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COMPARISON OF SERUM CALCIUM LEVELS BEFORE AND AFTER HEMODIALYSIS

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ABSTARCT
Objective: To compare the serum calcium levels before and after haemodialysis in patients with end-stage renal disease.
Study Design: A cross sectional study.
Place and Duration of the Study: Department of Nephrology, Sir Ganga Ram Hospital, Lahore, Pakistan, from 18 February to 18 June 2026.
Methodology: A total of 60 patients aged 30 to 75 years with end-stage renal disease receiving maintenance haemodialysis were included. Serum calcium was measured immediately before and after each haemodialysis session by using the Arsenazo III colorimetric method. Data were analysed using Statistical Package for the Social Sciences version 26. Paired t-test was used to compare the mean serum calcium levels before and after haemodialysis.
Results: The mean age of the patients was 53.77 ± 9.36 years, while the mean body mass index was 23.88 ± 3.55 kg/m². Males were 44 (73.3%) and females were 16 (26.7%). The mean duration of end-stage renal disease was 32.02 ± 15.62 months and mean dialysis duration was 4.12 ± 0.33 hours. Mean serum calcium level increased significantly from 8.17 ± 0.25 mg/dL before haemodialysis to 8.53 ± 0.34 mg/dL after haemodialysis (mean difference -0.37, 95% confidence interval -0.42 to -0.32; $p<0.001$). Significant rise in serum calcium was also observed in all stratified groups ($p<0.001$).
Conclusion: Serum calcium level increased significantly after haemodialysis in patients with end-stage renal disease. This improvement was seen in all patient groups, showing that haemodialysis has an important role in correcting calcium imbalance.
Key Words: *Body mass index, Calcium, End-stage renal disease, Haemodialysis, Kidney failure, Serum calcium.*

INTRODUCTION

Chronic kidney disease (CKD) is a progressive condition with gradual impairment of kidney function with time. After the progression of the disease to end-stage renal disease (ESRD), the kidney is no longer effective in removing waste products, electrolytes, and fluids from the blood.[1] At this point, the patients are dependent on renal replacement therapy such as hemodialysis, peritoneal dialysis, or kidney transplantation for survival.[1] Development of ESRD grossly disturbs the homeostasis of the body and is accountable for the abnormalities of numerous electrolytes, most notably calcium.[2] Calcium is such a vital component that is involved in an enormous variety of physiological processes such as maintenance of bone structure, nerve impulse transmission, and muscle contraction.[2] Calcium regulation is typically disturbed in the context of CKD and ESRD due to disturbed vitamin D metabolism, secondary hyperparathyroidism, and disruption of phosphate equilibrium, which are typically present.[2]

One of the most frequent treatments for ESRD patients is hemodialysis, the method of removing from the blood waste products, excess water, and electrolytes through the assistance of a machine known as an artificial kidney.[3] When blood is filtered through a dialyzer, it is bathed with a dialysate solution across which the solutes are passed.[3] Serum calcium is significant with reference to hemodialysis since it can be influenced by the composition of the used dialysate, the overall metabolic status of the patient, and the overall effectiveness of the hemodialysis process.[4] It is essential during hemodialysis to maintain the calcium level within the desired range to prevent hypocalcemia (low calcium) or hypercalcemia (high calcium), either of which can have serious clinical consequences.[4]

Before hemodialysis, patients with ESRD exhibit abnormal levels of serum calcium as a consequence of the changed mineral and bone metabolism associated with end-stage kidney disease.[5] Many patients exhibit low ionized calcium levels secondary to impaired activation of vitamin D with decreased calcium absorption from the intestine.[5] Elevated levels of phosphate in CKD also bind with calcium and reduce its circulating level.[5] Secondary hyperparathyroidism, a common complication of CKD, adds to the imbalance by elevating bone resorption with

release into the skeletal system.[6] Pre-dialysis serum calcium levels are highly variable in patients based on diet, phosphate binder intake, and severity of the disease.[6] Measurement of these levels prior to hemodialysis facilitates adjustment of treatment protocols and the delivery of proper interventions. After hemodialysis, the level of serum calcium can vary highly based on the composition of the dialysate and the quality and duration of the process.[7] When the dialysate concentration of calcium is greater than in blood, calcium can be transferred into the blood and raise the level of serum calcium.[7] The aim of hemodialysis is to achieve a balance where the level of calcium does not vary too much because hypo- and hypercalcemia are toxic and cause side effects like cardiac arrhythmia, muscle cramp, or seizure.[8] The assessment of the level of serum calcium after the process is thus highly important to assess the success of the process and make proper adjustments in the composition of the dialysate or other management.[8]

Understanding the impact of hemodialysis on the concentrations of calcium can provide insight into mechanisms of mineral metabolism disorders in end-stage renal disease. Monitoring of serum calcium before and following hemodialysis can give insight into the impact of the hemodialysis procedure on the electrolyte balance. This research has the potential to predict outcome, such as demineralization of the bones or cardiovascular complications. It may also enable optimization of dialysis protocols so that regimens of supplementation and treatment are optimized. Ultimately, this research has the potential to provide insight into the creation of guidelines for routine monitoring of calcium levels and to promote patient safety and the quality of care.

METHODOLOGY

A descriptive study was carried out at the Department of Nephrology, Sir Ganga Ram Hospital Lahore, from 18th February 2026 to 18th June 2026. Ethical approval was obtained from the institutional ethical review committee of the hospital before starting the study. The sample size was calculated by using the OpenEPI sample size calculator with 5% level of significance and 80% power, while taking the expected mean concentration of serum calcium before haemodialysis as 8.2 ± 0.8 mg/dL and after haemodialysis as 9.2 ± 0.72 mg/dL. The calculated sample size was 10 patients; however, a total of 60 patients were enrolled to improve the reliability of the findings. Patients of either gender aged 30 to 75 years, diagnosed with end-stage renal disease and receiving maintenance haemodialysis were included in the study. End-stage renal disease was considered when the glomerular filtration rate was less than 15 mL/min on laboratory assessment. Patients having history of acute kidney injury, parathyroidectomy within the previous 6 months, malignancy, active infections, acute illness or hospital admission within the previous 30 days, severe liver disease (Child-Pugh Class C), use of calcium or vitamin D supplements, recent blood transfusion within the last 2 weeks, or pregnancy or lactation were excluded.

Written informed consent was taken from all eligible patients before enrolment. Confidentiality of all collected information was maintained throughout the study. Baseline demographic data were recorded on a structured proforma, including age, gender, height, weight, body mass index (BMI), duration of end-stage renal disease and duration of dialysis.

A 5 mL venous blood sample was collected from the vascular access immediately before the start of haemodialysis by using standard aseptic technique. The blood sample was transferred into a plain red-top vacutainer tube, allowed to clot, and then centrifuged at 3000 rpm for 10 minutes to separate the serum. Serum calcium concentration was measured in the hospital laboratory by an automated biochemical analyser using the Arsenazo III colorimetric method. Following successful hemodialysis and attainment of fluid replacement, an additional 5 mL sample of venous blood was drawn from the same vascular access site. This was analyzed following the same procedure using the laboratory to determine post-hemodialysis serum calcium levels. Serum calcium levels were determined based on the serum calcium concentration expressed in mg/dL before and after hemodialysis.

Data were entered and analysed by using IBM SPSS version 26. Qualitative variables, including gender, were presented as frequencies and percentages. Quantitative variables, including age, height, weight, BMI, duration of end-stage renal disease and duration of dialysis, were expressed as mean ± standard deviation. Normality of the data was assessed by using the Shapiro–Wilk test, which showed that the data were normally distributed ($p > 0.05$). The mean concentration of serum calcium before and after haemodialysis was compared by using the paired t-test. A p-value of ≤ 0.05 was considered statistically significant. Stratification was performed with regard to age, gender, BMI, duration of end-stage renal disease and duration of dialysis to assess their effect on concentration of serum calcium. Post-stratification analysis was carried out by using the paired t-test and a p-value of ≤ 0.05 was considered statistically significant.

RESULTS

The mean age of the patients was 53.77±9.36 years, with weight of 64.03±8.85 kg, height of 1.64±0.09 m and BMI of 23.88±3.55 kg/m². The duration of end-stage renal disease was found to be 32.02±15.62 months and the duration of dialysis was 4.12±0.33 hours. Regarding gender distribution, majority of patients were male, comprising 44 (73.3%), whereas females were 16 (26.7%) (Table-I).

Table- I: Patient Demographics: (n = 60)

Demographics	**Mean ± SD**
Age (years)	53.77±9.36
Weight (kg)	64.03±8.85
Height (m)	1.64±0.09
BMI (kg/m²)	23.88±3.55
Duration of End-Stage Renal Disease (months)	32.02±15.62
Duration of Dialysis (hours)	4.12±0.33
Gender	
Male n (%)	44 (73.3%)
Female n (%)	16 (26.7%)

Serum calcium level before dialysis was noted to be 8.17±0.25 mg/dL which raised to 8.53±0.34 mg/dL after dialysis, showing a mean difference of -0.37 with 95% CI of -0.42 to -0.32, and this rise was found to be statistically highly significant (t=-15.097, p<0.001) (Table-II).

Table II: Effect of Hemodialysis on Serum Calcium: (n = 60)

Parameter	**Time Point**	**Mean ± SD**	**Mean Difference**	**95% CI of Difference**	**t Value**	**p-value**
Serum Calcium (mg/dL)	Before Dialysis	8.17 ± 0.25	-0.37	-0.42 to -0.32	-15.097	<0.001
	After Dialysis	8.53 ± 0.34				

On stratifying the results by subgroups, it was observed that serum calcium levels increased significantly after dialysis across all the categories. Among patients aged ≤50 years (n=23), calcium rose from 8.25±0.23 to 8.66±0.32 mg/dL, while those aged >50 years (n=37) it rose from 8.11±0.26 to 8.46±0.34 mg/dL, both being significant (p<0.001). In male patients (n=44), the levels increased from 8.17±0.24 to 8.54±0.34 mg/dL, and in female patients (n=16) from 8.15±0.30 to 8.51±0.38 mg/dL, again both significant (p<0.001). Regarding BMI, patients with BMI ≤25 kg/m² (n=38) showed a rise from 8.13±0.28 to 8.50±0.37 mg/dL, whereas those with BMI >25 kg/m² (n=22) it rose from 8.22±0.19 to 8.60±0.28 mg/dL, both significant (p<0.001). For duration of ESRD, patients with ≤24 months (n=16) demonstrated a rise from 8.27±0.21 to 8.74±0.27 mg/dL, while patients with >24 months (n=44) showed a rise from 8.13±0.26 to 8.46±0.34 mg/dL, both being significant (p<0.001). Lastly, for duration of dialysis, those undergoing ≤4 hours (n=23) had a rise from 8.20±0.22 to 8.55±0.28 mg/dL, and those undergoing >4 hours (n=37) had a rise from 8.14±0.27 to 8.53±0.38 mg/dL, both significant (p<0.001) (Table-III).

Table III: Serum Calcium Before and After Hemodialysis by Subgroups: (n = 60)

Subgroup	**Category**	**N**	**Time Point**	**Mean ± SD**	**p-value***
Age (years)	≤50	23	Before Dialysis	8.25 ± 0.23	<0.001
			After Dialysis	8.66 ± 0.32	
	>50	37	Before Dialysis	8.11 ± 0.26	<0.001
			After Dialysis	8.46 ± 0.34	
Gender	Male	44	Before Dialysis	8.17 ± 0.24	<0.001
			After Dialysis	8.54 ± 0.34	
	Female	16	Before Dialysis	8.15 ± 0.30	<0.001
			After Dialysis	8.51 ± 0.38	
BMI (Kg/m^2)	≤25	38	Before Dialysis	8.13 ± 0.28	<0.001
			After Dialysis	8.50 ± 0.37	
	>25	22	Before Dialysis	8.22 ± 0.19	<0.001
			After Dialysis	8.60 ± 0.28	
Duration of ESRD	≤24 months	16	Before Dialysis	8.27 ± 0.21	<0.001
			After Dialysis	8.74 ± 0.27	
	>24 months	44	Before Dialysis	8.13 ± 0.26	<0.001
			After Dialysis	8.46 ± 0.34	
Duration of Dialysis	≤4 hours	23	Before Dialysis	8.20 ± 0.22	<0.001
			After Dialysis	8.55 ± 0.28	
	>4 hours	37	Before Dialysis	8.14 ± 0.27	<0.001

			After Dialysis	8.53 ± 0.38	

*Paired t test

DISCUSSION

Total of 60 patients were included in present study, out of which 44 (73.3%) were male and 16 (26.7%) were female, with mean age of 53.77±9.36 years. Result of study shown that serum calcium level rises significantly after haemodialysis, from 8.17±0.25 mg/dL to 8.53±0.34 mg/dL. This rise could be explained on basis that standard dialysate solution contain higher concentration of calcium as compared to patient's serum, which lead to diffusion of calcium from dialysate into blood during procedure, hence raising the serum level.[10] Also correction of metabolic acidosis during dialysis may causes shift of calcium from bound to ionised form, further contributing towards this increase.[11]

This finding of rise in serum calcium after dialysis were in agreement with several previous studies. Sarhat *et al.* [12] also reported that calcium level increased after haemodialysis in their cohort of 100 patients, though values remained abnormal compared to healthy controls, which is similar pattern as observed in present study where calcium rise significantly but reason of rise, likely due to diffusion of calcium from dialysate into blood, remain consistent across both studies. Similarly, Nagwanshi *et al.* [13] found calcium rising from 9.17±0.50 to 9.46±0.44 mg/dL after dialysis in 100 sessions, which support the present result, although their baseline calcium value were higher as compare to present cohort, possibly due to difference in patient population or dialysate composition. Soumya *et al.* [9] in study of 70 patients also observed significant increase in calcium post-dialysis along with decrease in potassium, chloride and phosphorus, findings which corroborate closely with present study result of consistent calcium elevation.

In contrast, Yahia *et al.* [14] reported opposite trend, where calcium was found to decrease further after dialysis in 50 chronic renal failure patients, which contradict the present finding; this discrepancy could be attributed to differences in dialysate calcium concentration used or possibly severity of underlying mineral bone disorder in their population. Similarly, Chen *et al.* [15] in comparison of peritoneal dialysis and haemodialysis among 84 patients (42 each group) found no significant difference in calcium level between modalities, which differ from present study emphasis on pre-post dialysis change, though it does highlight that dialysate calcium concentration play important role, a factor also discussed by Hong *et al.* [16] who showed in 711 patients across 2,061 sessions that lower dialysate calcium (1.25 mmol/L) resulted in smaller intradialytic calcium changes and less blood pressure variability as compare to higher concentration.

Regarding subgroup findings, patients with shorter duration of ESRD (≤24 months, n=16) in present study showed greater rise in calcium as compare to longer duration group, which may relate to less advanced secondary hyperparathyroidism, a mechanism partly reflected in findings of Nafar *et al.* [17] who, in large multicentre study of 7,191 patients, found only 8.3% achieving all recommended target levels of calcium, phosphorus and iPTH, indicating that chronicity of disease strongly influences mineral homeostasis control. Ahmed *et al.* [18] and Saif *et al.* [19] both comparing phosphate binders, reported that calcium-based binders produced significant rise in serum calcium, which is broadly consistent with present study observation of calcium elevation, though mechanism in binder studies relate more to intestinal absorption rather than dialysate diffusion as in present case. Akman *et al.* [20] further noted that lower corrected and ionised calcium predicted need of emergency dialysis, a finding which, while not directly comparable, does support the overall importance of calcium monitoring during dialysis, as emphasised in present study across all subgroup of age, gender, BMI and dialysis duration.

The current research study was performed at a single center, which makes the generalization of results difficult when applied to the broader population. The sample size used was relatively low with 60 patients, which may have had some impact on the statistical power of the results obtained. This study did not have a follow up period, making the assessment of any sustained effect of dialysis on calcium levels difficult. Some other biochemical parameters such as phosphorous, magnesium, and parathyroid hormone were not included in the study with calcium levels.

CONCLUSION

This research found out that there is an increase in serum calcium level post-haemodialysis session for patients suffering from end-stage renal disease. The findings show an increase in serum calcium level among all the subgroups of age, gender, body mass index, and time of duration of haemodialysis/ESRD.

Ethical Approval: Approval for conducting this research was taken from the Institutional Ethics Reviews Committee before starting the study.

Patients' Consent: Written informed consent was taken from every participant before their enrolment in the study.

Competing Interest: The author stated that they had no competing interests related to this research.

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