Acta Scientific NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 5 Issue 12 December 2021

Research Article

Protein and Phosphate Intake as Determinants of Hyperphosphatemia in Hemodialysis Patients at Sanglah General Hospital Bali

Made Dyah Vismita Indramila Duarsa[1], Yenny Kandarini[2]*, Gede Wira Mahadita[2] and Ni Nyoman Shinta Prasista Sari[1]

[1]Bachelor of Medicine and Doctoral Profession Study Program, Faculty of Medicine, Udayana University, Bali

[2]Department of Internal Medicine, Division of Nephrology, Faculty of Medicine, Udayana University, Sanglah Hospital, Bali

***Corresponding Author:** Yenny Kandarini, Department of Internal Medicine, Division of Nephrology, Faculty of Medicine, Udayana University, Sanglah General Hospital, Bali.

Received: October 11, 2021

Published: November 29, 2021

Abstract

Background: Incidence of the chronic kidney disease (CKD) is quite high and is increasing every year. The increase in CKD mortality rate is significantly associated with the increase of the blood phosphate levels, in related to that the control of hyperphosphatemia is one of the main focuses in the management of CKD. A high protein diet has been recommended to prevent malnutrition in CKD patients with hemodialysis. However, a high protein and phosphorus diet has the risk of increasing phosphate levels in the blood circulation of CKD patients. The purpose of this study was to prove that the level of protein and phosphate intake can be used as a determinant of hyperphosphatemia in CKD patients with routine HD.

Methods: Cross-sectional analytic method is used in this research. The research subjects were 66 CKD patients with routine hemodialysis (HD). Subject characteristics, data on phosphorus intake, protein and phosphorus-protein ratio were obtained from a questionnaire food record adapted from the Food and Agriculture Organization of The United Nations. Data on consumption patterns are processed using nutritional survey software to obtain nutritional values.

Results: There was a significant relationship between protein intake and phosphorus intake on hyperphosphatemia in CKD patients. The risk factors for hyperphosphatemia were high phosphorus intake (p = 0.018; OR = 3.886; 95% CI: 1.212-12.460) and adequate protein intake (p = 0.035; OR = 3.674; 95% CI: 1.049-12.865). In this study, there was no significant relationship between phosphorus-protein ratio to the incidence of hyperphosphatemia.

Conclusion: Adequate protein intake and excess phosphorus intake can be used as determinants of hyperphosphatemia in hemodialysis CKD patients with routine HD.

Keywords: Hyperphosphatemia; Protein Intake; Phosphorus Intake; Phosphorus-Protein Ratio; Chronic Kidney Disease; Hemodialysis

Introduction

The incidence of chronic kidney disease (CKD) is quite high and is increasing every year. CKD needs to be handled holistically also optimally to prevent any unwanted fatal events [1-3]. Hemodialysis (HD) is a treatment option as the management of the terminal phase. The hemostasis condition of CKD patients with HD has a

significant difference compared to CKD patients without HD [4]. In the CKD with HD, cardiovascular disease is one of the leading causes of death. Cardiovascular disease in CKD patients with HD is associated with decreased renal function that lead to systemic hyperphosphatemia; high levels of phosphorus in the blood [4,5].

Control of hyperphosphatemia is one of the main component focuses in the management of CKD patients undergoing routine HD processes which is also associated with the amount of the protein intake [4]. A high-protein diet is recommended by the National Kidney Foundation; Kidney Disease Outcomes Quality Initiative (NKF K/DOQI) for CKD patients with HD, but high protein diet will give a negative effect on the phosphate control process. The cause of hyperphosphatemia is due to an increase in phosphorus as a result of a high protein diet. Previous studies have shown that high protein intake in CKD patients causes hyperphosphatemia due to decreased kidney conditions. The glomerular filtration rate (GFR) decreases so that the mineral metabolism is disrupted, then phosphate excretion is reduced [4,5]. In addition to protein, phosphorus intake from other sources also needs to be considered.

Adequate protein intake is an important component in the management of CKD patients with HD, but on the other hand the control of hyperphosphatemia conditions is also important to reduce the mortality rate of CKD patients with HD. Intake of other sources of phosphorus, and other risk factors should also be considered [5]. Another study states that choosing foods with a low protein-phosphorus ratio is one of important consideration, so that protein levels are still be achieved but phosphorus levels in the blood also be maintained [6]. This study aims to assess whether the level of protein and phosphate intake can be used as a determinant of hyperphosphatemia in PKG patients on routine hemodialysis.

Materials and Methods

This research was conducted for 1 month from September 2020 to October 2020 at the Hemodialysis Installation of the Sanglah General Hospital, Bali. This study is an analytic observational study, using cross-sectional analytical design study.

This research method was carried out by taking a random sample (Stratified Proportional Random Sampling) in patients who matched the inclusion criteria that have been diagnosed with CKD Stage 5 with Regular HD in the period August 2020 at Sanglah Hospital. The inclusion criteria used were willingness to participate in the study with informed consent, patients aged 18-65 years diagnosed with CKD Stage 5 who had routinely undergone at least 2 months of regular hemodialysis. Some of the exclusion criteria were; no inpatient treatment in the last 3 months from the start of the study, incomplete medical records, patients with sepsis, malignancy, chronic liver disease, HIV infection, pulmonary tuberculosis, dementia, history of parathyroidectomy or total thyroidectomy.

Variable depending on the research is the level of phosphorus in the blood. The independent variables of this study were phosphorus intake, protein intake, and phosphorus-protein ratio. The basic characteristics of the subjects included age, gender, long history of HD, nutritional status, etiology of CKD. A questionnaire food record adapted from the Food and Agriculture Organization of the United Nations was used to obtain data of the protein-phosphorus ratio, protein and phosphorus intake. Nutri survey software is used to analyze consumption pattern data. Data on protein consumption patterns will be converted in grams per kilogram of body weight per day, and phosphorus intake in milligrams per day. Furthermore, the intake needs of each person per day will be assessed based on the subject's body weight. Data on age, gender, long history of HD, nutritional status, etiology of CKD were obtained based on medical records and history taking to confirm data in medical records. Phosphorus levels in the blood are obtained through the results of blood tests in the laboratory before HD.

The food record's interviews were conducted twice a week during the hemodialysis schedule to see phosphorus and protein intake. Protein intake is said to be adequate (high) if ≥1.2 grams/kg BW/day and inadequate (low) intake if <1.2 grams/kg BW/day. Meanwhile, phosphorus intake is said to be sufficient if it is 17 milligrams/kg BW and the excessive intake if it is more than 17 milligrams/kg BW. Intake with a low phosphorus-protein ratio if 5 milligrams/dl, and high if >5 milligrams/dl. It is calculated by averaging the amount of protein and phosphorus intake from each meal or drink in grams (gr) [7]. Hyperphosphatemia is a condition when the level of phosphorus in the blood is **>** 5 mg/dl. If levels 5 mg/dl is said to be normal. Phosphorus levels in the blood or called serum phosphorus are measured in pre-HD [7].

Analysis of research data using SPSS 21-version. Univariate analysis was carried out to provide a description of the data on the characteristics of the subject, namely age, gender, long history of HD, nutritional status and etiology of CKD using univariate analy-

sis. The analysis method uses Chi-Square which aims to find the relationship between hyperphosphatemia and diet protein, phosphorus and protein-phosphorus ratio. Probability is considered statistically significant if the p value <0.05 is obtained with 95% confidence.

Results

66 subjects were successfully collected in this study. The data shows 72.7%, there are more males than females as listed in table 1, productive age (28.8%), and more in the good nutrition category (45.5%).

Characteristics	Total	%
Gender		
Male	48	72.7
Female	18	27.3
Age (years)		
20-30	4	6.1
31-40	9	13.6
41-50	17	25.8
51- 60	19	28.8
61-70	14	21.2
>70	3	4.5
Status Category Nutrional		
Over nutrition	28	42.4
Good nutrition	30	45.5
Undernourished	8	12.1
Length of HD (months)		
4-24	8	12 ,1
25-48	16	24.2
49-72	17	25.8
>72	25	37.9
Etiology of		
DKD	11	16.7
PNC	51	77.3
Other	4	6.1

Table 1: Characteristics of research subjects.

DKD: Diabetic Kidney Disease; PNC: Chronic Pyelonephritis.

The results of the analysis showed that 74.2% of the subjects had hyperphosphatemia and the majority were classified as having adequate protein intake (54.5%) according to table 2, most of the phosphorus intakes were classified as the excessive intake (69.7%), and most of the protein ratio and phosphorus is the low ratio (69.7%).

Characteristics	Total	%
Protein intake		
Adequate (≥1.2 g/kg BW/day)	30	45.5
Inadequate (<1,2 g/kg BW/day)	36	54.5
Phosphorus intake		
Sufficient (≤17 mg/kg BW)	20	30.3
Excessive (>17 mg/kg BW)	46	69.7
Phosphorus-protein ratio		
Low (≤5 mg/dl)	46	69.7
High (>5 mg/dl)	20	30.3
blood phosphorus level		
Normal	17	25.8
Hyperphosphatemia	49	74.2

Table 2: Distribution of protein intake, phosphorus intake, phosphorus-protein ratio, and blood phosphorus levels.

This study obtained 2 variables that significantly related; the intake of protein and the phosphate to phosphorus levels in the blood as listed in table 3. In contrast to the protein-phosphorus ratio variable which showed no significant results.

The next stage was carried out with risk analysis on 2 variables that had a significant relationship with the condition of hyperphosphatemia (Table 4). There was an increase in the incidence of hyperphosphatemia 3.9 times more often in subjects with high phosphorus intake than in subjects with normal phosphorus intake. In subjects with adequate protein intake, the incidence of hyperphosphatemia also experienced an increased risk of 3.7 times when compared to the inadequate protein intake group.

Discussion

In this study, the phosphorus levels in the blood of the subjects mostly were classified as high category. This finding is supported by other studies conducted in several cities in Indonesia such as Jakarta, Semarang, Manado, and Palembang which all stated that more than 50% of research subjects had hyperphosphatemia [8-11]. Chronic kidney disease can lead to imbalances in mineral regu-

Characteristics	Category blood phosphorus level				Total		p
	Hyperphosphatemia		Normal				
	n	%	n	%	n	%	
Protein intake							
Adequate (≥1.2 g/kg BW/day)	26 23	39.4	4	6.1	30	45.5	0.018
Inadequate (<1,2 g/kg BW/day)		34.8	13	19.7	36	54.5	
Phosphorus intake							
Sufficient (≤17 mg/kg BW)	11	16.7	9	13.6	20	30.3	0.009
Excessive (>17 mg/kg BW)	38	57.6	8	12.1	46	69.7	
Phosphorus-protein ratio							
Low (≤5 mg/dl)	33	50	13	19.7	46	69.7	
High (>5 mg/dl)	16	24.2	4	6.1	20	30.3	0.087

Table 3: Variable relationship to hyper phosphate level condition.

Characteristics	p	SE	OR	CI 95%	
Protein intake (g/kg BW)	0.035	0,111	3,674	1,049	12.865
Phosphorus intake (mg/kg BW)	0.018	0 ,128	3.886	1.212	12.460

Table 4: The intake of protein and phosphorus as a risk factor for hyperphosphatemi.

lation, primarily causing hyperphosphatemia. Hyperphosphatemia conditions must be treated immediately because it can cause bone disease called Mineral and Bone Disorders in Chronic Kidney Disease and also as risk factor for the cardiovascular disease [7,12]. Many studies have reported that the mortality rate of chronic kidney disease is significantly increasing due to an increase in phosphate levels in the blood [13,14].

Phosphorus intake in most of the research subjects was excessive. This study showed that excess phosphorus and adequate protein intake had a significant relationship to the incidence of hyperphosphatemia. In this study found that adequate (high) protein intake can increase the risk of hyperphosphatemia 3.7 times compared to inadequate (low) protein intake. A high intake of phosphorus also increases the risk of hyperphosphatemia by 3.9 times compared to a lower intake of phosphorus. The results of this study are in line with several other studies that reported a significant relationship between high intake of protein and phosphorus to the incidence of hyperphosphatemia [5,9,15]. Several studies have also stated that high protein intake, which is more than 1.2 g/kg BW per day in CKD patients plays a role in the occurrence of renal hemodynamic imbalances that will damage tissues and reduce kidney function [16].

Modification of nutrition is an important point in the treatment of CKD because it is needed to improve the quality of life, reduce morbidity and mortality also hinder the progression of the disease. One of them is modifying the intake of protein and phosphorus. This modification depends on the stage of CKD and the type of dialysis being undertaken. The recommended daily protein intake for CKD patients undergoing routine hemodialysis is 1.2 grams/kg BW, phosphorus intake not more than 17 milligrams/kg/day or a maximum of 900 mg per day [17]. Previous studies have shown that a low protein diet in patients with CKD can significantly improve the anemia, reduce cardiovascular risk associated with uremia, control blood pressure, inhibit the progression of CKD, but increase the risk of malnutrition [18,19].

Until now, a low protein diet in CKD patients with HD is still a debate, because it can cause protein malnutrition which can certainly worsen the patient's condition. The selection of protein intake is certainly an important point in modifying the diet of CKD

patients. Selection of a good type of protein intake can be done by calculating the phosphorus-protein ratio. This ratio is obtained by comparing the content of protein with the phosphorus on protein foods consumed. Previous studies have stated that eating foods with high phosphorus levels or having a high phosphorus-protein ratio causes hyperphosphatemia which will increase the risk of mortality in CKD patients with HD [5,6]. The ratio of phosphorus-protein in animal protein is lower, namely ±11 milligrams of phosphorus per gram of protein, while vegetable protein contains ±20 milligrams of phosphorus per gram of protein. Selection of protein intake by paying attention to the ratio of low phosphorus levels in addition to controlling serum phosphate in the blood can also prevent malnutrition. Fish and egg whites have a low phosphorus-to-protein ratio. Chicken liver, cow's milk, soy milk, cheese, nuts and seeds are foods with a high phosphorus-protein ratio [6]. The subjects in this study still chose foods with a high phosphorus-protein ratio such as green beans, chicken liver, milk and their products for daily consumption.

This study did not find a significant relationship between the phosphorus-protein ratio and the state of hyperphosphatemia in this study, but this result is different from other studies that have reported a significant relationship between these two variables.[9] Studies from the United States reported that CKD patients on hemodialysis who eat foods with low protein levels and low phosphorus-protein ratios tend to have lower blood serum phosphorus, which can increase life expectancy [6].

Conclusion

High protein intake and excessive phosphorus intake provide a significant relationship to the incidence of hyperphosphatemia in CKD patients undergoing routine hemodialysis. So that the intake of protein and phosphorus can be a determinant of hyperphosphatemia in hemodialysis patients.

Conflict of Interest

None.

Research Ethics

Has been reviewed by the research ethics commission of the Faculty of Medicine, Udayana University/Sanglah Geneeral Hospital Denpasar and has been approved with permit number 2482/UN.14.2.2.VII.14/LT/2020.

Funding

There is no involvement of other funding sources or sponsors.

Author's Contribution

MDVID worked on the subject and action research process. The NNSPS did analyze the data and report on the research. YK did the concept design.

Bibliography

1. Hill NR., *et al*. "Global Prevalence of Chronic Kidney Disease – A Systematic Review and Meta-Analysis". *PLOS One* 11.7 (2016): e0158765.
2. Bikbov B., *et al*. "Disparities in Chronic Kidney Disease Prevalence among Males and Females in 195 Countries: Analysis of the Global Burden of Disease 2016 Study". *Nephrons* 139.4 (2018): 313-318.
3. Zhang L., *et al*. "Prevalence of chronic kidney disease in China: a cross-sectional survey". *Lancet* 379.9818 (2012): 815-822.
4. Kidney Disease Improving Global Outcome (KDIGO). "KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease". *International Society of Nephrology* 3.1 (2013): 1-150.
5. Barril-Cuadrado G., *et al*. "Table showing dietary phosphorus/protein ratio for the Spanish population. Usefulness in chronic kidney disease". *Nephrology* 33.3 (2013): 362-371.
6. Kalantar-Zadeh K., *et al*. "Understanding Sources of Dietary Phosphorus in the Treatment of Patients with Chronic Kidney Disease". *Clinical Journal of the American Society of Nephrology* 5.3 (2010): 519-530.
7. Kidney Disease: Improving Global Outcomes (KDIGO) CKD-MBD Update Work Group. "KDIGO 2017 Clinical Practice Guideline Update for the Diagnosis, Evaluation, Prevention, and Treatment of Chronic Kidney Disease–Mineral and Bone Disorder (CKD-MBD)". *Kidney International* 7 (2017): 1-59.
8. Rachmawati TY and Syauqy A. "Relationship of nutritional knowledge with routine energy, protein, phosphor, and potassium intake of chronic kidney disease patients with routine hemodialysis in RSUD Tugurejo Semarang". *Journal of Nutrition College* 3.1 (2014): 271-277.

9. Syauqy A., *et al*. "Protein and phosphorus intake, phosphorus-protein ratio, and blood phosphorus levels in chronic renal failure patients on hemodialysis". *Jurnal Gizi Indonesia* 9.2 (2012): 58.

10. R RM., *et al*. "Relationship between Compliance and Pattern of Phosphate-Binding Drug Consumption on Phosphate Levels in Stage V Chronic Kidney Disease". *Maj Kedokt Sriwij* 2 (2015): 97-104.

11. Yauri LF., *et al*. "Overview of calcium and phosphorus products in patients with chronic kidney disease stage V in the Hemodialysis Room of Prof. RSUP. Dr. RD Kandou Manado". *e-ClinicC*. 4.2 (2016).

12. Ix JH., *et al*. "Effect of dietary phosphate intake on the circadian rhythm of serum phosphate concentrations in chronic kidney disease: a crossover study". *American Journal of Clinical Nutrition* 100.5 (2014): 1392-1397.

13. Di Marco GS., *et al*. "High phosphate directly affects endothelial function by downregulating annexin II". *Kidney International* 83.2 (2013): 213-222.

14. Da J., *et al*. "Serum Phosphorus and Progression of CKD and Mortality: A Meta-analysis of Cohort Studies". *American Journal of Kidney Diseases* 66.2 (2015): 258-265.

15. Streja E., *et al*. "Hyperphosphatemia is a combined function of high serum PTH and high dietary protein intake in dialysis patients". *Kidney International* 3.5 (2013): 462-468.

16. Ko GJ., *et al*. "Dietary protein intake and chronic kidney disease". *Current Opinion in Clinical Nutrition and Metabolic Care* 20.1 (2017): 77-85.

17. Goldstein-Fuchs DJ and LaPierre AF. "Nutrition and Kidney Disease". *Kidney Disease* (2014): 467-475.

18. Indonesian Nephrology Association. "Nutrition Consensus in Chronic Kidney Disease". Indonesian Nephrology Association (2011).

19. Aparicio M., *et al*. "Keto Acid Therapy in Predialysis Chronic Kidney Disease Patients: Final Consensus". *Journal of Renal Nutrition* 22.2 (2012): S22-S24.

Volume 5 Issue 12 December 2021