary phosphate restriction and controlling hyperphosphatemia.

Conclusion

The study demonstrated that effective nutritional counseling in the form of individualized meal planning with restricted dietary phosphorus intake (adequate dietary phosphorus intake) was effective in the control and improvement of serum phosphorus levels among HD patients. Therefore, nutritional counseling by qualified dietitians should be mandatory in renal units as part of the medical therapy management to reduce the incidence of hyperphosphatemia in HD.

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