MEDICINE UPDATES JOURNAL
Faculty of Medicine Port Said University
Volum: 17 No:7 PP:55 - 65

"Comparison between calcium and non-calcium-based phosphate binders concerning acid-base status and electrolytes in hemodialysis patients in Al-Hayah hospital. "

Authors **Authors**
Heba Mohamed Abd El ghany [1], Mamdouh El Nahas [2], Amir Okeely [3], Basma Badreldin [4], Fatima Al-Taher Taha Morsi [5]
[1] **Internal medicine.**
[2] **Internal medicine faculty of medicine Port Said University**
[3] **Internal Medicine and nephrology, Faculty of Medicine Zagazig University**
[4] **Clinical pathology faculty of medicine Port said University**
[5] **Nephrology, Internal Medicine, faculty of Medicine Zagazig University,**

Submitted: 05/03/2024
Accepted:29/03/2024

DOI: 10.21608/MUJ.2024.274272.1163

ISSN : 2682-2741

https://muj.journals.ekb.egdean@med.psu.edu.eg
vice_dean_postgraduate@med.psu.edu.eg

ABSTRACT:

Background: End-stage rena1 disease (ESRD) requiring rena1 rep1acement therapy (RRT) has become a major health problem worldwide. Approximately 2.5 million people were estimated to be receiving chronic RRT in 2010. Hyperphosphatemia is one of the major clinical manifestations of decreased kidney function that is more pronounced in CKD stages 3–5. High serum phosphorus is actively involved in soft tissue and vascular calcification with increased cardiovascular disease (CVD) and mortality in these patients.
Aim and objectives: To compare calcium-based versus non-calcium-based phosphate binders concerning parameters of acid-base balance and electrolytes in hemodialysis (HD) patients from the Al-Hayah Hospital hemodialysis unit in Port Said Governorate.

Patients and methods: This prospective cohort trail was performed on 116 ESRD individuals on regular hemodialysis for at least 6 months, selected from the Al-Hayah Hospital hemodialysis unit in Port Said Governorate.

Results: At base line there were no significant difference between total Ca2+, Ionized Ca2+, HCO3, PO4-, K +and Na+ after three months of treatment total calcium levels were higher among calcium- based phosphate binders than non- calcium-based phosphate binders group with statistically significant difference. Otherwise, there were no statistically significant differences between calcium- based phosphate binders than non- calcium- based phosphate binders groups as regard ionized calcium, phosphate levels, sodium, potassium and bicarbonate levels

Conclusion: we concluded that treatment with calcium-based phosphate binders and non-calcium-based phosphate binder with meals both reduce serum phosphate, but regarding initial and follow up electrolyte and acid -base results between groups we found that total calcium levels were higher among calcium- based phosphate binders than non-calcium- based phosphate binders group with statistically significant difference. Otherwise, there were no statistically significant differences between calcium- based phosphate binders than non- calcium- based phosphate binders groups as regard ionized calcium, phosphate levels, sodium, potassium and bicarbonate level

Key words: Calcium and non-calcium phosphate binders; Acid-base balance; Sevelamer; electrolytes; hemodialysis patients.

Introduction

ESRD requiring renal replacement therapy (RRT) has become a major health problem worldwide including Egypt. In 2017 the prevalence of ESRD patients on maintenance HD in the Sharkia governorate was 442 per million populations (pmp) ***(Abou-Bakr et al., 2022)***.

Reduced kidney function often manifests clinically as hyperphosphatemia. The rise of parathyroid hormone (PTH) and fibroblast growth factor (FGF)-23, which augment phosphaturia, usually postpone hyperphosphatemia until the later stages of chronic kidney disease (CKD), despite the fact that a phosphate-positive balance develops from the early stages of CKD***(Vervloet, 2019)***

Hyperphosphatemia in ESRD increased as CKD progresses and is assumed to contribute to various, cardiovascular and bone - mineral complications in advanced CKD. Thus hyperphosphatemia usually requires therapeutic interventions ranging from dietary counselling to adaption of dialysis prescription and/or drug therapy***(Moon et al., 2019)***. Phosphate binders are the mainstay of pharmacological therapy aiming at improving bone disease and decreasing CVD morbidity and mortality in CKD patients via phosphate control. The 2017 KDIGO (kidney disease: Improving Global Outcomes) guidelines illustrate the significance of early and effective phosphate control, stating that serum phosphorus levels should be maintained within the norma1 range in CKD stages 3-5 and raised phosphorus levels should be lowered towards the normal range in CKD stage 5D ***(Isakova et al., 2017)***, Phosphate-binder drugs used for hyperphosphatemia are an essential part of treatment of patients with CKD - mineral and bone disease (MBD)***(Dzingarski and Mladenovska, 2017).***

One of the most hazardous side effects of sevelamer is metabolic acidosis especially with sevelamer hydrochloride and to lesser degree with sevelamer carbonate. The role of sevelamer in inducing MA was supported by animal studies that showed reduced urinary PH, increased urinary calcium and ammonium excretion in animals treated with sevelamer indicating increased net acid excretion. Chronic MA is associated with several hazardous complications including risks of CVD, BMD as well as associated electrolytes disturbance, most seriously hyperkalemia ***(Jokihaara et al., 2016)***.

The exact pathophysiological mechanisms underlying this MA is still unclear, but potential explanations are, first patients treated with sevelamer will stop treatment with CBPB, losing their alkalizing effects. Another mechanism could be through resulting hyperchlorademia as sevelamer is a resin-based binder acts through anion exchange where monovalent phosphate bounds through hydrogen and ionic bonding in exchange for the release of chloride, so one hydrochloric acid molecule is released for each phosphate molecule bound in the GIT tract ***(Locatelli et al., 2014)***.

Chloride content of sevelamer is 17% of its weight and assuming complete exchange of sevelamer content of chloride for bicarbonate, phosphate bile acids, and other anions, so each800 mg tablet of sevelamer would theoretically increase acid load by 4 mEqHCl acid, with total acid load increase 12-16 mEq in dialysis patients receiving 800 mg tablets of sevelamer for 3-4 times daily ***(Yang et al., 2016)***.

The objective of this research was to compare calcium-based versus non-calcium-based phosphate binders concerning parameters of acid-base balance and electrolytes in hemodialysis patients

Patients & methods

This prospective cohort trail was performed on 116 ESRD individuals on regular hemodialysis for at least 6 months, selected from the Al-Hayah Hospital hemodialysis unit in Port Said Governorate from April 2022 till august 2022.

Inclusion criteria

Patients 18 years old and older at the beginning of the study, Patients on hemodialysis for more than 6 months, Patients on thrice-weekly hemodialysis regimen taking phosphate binders.

Exclusion criteria

Intact parathyroid hormone over 1000pg/ml, previous history of parathyroidectomy, inability to obtain patient's consent, patients with severe comorbidities (decompensated chronic liver disease, advanced cancer), active infection at the time of the study.

Ethical consideration Informed consent was signed by all patients who are invited to participate in the research. Participation was completely voluntary; withdrawal or stop sharing at any time was possible without any consequence or loss of benefits. Individual privacy was preserved in all published and written data which result from the study. The research didn't expose patients to further risks or complications. All participants will be announced by the result of the study.

Methods

All the patients were subjected to the following:

History taking: Personal history, previous medical illness co-morbidities (HTN, DM), drug history, clinical examination: general examination, BMI(body mass index) in addition to full history talking and clinical examination.

Dialysis prescription: All patients received hemodialysis 4- hour per session, thrice weekly via A- v fistula on Gambro K98 hemodialysis machine. The used hemodialyzer was high- flux (KUF 10- 50 mL/min/mmHg), Where, KUF(The ultrafiltration coefficient of a dialyzer) is defined as volume of plasma water filtered in mL/ hour for each mmHg TMP**.** Haemodialysis sessions are Glucose- free dialysate was used with calcium concentration 1.25 mmol/mL, potassium concentration 2 mEq/mL. Bicarbonate was used as acid buffer. Dialysis session was adjusted as follows: Temperature: 36.3 c, Sodium: 140 mEq and Bicarbonate: 38 mEq.

Laboratory tests

Arterial sample: tube on lithium heparin for (ABG). venous sample: one tube on lithium heparin for (HCO3, ionized calcium), second tube plain tube for (vitD, serum calcium(total)), Third tube EDTA tube for assessment of intact parathyroid hormone (IPTH). To obtain the clear serum for the tests then centrifuged at 3500 round per minute.

Type of sample:

Sampling method

First: Washout period**.** All patients did not receive calcium or non- calcium containing phosphate binders for at least 3months before being enrolled in the study.

Second: Patients enrollment**.** All patients in the hemodialysis patients with hyperphosphatemia after the washout period were enrolled in the study as long as serum calcium was within normal ranges (8.5- 10.5 mg/dL). Hyperphosphatemia was considered of a serum phosphate concentration > 4.5 mg/dL (> 1.46 mmol/L).

Group1: 58 patients: (19 female ,39 male) were allocated for calcium- based phosphate binders arm.

Group2: 58 patients :(28 female, 30male) were allocated for non- calcium containing phosphate binders arm

Sample size

Sample size was calculated using G-power program with α. Error = 0.05 and power 95% and it was equal to 58 patients distributed in 2 groups according to population size in a previous study by ***Di Lorio et al., (2013).***

Study Procedures

We stopped the phosphate binders 3 months before the beginning of the study as wash out period

The samples were collected at baseline and after three months.

Venous blood was taken from each patient fasting overnight: bloodwas collected into: an EDTA tube for the analysis of intact parathyroid hormone (iPTH), centrifuged and stored at -70 until laboratory assessment

Tube plain for analysis of vitD, serum Calcium separated serum stored at -70 until assessed
An arterial blood sample was taken using a heparinized syringe. The sample was analyzed immediately in an ABG analyzer to measure bicarbonate, pCO^2, and potassium
We classified the patient in to two groups58 patients in each group:
Group 1: Included 58 patient: (19 female ,39 male), received calcium-based phosphate binders (calcium acetate Marcal dose: one tablet 700mg q8hr with meals)
Group 2: Include 58 patient :(28 female, 30male).
received non-calcium-based phosphate binder (sevelamer: (renagel) dose one tablet 800 mg q8hr with meals)

Statistical analysis:

All data were tabulated in SPSS sheet version (26). Categorical data were expressed as number and percent. Continuous data were tested for normality using Kolmogorov test; Normally distributed data were expressed as mean ± Standard deviation. Abnormally distributed data were expressed as median and interquartile ranges. Appropriate statistical tests were used according to data type:

- Chi square test was used to compare categorical data.
- Student t- test was used to compare normally distributed continuous data between 2 groups.
- Paired t- test was used to compare normally distributed continuous data at 2 different time-points.
- Binary logistic regression analysis was used to assess predictors for hyperphosphatemia.

A p value less than 0.05 was considered of statistical significance.

Results

In non-Ca phosphate binder group, the mean age was 53.19 ± 13.58 years, more than half of them (51.72%) were males, with mean BMI was 32.49 ± 7.54 kg/m2. Hypertension was the most frequent comorbidity found (96.55%), and mean hemodialysis vintage was 3.71 ± 2.59, 75 patients had AVF as a vascular access while only one patient had Tunneled CVC as a vascular access. In Ca phosphate binder group, the mean age was 54.26 ± 14.71 years, more than half of them (67.24%) were males, with mean BMI was 28.33 ± 5.84 kg/m2. Hypertension was the most frequent comorbidity found (98.3%), and mean hemodialysis vintage was 4.09 ± 2.87, 57 patients had AVF as a vascular access while only one patient had Tunneled CVC as a vascular access. Causes of ESRD in both groups was illustrated in table (1). Non-significant difference was found between the two groups regarding age, sex, BMI, comorbidities, dialysis data, vascular access or cause of ESRD ($p>0.05$).

Table (1): Demographic data of involved individuals.

	Non-calcium-phosphate binders		Calcium-phosphate binders		T	P
	(n= 58)		(n=58)			
Age (years)	53.19 ± 13.58		54.26 ± 14.71		1.04	0.76
Sex						
Female	28	48.28%	19	32.76%	2.9	0.08
Male	30	51.72%	39	67.24%		
BMI	32.49 ± 7.54		28.33 ± 5.84		3.26	0.071
Comorbidities						
HTN	56	96.552%	57	98.3%	1.6	0.8
DM	11	18.965%	12	20.68%	0.054	0.816
IHD	24	41.379%	22	37.9%	2.4	0.7
COPD	1	1.724%	1	1.7%	0	1
HCV +ve	1	1.724%	0	0.0%	3.2	0.78
Dialysis data						
HD vintage (years) (mean±SD)	3.71 ± 2.59		4.09 ± 2.87		1.4	0.87
Anuria N (%)	37	63.79%	39	67.24%	2.2	0.65
Vascular Access						
AVF N (%)	57	98.28%	57	98.28%	0	1
Tunneled CVC N (%)	1	1.72%	1	1.72%		
Cause of ESRD N (%)						
Analgesic Nephropathy	8	13.79%	8	13.79%	0	1
Cardiorenal Syndrome	2	3.44%	3	5.2%	1.76	0.54
Chronic Pyelonephritis	4	6.9%	2	3.44%	3.46	0.9
Chronic Tubulointerstitial Nephritis	0	0.0%	1	1.7%	3.2	0.87
Contrast Induced nephropathy	0	0.0%	1	1.7%	3.2	0.87
Diabetic Nephropathy	8	13.79%	7	12.068%	1.722	0.6
Lupus Nephritis	3	5.2%	3	5.2%	0	1
Autosomal dominant Polycystic Kidney	1	1.7%	1	1.7%	0	1
Congenital Polycystic Kidney	0	0.0%	1	1.7%	3.2	0.87
Post Infectious Glomerulonephritis	0	0.0%	1	1.7%	3.2	0.87
hypertensive nephrosclerosis	30	51.72%	29	50.0%	1.34	0.65
Chronic allograft nephropathy	2	3.4%	1	1.7%	2.3	0.75

Our results showed that all patients received adequate dialysis and there was no statistically significant difference between the two studied groups regarding both initial urea pre dialysis, urea post dialysis, urea reduction ratio, Kt/V as well as no statistically significant difference between initial ultrafiltration and albumin in both non-calcium-phosphate binders' group and calcium-phosphate binders. there was no statistically significant difference between the non-calcium-phosphate binders' group and calcium-phosphate binders regarding CBC, HbA1c pre-dialysis, HbA1c post dialysis.

Table (2): Baseline laboratory data of the studied group:

	Non-calcium-phosphate binders (n= 58)	Calcium-phosphate binders (n=58)	T	P
Hb (g/dl)	10.02 ±1.29	9.6 ± 1.07	1.4	0.1611
PLT (/cmm)	217.3±55.4	224.06 ± 59.5	1.15	0.59
TLC (10^3/ul)	6.60 ± 1.99	7.34 ± 2.46	1.52	0.11
Albumin (g/dl)	3.7 ± 0.5	3.8 ± 0.55	1.12	0.474
Urea Pre dialysis (mg/dl)	164.8 ± 40.4	164.9 ± 36.5	1.22	0.4458
Urea post dialysis (mg/dl)	75.7± 26.2	75.9± 28.8	1.2	0.4773
Ultrafiltration (L)	2.99 ± 0.82	2.96± 0.81	1.024	0.92
Urea reduction ratio	0.54 ± 0.09	0.54 ± 0.11	1.49	0.13
Kt/V (blood water urea clearance)	0.99 ± 0.26	0.98± 0.3	1.331	0.2829
HbA1c Pre dialysis (%)	6.54 ± 1.5	5.99 ± 1.6	1.910	0.059
HbA1c post dialysis (%)	5.36± 0.65	5.31± 0.94	0.333	0.74

There was no significant difference between non-calcium-phosphate binders and Calcium-phosphate binders' groups as regard baseline level of 25-OH-Vitamin D3 (10 ± 4.5 ng/ml Vs 10.2 ± 4.8 ng/ml, p>0.05), PTH (656.13 ± 496.39 Pg/mL Vs 825.04 ± 531.10 Pg/mL, p>0.05), ALP (423.95 ± 242.89 IU/L Vs 423.95 ± 242.89 IU/L, p>0.05) or Albumin (3.7 ± 0.5 g/dl Vs 3.8 ± 0.55 g/dl, p>0.05).

Table (3): Baseline levels of vitamin D, PTH, ALP and albumin

	Non-calcium-phosphate binders (n= 58)	**Calcium-phosphate binders (n=58)**	**T**	**P**
25(OH)D3 (ng/ml)				
	10 ± 4.5	10.2 ± 4.8	0.2315	0.817
PTH (Pg/mL)				
	656.13 ± 496.39	825.04 ± 531.10	1.7695	0.079
ALP (IU/L)				
	423.95 ± 242.89	384.00 ± 286.48	0.8101	0.419
Albumin (g/dl)				
	3.7 ± 0.5	3.8 ± 0.55	1.0246	0.307

There was no significant difference between non-calcium-phosphate binders and Calcium-phosphate binders groups as regard as regard initial total Ca (9.8 ± 2.38 mg/dl Vs 39.4 ± 2.36 mg/dl, p>0.05), initial ionized Ca (4.5± 0.35 mg/dl Vs 4.4 ± 0.38 mg/dl, p>0.05), initial PO4- (7.78 ± 2.8 mg/dl Vs 7.41 ± 2.72

mg/dl, p>0.05), initial Na+ (135.51 ± 3.83 mEq/L Vs 137.19 ± 3.69 mEq/L, p>0.05), initial K+ (5.1 ± 0.8 mmol/L Vs 4.8 ± 0.7 mmol/L, p>0.05) or initial **HCO3** + (22.7 ± 2.03 mEq/L Vs 20.5 ± 1.6 mEq/L, p>0.05)

Table (4): Baseline electrolyte and acid -base results in the studied groups:

	Non-calcium-phosphate binders (n= 58)	**Calcium-phosphate binders (n=58)**	**t**	**P**
Total Ca2+ (mg/dl)				
Initial	9.8 ± 0.4	9.6 ± 0.3	1.01	0.9
Ionized Ca2+ (mg/dl)				
Initial	4.2 ± 0.35	4.3 ± 0.38	1.17	0.53
PO4- (mg/dl)				
Initial	7.78 ± 2.8	7.41 ± 2.72	1.06	0.82
Na+ (mEq/L)				
Initial	135.51 ± 3.83	137.19 ± 3.69	1.07	0.78
K+ (mmol/L)				
Initial	5.1 ± 0.8	4.8 ± 0.7	1.3	0.316
HCO3 (mEq/L)				
Initial	22.7 ± 2.03	20.5 ± 1.6	1.024	0.927

Our results showed that all patients received adequate dialysis and there was no statistically significant difference between the two studied groups regarding follow up urea pre dialysis, urea post dialysis, urea reduction ratio, Kt/V as well as no statistically significant difference between follow up ultrafiltration in both non-calcium-phosphate binders' group and calcium-phosphate binders, or hba1c after 3 months

Table (5): follow up values of routine lab investigations

	Non-calcium-phosphate binders (n= 58)	Calcium-phosphate binders (n=58)	T	P
Hb(g/dl)	9.30 ± 1.84	9.83 ± 1.73	1.6	0.15
PLT(/cmm)	218.84 ± 47.5	240.8 ± 56.1	1.39	0.212
TLC (10^3/ul)	6.08 ± 1.50	6.88 ± 1.67	1.23	0.4201
Albumin (g/dl)	4.12 ± 0.8	4 ± 0.34	-0.9	0.4
Urea Pre dialysis (mg/dl)	165.43 ± 37.5	165.11 ± 44.4	1.4	0.2053
Urea post dialysis (mg/dl)	76.2 ± 22.8	76.48 ± 23.3	1.04434	0.8705
Ultrafiltration (L)	2.97 ± 0.83	2.9 ± 0.82	1.02	0.9274
Urea reduction ratio	0.55 ± 0.11	0.55 ± 0.13	1.39	0.2103
Kt/V (blood water urea clearance)	1.003± 0.37	1± 0.38	1.336	0.976
HbA1cAfter 3 months (%)	4.96± 0.89	5.06± 0.86	0.615	0.539

After 3 months of treatment, there was no significant difference between non-calcium-phosphate binders and calcium-phosphate binders groups as regard level of 25-OH-Vitamin D3 (10.7 ± 5.12 ng/ml Vs 10.78 ± 4.65 ng/ml, p>0.05), PTH (312.07 ± 109.24 Pg/mL Vs 365.73±120 Pg/mL, p>0.05) , ALP (151.32 ± 110.37 IU/L Vs 114.5±80 IU/L, p>0.05) or Albumin (4.12 ± 0.8 g/dl Vs 4 ± 0.34g/dl, p>0.05).

Table (6): After 3 months Levels of vit D, PTH, ALP and albumin:

	Non-calcium-phosphate binders (n= 58)	**Calcium-phosphate binders (n=58)**	**T**	**P**
25(OH)D3 (ng/ml)				
	10.7 ± 5.12	10.78 ± 4.65	1.212	0.469
PTH (Pg/Ml				
	312.07 ± 109.24	365.73±120	1.769	0.79
ALP (IU/L)				
	151.32 ± 110.37	114.5±80	0.601	0.310
Albumin (g/dl)				
	4.12 ± 0.8	4 ± 0.34	0.231	0.76

After 3 months of treatment, total calcium levels were higher among calcium- based phosphate binders than non- calcium- based phosphate binders group with statistically significant difference ***(p< 0.001)***. Otherwise, there were no statistically significant differences between calcium- based phosphate binders than non- calcium- based phosphate binders groups as regard ionized calcium, phosphate levels, sodium, potassium and bicarbonate levels ***(table 7).***

Table (7): follow up electrolyte and acid -base results

	Non-calcium-phosphate binders (n= 58)	**Calcium-phosphate binders (n=58)**	**T**	**P**
Total Ca2+ (mg/dl)				
After 3 months	9.4 ± 0.9	9.9 ± 0.6	2.8	***0.005***
Ionized Ca2+ (mg/dl)				
After 3 months	4.1 ± 0.71	4.2 ± 0.46	0.9	0.38
PO4- (mg/dl)				
After 3 months	4.9 ± 1.2	5.3 ± 1.6	1.77	0.13
Na+ (mEq/L)				
After 3 months	136.30 ± 2.68	137.1 ± 3.55	1.75	0.17

K+ (mmol/L)				
After 3 months	5.1 ± 0.91	4.9 ± 0.58	1.4	0.15
HCO3 (mEq/L)				
After 3 months	19.90 ± 4.93	19.00 ± 4.99	1.60	0.0749

The results showed that phosphate levels were comparable between both groups pre and post treatment. Pair wise analysis showed that phosphate levels decreased significantly in both groups ***(p< 0.001)***.

Table (8) : serum phosphorus pre and post treatment

	Non-calcium-phosphate binders (n= 58)	**Calcium-phosphate binders (n=58)**	
Baseline PO4	7.78 ± 2.8	7.41 ± 2.72	0.8
Follow up PO4	4.9 ± 1.2	5.3 ± 1.6	0.13
	<0.001	***<0.001***	

Discussion

In our study total calcium levels were higher among calcium- based phosphate binders than non-calcium- based phosphate binders group with statistically significant difference .Otherwise, there were no statistically significant differences between calcium- based phosphate binders than non- calcium- based phosphate binders groups as regard ionized calcium, phosphate levels, sodium, potassium and bicarbonate levels Hyperphosphatemia is a critical and almost inevitable progression of advanced chronic kidney disease, and clinicians consider regulating serum phosphate levels with a phosphate binder (calcium-based or non-calcium-based) or dietary restriction as a crucial therapeutic intervention) ***Vardhan and Hutchison, 2022)***.

The main results of our study were as following:

There was a significant variation among initial and follow up total calcium levels in both studied groups. Phosphate binder associated hypercalcemia is a well-documented metabolic effect of both calcium containing and non-calcium containing phosphate binder. This hypercalcemia is a double-edged weapon, where it can be beneficial to correct hypocalcemia that is commonly encountered in advanced stages of CKD in addition to dialysis patients, meanwhile may predispose the patient to accelerated vascular calcification and increase the cardiovascular risk and complications among ESRD patients specially when combined with vitamin D administration**.** This hypercalcemia is more prevalent with calcium containing binders. But calcium-based phosphate binders are more widely used as they are cheaper, available and the risk of hypercalcemia can be reduced by taking these drugs with or immediately after meals to limit calcium absorption. Current Kidney Disease Improving Global Outcomes (KDIGO) guidelines recommended restricting CBBs for patients known to have vascular calcification, low/adynamic bone turnover or, persistent low PTH and persistent or recurrent hypercalcemia**.**

Serum calcium and the risk of hypercalcemia were evaluated in a meta-analysis of the results of 22 studies with n=3933 participants, revealed that the end of treatment serum Ca levels was significantly lower with sevelamer compared with CBB while the risk of hypercalcemia was evaluated in a meta-analysis of 15 studies including n=1537 participants and was also significantly lower with sevelamer ***(Patel et al., 2016)***. these results were concordant with our current findings.

In our study , there was a significant decline in each group separately (non- calcium phosphate binders) NCBPB and CBPB (calcium phosphate binders) regarding end of treatment, these findings were

in concordance of the results of **patel et al** ***(Patel et al., 2016)*** who conducted a meta-analysis of 23 studies including 4010 ESRD patients and revealed no significant disparity in serum phosphate between CBPB and sevelamer and CBPB , unlike other investigators as **Di Iorio B et al** and **Navaneethan SD et al** who reported better phosphate control in sevelamer treated patients ***(Di Iorio et al., 2012, Thomas et al., 2011)*.**

In our study , although we found reduction in level of follow up serum HCO3 from pretreatment level , these reductions were statistically non-significant among the two studied groups , which was discordant with the results of **Gonzalez E et al** , who reported increase serum HCO3 with sevelamer carbonate , however in their study , Gonzalez and his colleague shifted from sevelamer hydrochloride to sevelamer carbonate, thus their results could indicate lower risk of MA with sevelamer carbonate compared with sevelamer carbonate, still sevelamer carbonate can cause milder degree of MA ***(Gonzalez et al., 2010)***.

Our results could be explained by short term follow up of the patients for 3 months only, in addition, our patients were treated with sevelamer carbonate that causes milder degree of MA acidosis compared with sevelamerhydrochroride.

In our study, post treatment serum K level revealed non-significant difference in both groups; this was in discordance with the research by **Filiopoulos V et al** who reported a significant increase in serum potassium in sevelamer-treated patients. The authors explained this hyperkalemia as a secondary consequence to metabolic acidosis. Another possible cause for hyperkalemia is patients' noncompliance to diet restrictions ***(Filiopoulos et al., 2011)***

Our results showed that both calcium based binders and sevelamer managed to reduce phosphorus levels, this is supported, this finding is supported by the study carried by Prajapati et.al.***(Prajapati et al., 2014)***

CONCLUSION

Calcium- based phosphate binders and non- calcium- based phosphate binders had comparable effect on phosphate and treatment with both agents was associated with significant reduction of phosphate levels among hemodialysis patients with no significant effect on other electrolytes or acid- base balance. The only reported electrolyte changes beside changes in phosphate level, calcium increased significantly in calcium- based phosphate binders. Reported adverse events were not so much especially dyspepsia and xerostomia in patients received non- calcium- based phosphate binders and hyperacidity in patients received calcium- based phosphate binders.

REFERENCES

Abou-Bakr, A., Hussein, R. R., Khalil, E. & Ahmed, E. 2022. The frequency of periodontitis in end-stage renal disease on hemodialysis in a sample of Egyptian population: multi-center clinical cross-sectional study. *BMC Oral Health,* 22**,** 1.

Di Iorio, B., Bellasi, A., Russo, D. & Investigators, I. S. 2012. Mortality in kidney disease patients treated with phosphate binders: a randomized study. *Clinical Journal of the American Society of Nephrology,* 7**,** 487-493.

Dzingarski, D. & Mladenovska, K. 2017. Pharmacotherapy in chronic kidney disease hyperphosphatemia–effects on vascular calcification and bone health. *Macedonian Pharmaceutical Bulletin,* 63.

Filiopoulos, V., Koutis, I., Trompouki, S., Hadjiyannakos, D., Lazarou, D. & Vlassopoulos, D. 2011. Lanthanum carbonate versus sevelamer hydrochloride: improvement of metabolic acidosis and hyperkalemia in hemodialysis patients. *Therapeutic Apheresis and Dialysis,* 15**,** 20-27.

Gonzalez, E., Schomberg, J., Amin, N., Salusky, I. B. & Zaritsky, J. 2010. Sevelamer carbonate increases serum bicarbonate in pediatric dialysis patients. *Pediatric Nephrology,* 25**,** 373-375.

Isakova, T., Nickolas, T. L., Denburg, M., Yarlagadda, S., Weiner, D. E., Gutiérrez, O. M., *et al.,* 2017. KDOQI US commentary on the 2017 KDIGO clinical practice guideline update for the diagnosis, evaluation, prevention, and treatment of chronic kidney disease–mineral and bone disorder (CKD-MBD). *American Journal of Kidney Diseases,* 70**,** 737-751.

Jokihaara, J., Pörsti, I. H., Sievänen, H., Kööbi, P., Kannus, P., Niemelä, O., *et al.,* 2016. Phosphate Binding with Sevelamer Preserves Mechanical Competence of Bone Despite Acidosis in Advanced Experimental Renal Insufficiency. *Plos one,* 11**,** e0163022.

Locatelli, F., Del Vecchio, L., Violo, L. & Pontoriero, G. 2014. Phosphate binders for the treatment of hyperphosphatemia in chronic kidney disease patients on dialysis: a comparison of safety profiles. *Expert opinion on drug safety,* 13**,** 551-561.

Moon, H., Chin, H. J., Na, K. Y., Joo, K. W., Kim, Y. S., Kim, S., *et al.,* 2019. Hyperphosphatemia and risks of acute kidney injury, end-stage renal disease, and mortality in hospitalized patients. *BMC nephrology,* 20**,** 1-7.

Patel, L., Bernard, L. M. & Elder, G. J. 2016. Sevelamer versus calcium-based binders for treatment of hyperphosphatemia in CKD: a meta-analysis of randomized controlled trials. *Clinical Journal of the American Society of Nephrology,* 11**,** 232-244.

Prajapati, V. A., Galani, V. J. & Shah, P. R. 2014. A Comparative Study of Phosphate Binders in Patients with End Stage Kidney Disease Undergoing Hemodialysis. *Saudi Journal of Kidney Diseases and Transplantation,* 25**,** 530-538.

Thomas, G., Sehgal, A. R., Kashyap, S. R., Srinivas, T. R., Kirwan, J. P. & Navaneethan, S. D. 2011. Metabolic syndrome and kidney disease: a systematic review and meta-analysis. *Clinical journal of the American Society of Nephrology,* 6**,** 2364-2373.

Vardhan, A. & Hutchison, A. 2022. Calcium, Phosphate, and Renal Osteodystrophy: CKD: Mineral and Bone Disorder. *Nolph and Gokal's Textbook of Peritoneal Dialysis.* Springer.

Vervloet, M. 2019. Renal and extrarenal effects of fibroblast growth factor 23. *Nature Reviews Nephrology,* 15**,** 109-120.

Yang, Y., Mohammad, A., Berendt, R. T., Carlin, A., Khan, M. A. & Faustino, P. J. 2016. Evaluation of the in vitro efficacy of sevelamer hydrochloride and sevelamer carbonate. *Journal of Pharmaceutical Sciences,* 105**,** 864-875.