

Assessment of Calcium and Phosphorus levels in Hemodialysis patients Pre and Post Hemodialysis at the kidney center in Tarhuna city, Libya

Hussein Salama ^{1*}, Munder Zaied ², Embarka Aqela ³, Entesar Al-Mazoughi ⁴, Manal Fariah ⁵, Nosiba Mohamed⁶

^{1,2,3,4,5,6} Faculty of medical technology, Azzytona University, Tarhuna, Libya

تقييم مستويات الكالسيوم والفسفور لدى مرضى غسيل الكلى قبل وبعد جلسة الغسيل الدموي في مركز الكلى بمدينة ترهونة – ليبيا

حسين سلامة^{1*}, مندر زايد², امباركة عقيلة³, انتصار المزوغي⁴, منال افريرة⁵, نسبية محمد⁶
^{1,2,3,4,5,6} كلية التقنية الطبية، جامعة الزيتونة، ترهونة، ليبيا

*Corresponding author: Hussein_salama84@yahoo.com

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Abstract:

Chronic kidney disease (CKD) is associated with disturbances in calcium and phosphorus metabolism due to the progressive loss of renal function. Hemodialysis is commonly used in patients with end-stage renal disease (ESRD) to maintain metabolic balance; however, it may influence serum calcium and phosphorus levels. Therefore, this study aimed to evaluate serum calcium and phosphorus levels in patients with renal failure before and after hemodialysis. A paired pre–post analytical study was conducted on 60 patients receiving hemodialysis. Serum calcium and phosphorus levels were measured immediately before and after dialysis. Data were analyzed using IBM SPSS Statistics version 22. Normality of difference scores was assessed using the Shapiro–Wilk test. The paired samples t-test was used for normally distributed variables, while the Wilcoxon signed-rank test was applied for non-normally distributed variables. Effect sizes were calculated using Cohen’s d and r. A two tailed p-value < 0.05 was considered statistically significant. Serum phosphorus levels demonstrated a statistically significant reduction following hemodialysis (4.21 ± 0.97 mg/dL vs. 3.11 ± 0.74 mg/dL; mean difference = 1.10 mg/dL; 95% CI: 0.95–1.25; $t(59) = 14.74$, $p < 0.001$; Cohen’s $d = 1.90$), indicating a very large effect size. Serum calcium levels also showed a statistically significant decrease after dialysis (Wilcoxon $Z = -6.06$, $p < 0.001$), with a large effect size ($r = 0.78$). However, the magnitude of change in calcium levels was modest compared to phosphorus. Researchers concluded that Hemodialysis significantly reduces serum phosphorus levels with a substantial therapeutic effect and produces a statistically significant, though comparatively smaller, reduction in serum calcium levels. These findings highlight the strong impact of hemodialysis on phosphorus control and its important role in managing mineral imbalance in patients with chronic kidney disease.

Keywords: Hemodialysis, Kidney, Calcium, Phosphorus.

الملخص

يرتبط مرض الكلى المزمن بحدوث اضطرابات في أيض الكالسيوم والفسفور نتيجة التدهور التدريجي في وظائف الكلى. ويعد غسيل الكلى الدموي العلاج الأكثر شيوعاً للمرضى المصابين بالمرحلة النهائية من الفشل الكلوي بهدف المحافظة على الاتزان الأيضي، إلا أنه قد يؤثر في مستويات الكالسيوم والفسفور في مصل الدم. لذلك هدفت هذه الدراسة إلى تقييم مستويات الكالسيوم والفسفور في مصل الدم لدى مرضى الفشل الكلوي قبل وبعد جلسات غسيل الكلى.

الدموي. أجريت دراسة تحليلية مزدوجة (قبل-بعد) على 60 مريضاً يخضعون لغسيل الكلى الدموي. تم قياس مستويات الكالسيوم والفوسفور في مصل الدم مباشرة قبل جلسة الغسيل الكلوي وبعدها. جرى تحليل البيانات باستخدام برنامج IBM SPSS Statistics الإصدار 22 وتم تقييم التوزيع الطبيعي لفروق القياسات باستخدام اختبار Shapiro-Wilk. استخدم اختبار t للعينات المترابطة (Paired Samples t -test) للمتغيرات ذات التوزيع الطبيعي، بينما استخدم اختبار Wilcoxon Signed Rank للمتغيرات غير الموزعة طبيعياً. كما تم حساب حجم الأثر باستخدام Cohen's d و r . واعتُبرت القيمة الاحتمالية (p -value) الأقل من 0.05 ذات دلالة إحصائية. أظهرت مستويات الفوسفور في المصل انخفاضاً ذا دلالة إحصائية بعد غسيل الكلى الدموي (12.4 ± 79.0) ملغم /ديسيلتر مقابل 47.0 ± 3.11 ملغم /ديسيلتر؛ متوسط الفرق = 1.10 ملغم/ديسيلتر؛ فاصل الثقة: 95% من 0.95 إلى 1.25؛ $t(59) = 14.74$ ، $p < 0.001$ ؛ Cohen's $d = 1.90$ ، مما يشير إلى حجم أثر كبير جداً. كما أظهرت مستويات الكالسيوم في المصل انخفاضاً ذا دلالة إحصائية بعد الغسيل الكلوي (Wilcoxon $Z = -6.06$ ، $p < 0.001$)، مع حجم أثر كبير ($r = 0.78$) ومع ذلك، كان مقدار التغير في مستويات الكالسيوم أقل مقارنة بالفوسفور. توصل الباحثين إلى أن غسيل الكلى الدموي يؤدي إلى خفض مستويات الفوسفور في المصل بشكل ملحوظ مع تأثير علاجي كبير، كما يحدث انخفاضاً ذا دلالة إحصائية في مستويات الكالسيوم، وإن كان هذا الانخفاض أقل مقارنة بالفوسفور. وتؤكد هذه النتائج التأثير القوي لغسيل الكلى الدموي في التحكم بمستويات الفوسفور دوره المهم في إدارة اضطرابات توازن المعادن لدى المرضى المصابين بمرض الكلى المزمن.

الكلمات المفتاحية: الغسيل الكلوي، الكلى، الكالسيوم، الفوسفور.

Introduction

Chronic kidney disease is an illness that disrupts the kidneys' ability to perform their important duties; since kidneys are crucial in filtering the blood from waste and controlling the fluids and minerals' balance in the body, especially calcium and phosphorus [1,2]. Due to the progressive nature of the disease, kidney performance has decreased, thus necessitating the use of hemodialysis to get rid of waste products and excess fluids for better chemical balance in the body. [2,3]. The levels of calcium and phosphorus are affected by kidney failure because of the reduced capacity of the kidneys to control them. Hemodialysis can also alter their levels because it eliminates some phosphorus and may influence how much calcium there is in the body considering the type of fluid used during the dialysis sessions [1,3,4]. Calcium and phosphorus are vital minerals that work in maintaining bone health and normal function of the body. If kidney function is impaired, due to chronic kidney disease, the balance of calcium and phosphorus may be disturbed by hemodialysis. [1,4,5]. The levels of calcium in normal adult serum are generally known to be around 8.6 to 10.2 milligrams per deciliter, and phosphorus level should be anywhere between 2.5 and 4.5 milligrams per deciliter; the reference range varies between laboratories [6,7]. Abnormal calcium and phosphorus will lead to mineral and bone related disorders for patient suffering from chronic kidney disease [1,4]. Clinical guidelines dictate that clinicians should monitor the levels of serum calcium and phosphorus [1,5,8]. Hence, any laboratory tests for measuring calcium and phosphorus before and after a dialysis session are also important for assessing effects of hemodialysis [1,5,8].

Research Problem

Chronic kidney disease is a common health problem that disrupts many physiological functions, most notably the balance of essential minerals and elements in the body, especially calcium and phosphorus. This occurs due to the kidneys' reduced ability to regulate the metabolism of these elements and maintain their concentrations within normal limits. Although dialysis is one of the most important treatment methods used to improve the health of chronic kidney disease patients and alleviate complications associated with kidney failure, its effect on calcium and phosphorus levels can vary depending on several factors, necessitating periodic assessment of these levels. Therefore, the research problem stems from the need to study the changes in calcium and phosphorus levels in chronic kidney disease patients undergoing dialysis. This is achieved by comparing these levels before and after dialysis sessions to determine the extent to which dialysis modifies the concentrations of these two elements and to identify any statistically significant differences between the two measurements.

Study Objective

The main objective of this study, to study calcium and phosphorus levels in chronic kidney disease (CKD) patients before and after dialysis sessions.

Significance of the Study

Chronic kidney disease is a health problem that requires increasing attention due to its high prevalence and its impact on many vital body functions. One of the most prominent disorders associated with this disease is an imbalance in calcium and phosphorus levels resulting from the kidneys' reduced ability to regulate and maintain these elements within normal limits. The significance of this study lies in identifying the changes that occur in calcium and phosphorus levels in chronic kidney disease patients before and after dialysis sessions. This contributes to evaluating the role of dialysis in improving or modifying these levels. The study also provides data that can be used to monitor patients' health status and understand the biochemical changes associated with

dialysis treatment. This may positively impact the healthcare provided to this patient group and reduce complications related to mineral metabolism disorders.

Materials and methods

3.1 Study Design

This study was conducted as Cross-sectional Study to evaluate serum calcium and phosphorus levels in patients with chronic kidney disease undergoing hemodialysis. Measurements were obtained from the same patients immediately before and after hemodialysis sessions to assess the effect of dialysis on these biochemical parameters. The study was carried out at the Hemodialysis Center in Tarhuna City, Libya, during the period from December 1, 2025, to January 1, 2026.

3.2. Study Population and Sample Size

The study included 60 patients diagnosed with chronic kidney disease and undergoing regular hemodialysis treatment at the Hemodialysis Center in Tarhuna. Participants were selected using a convenience sampling technique from patients attending the center during the study period.

Inclusion Criteria

- Patients diagnosed with chronic kidney disease
- Patients undergoing regular hemodialysis sessions.
- Patients aged 18 years and above.
- Patients who agreed to participate in the study.

Exclusion Criteria

- Patients with acute kidney injury.
- Patients suffering from diseases known to affect calcium or phosphorus metabolism, such as severe parathyroid disorders.
- Patients with incomplete laboratory or demographic data.
- Patients who declined participation in the study.

3.3. Data Collection

Demographic information was collected from all participants, including:

- Age
- Gender

3.4. Sample Collection and Processing

Venous blood samples were collected from each patient twice: immediately before the hemodialysis session and immediately after completion of the hemodialysis session. Approximately 5 mL of venous blood was collected under aseptic conditions using plain blood collection tubes. The blood samples were allowed to clot at room temperature, after which the serum was separated by centrifugation. The obtained serum was then used for the biochemical analysis of calcium and phosphorus levels.

3.5. Laboratory Analysis

Serum calcium and phosphorus concentrations were determined using an Auto Chemistry Analyzer (Photometer 4040) according to the manufacturer's instructions supplied with the commercial reagent kits. The analytical method is based on spectrophotometric principles, whereby the analyte reacts with specific reagents to produce a colored complex. The absorbance of the resulting color was measured photometrically, and the concentrations of calcium and phosphorus were automatically calculated by the analyzer according to the calibration standards provided by the manufacturer.

3.6. Statistical Analysis

Data were entered and analyzed using IBM SPSS Statistics version 22. Descriptive statistics were used to summarize the study data. Categorical variables were presented as frequencies and percentages, whereas continuous variables were expressed as mean $\pm$ standard deviation (SD). The normality of data distribution was assessed using the Shapiro–Wilk test. For normally distributed variables, the paired samples t-test was applied to compare serum calcium and phosphorus levels before and after hemodialysis. For variables that were not normally distributed, the Wilcoxon signed-rank test was used. A p-value of less than 0.05 was considered statistically significant.

Results:

4.1. The Age

Regarding age distribution, the largest proportion of patients belonged to the 41– 60 years age group (43.3%), followed by the 20–40 and 61–80 years groups (26.7% each). Only a small percentage (3.3%) were under 20 years old. These findings suggest that most patients undergoing hemodialysis fall within middle-aged and older adult groups, which are more susceptible to chronic kidney complications.

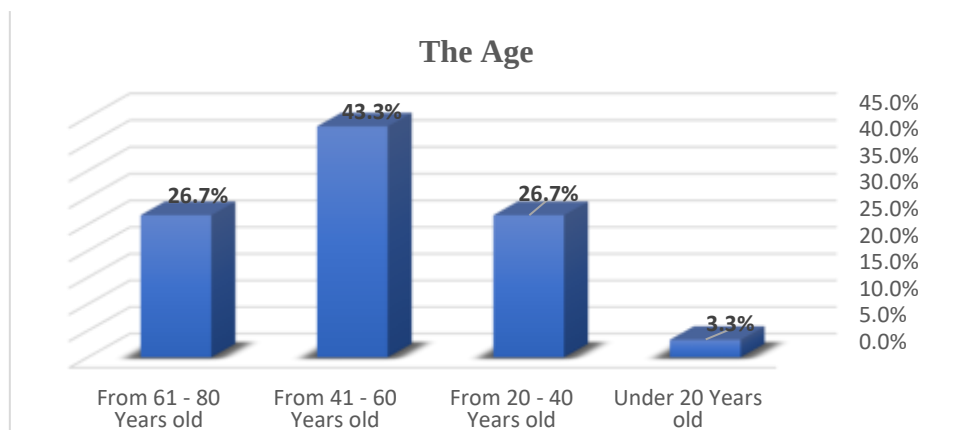


Figure 1. Age Distribution of Hemodialysis Patients

4.2. The gender

The results indicate that the majority of participants were male (70%), compared to 30% female. This distribution may reflect a higher prevalence or treatment rate of chronic kidney disease among males in the studied sample.

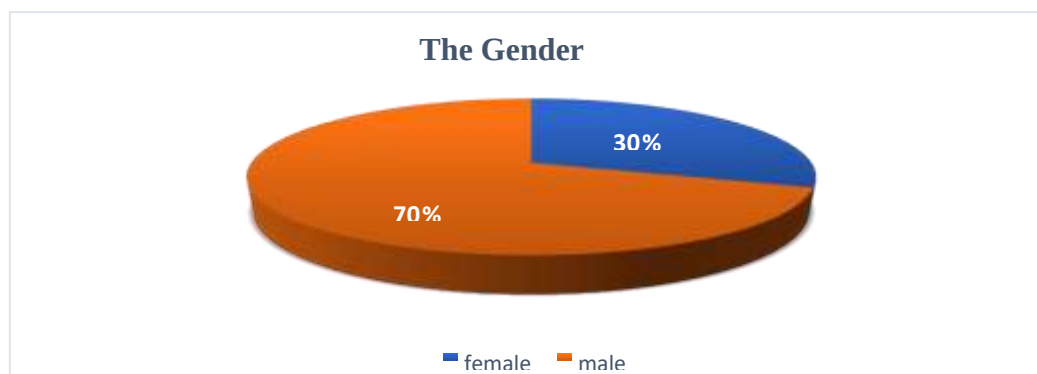


Figure 2. Gender Distribution of Hemodialysis Patients

4.3.Descriptive Statistics:

Table 1 Descriptive Statistics of Serum Calcium and Phosphorus Levels pre and post Hemodialysis

		Descriptive Statistics			
Medical tests	N	Minimu	mMaximum	Mean	Std. Deviation
Calcium / Before	60	5.8	10.9	8.522	1.0959
Calcium / After	60	5.6	10.5	8.415	1.1246
Phosphor / Befor	e60	2.1	6.2	4.212	.9748
Phosphor / After	60	2.0	4.5	3.108	.7420

The descriptive statistical results indicate that serum calcium levels before hemodialysis ranged from 5.8 to 10.9 mg/dL, with a mean and St. Deviation of 8.522 ± 1.10 . After dialysis, calcium levels ranged from 5.6 to 10.5 mg/dL, with a mean and St. Deviation of 8.42 ± 1.12 . The slight reduction in the mean suggests a relatively modest effect of hemodialysis on serum calcium levels. The similarity in standard deviation values before and after dialysis indicates stability in variability and no substantial change in dispersion among patients. Regarding phosphorus levels, pre-dialysis values ranged from 2.1 to 6.2 mg/dL, with a mean and Std. Deviation of 4.21 ± 0.97 , whereas post-dialysis values ranged from 2.0 to 4.5 mg/dL, with a mean and Std. Deviation of 3.11 ± 0.74 . The marked decrease in the mean, along with the reduction in maximum values after dialysis, reflects the effectiveness of hemodialysis in lowering elevated serum phosphorus levels. Furthermore, the decrease in standard deviation following dialysis suggests improved homogeneity and reduced variability among patients, indicating a more uniform therapeutic response. Collectively, these findings demonstrate that the impact of

hemodialysis was more pronounced on phosphorus levels than on calcium levels, both in terms of mean reduction and narrowing of the value range.

Table 2. Shapiro Wilk Test of Normality for Calcium and Phosphorus Difference Scores Tests of Normality

Shapiro-Wilk	Statistic	df	Sig.
Diff_Ca ⁺	.839	60	.000
Diff_Phos	.970	60	.152

The Shapiro–Wilk test indicated that the difference in calcium levels (Diff_Ca⁺) significantly deviated from normal distribution ($W = 0.839$, $p < 0.001$). In contrast, the difference in phosphorus levels (Diff_Phos) did not significantly deviate from normality ($W = 0.970$, $p = 0.152$), indicating an approximately normal distribution.

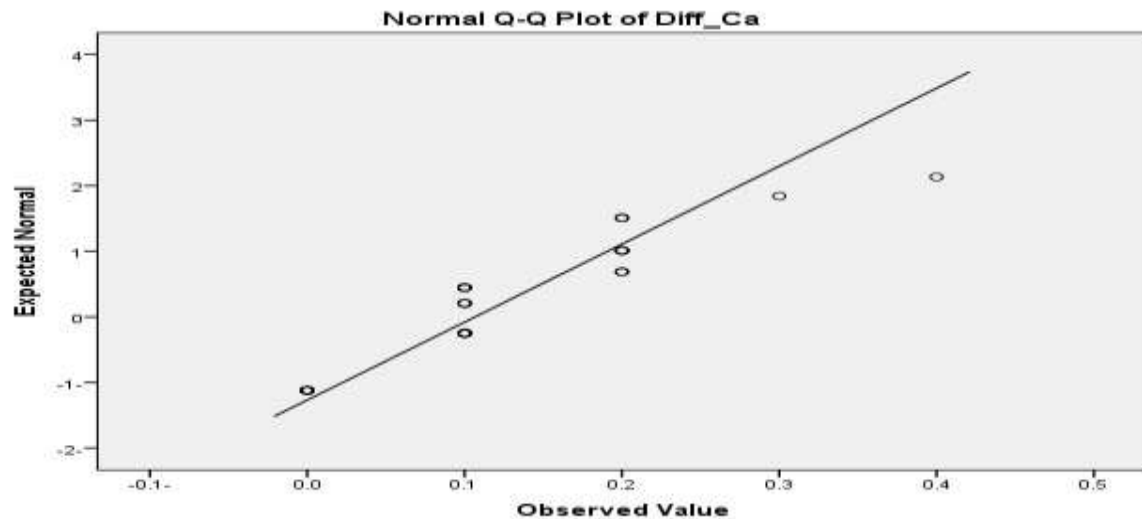


Figure 3. Q Q Plot of Calcium Difference Scores

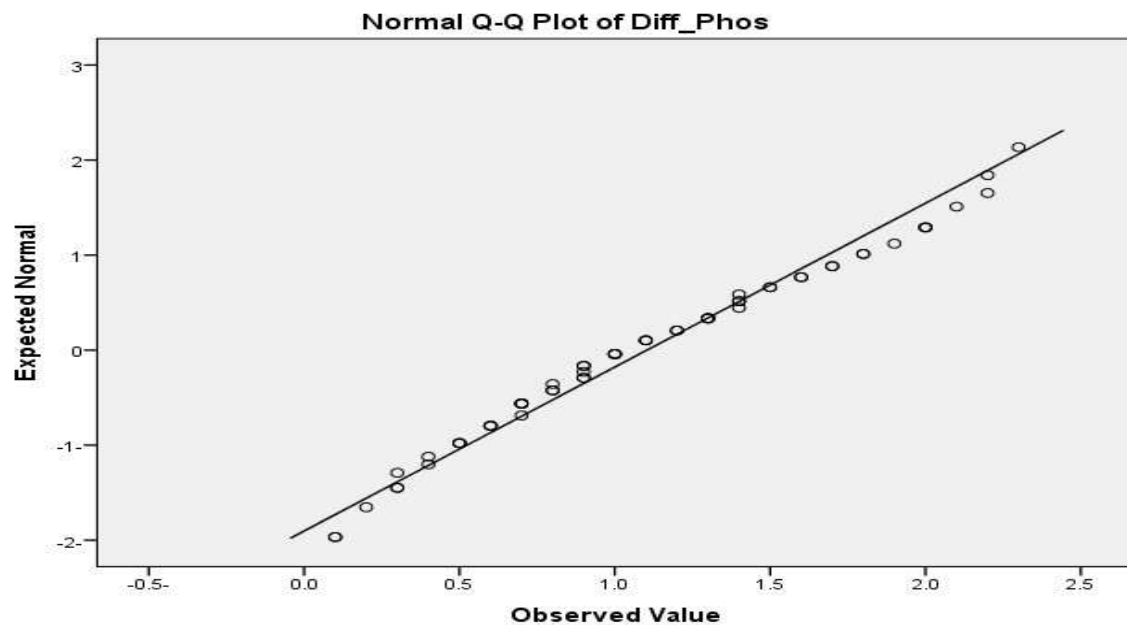


Figure 4. Q Q Plot of Phosphorus Difference Scores

4.4 .Wilcoxon Signed Rank Test:

The Shapiro–Wilk test indicated that calcium difference values were not normally distributed ($p < 0.001$). Therefore, the Wilcoxon signed-rank test was applied.

Table 3. Wilcoxon Signed-Rank Test for Changes in Serum Calcium Levels pre and post - hemodialysis

Variable	Decreased n (%)	Increased n (%)	Ties n (%)	Z	p	Effect Size (r)
Calcium	45 (75.0%)	0 (0.0%)	15 (25.0%)	-6.06	< .001	0.78

Note. Wilcoxon Signed Rank Test was used to compare pre- and post-hemodialysis measurements. Effect size (r) was calculated as $Z/\sqrt{N}$. The Wilcoxon signed-rank test demonstrated a statistically significant reduction in serum calcium levels following hemodialysis ($Z = -6.06$, $p < 0.001$). Calcium levels decreased in 45 out of 60 patients (75.0%), with no observed increases and 15 cases (25.0%) showing no change. The effect size was large ($r = 0.78$), indicating a strong impact of hemodialysis on serum calcium levels. These findings confirm a significant treatment effect of hemodialysis on calcium levels within the studied sample.

4.5. The paired samples t-test:

Phosphorus difference values were normally distributed (Shapiro–Wilk $p = 0.152$); therefore, a paired samples t-test was performed.

Table 4. Paired Samples t-Test for Changes in Serum Phosphorus Levels Before and After Hemodialysis

Variable	Before (Mean $\pm$ SD)	After (Mean $\pm$ SD)	Mean Difference	95% CI	t (df)	pvalue	Effect Size (d)
Phosphorus (mg/dL)	4.21 $\pm$ 0.97	3.11 $\pm$ 0.74	1.10	0.95 – 1.25	14.74 (59)	<0.001	1.90

Note. Paired samples t-test was used. Cohen's d was calculated as mean difference divided by the standard deviation of differences.

A paired samples t-test was conducted to examine the effect of hemodialysis on serum phosphorus levels. The results revealed a statistically significant reduction in phosphorus levels following dialysis ($t(59) = 14.74$, $p < 0.001$).

The mean phosphorus level decreased from 4.21 ± 0.97 mg/dL before dialysis to 3.11 ± 0.74 mg/dL after dialysis, with a mean reduction of 1.10 mg/dL. The 95% confidence interval (0.95–1.25) indicates a precise and clinically meaningful decrease.

The effect size was extremely large (Cohen's $d = 1.90$), demonstrating a substantial therapeutic impact of hemodialysis on serum phosphorus levels.

Discussion

In the present study, serum calcium levels showed a slight decrease after hemodialysis, with the mean value declining from 8.52 ± 1.10 mg/dL before dialysis to 8.42 ± 1.12 mg/dL after dialysis. This finding is consistent with the study conducted by another group, who reported a decrease from 8.56 ± 0.55 mg/dL to 8.30 ± 0.53 mg/dL following dialysis [9]. Similarly, a similar study observed a reduction in serum calcium levels from 5.4 ± 0.85 mg/dL before dialysis to 4.4 ± 1.07 mg/dL after dialysis, although the decline in her study was more pronounced compared to the present study [10]. In contrast, a study reported an increase in serum calcium levels from 8.7 ± 0.1 mg/dL before dialysis to 9.4 ± 0.1 mg/dL after dialysis, indicating disagreement with our findings [11]. These differences may be attributed to variations in dialysate calcium concentration, patient characteristics, dialysis duration, and treatment protocols. The slight decrease observed in the present study may be explained by calcium diffusion across the dialysis membrane and changes in protein binding during the dialysis process. The present study, serum phosphorus levels showed a marked decrease after hemodialysis, with the mean value declining from 4.21 ± 0.97 mg/dL before dialysis to 3.11 ± 0.74 mg/dL after dialysis. This finding is consistent with a study, which reported a reduction from 5.2 ± 0.2 mg/dL before dialysis to 2.2 ± 0.1 mg/dL after dialysis [11]. Similarly, another study demonstrated a decrease from 5.7 ± 2.04 mg/dL to 3.1 ± 1.30 mg/dL following dialysis [10]. Likewise, a study has been done by Zhan et al showed a significant reduction in phosphorus levels

by 0.219 mg/dL after hemodialysis ($P < 0.001$) [12]. However, in contrast, Rastogi et al reported a slight increase in serum phosphorus levels from 4.37 ± 0.97 mg/dL before dialysis to 4.51 ± 0.59 mg/dL after dialysis [9]. Overall, these findings consistently indicate a reduction in serum phosphorus levels after hemodialysis across different studies, confirming the effectiveness of hemodialysis in phosphorus removal. This reduction is mainly due to the diffusion of phosphorus from the blood into the dialysate driven by the concentration gradient during the dialysis process.

Conclusion

The results of this study showed that hemodialysis sessions led to a statistically significant decrease in the level of phosphorus in blood serum, which confirms the effectiveness of hemodialysis in getting rid of excess phosphorus in patients with chronic kidney failure. A decrease in the level of calcium was also observed after dialysis, but the amount of this decrease was less compared to phosphorus. These results confirm the importance of periodically monitoring mineral levels in hemodialysis patients to ensure mineral balance and reduce complications associated with chronic kidney disease.

Recommendations

1. Conduct periodic monitoring of calcium and phosphorus levels in hemodialysis patients before and after sessions.
 2. Promoting health education for patients about the importance of adhering to diet and medications that regulate mineral levels.
 3. Pay attention to adjusting the components of the washing fluid according to each patient's condition to help maintain the mineral balance.
 1. 4. Conduct future studies on larger samples and from multiple dialysis centers to obtain more comprehensive results.
 2. 5. Expanding future studies to evaluate the effect of hemodialysis on other minerals and elements, such as potassium and magnesium, because they are of great importance in heart and muscle functions and electrolyte balance in patients with kidney failure.
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