Association between vitamin D3 and some Biochemical parameters in Iraqi patients with chronic kidney disease

Asociación entre la vitamina D3 y algunos parámetros bioquímicos en pacientes iraquíes con enfermedad renal crónica

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Abstract

Chronic kidney disease (CKD): is characterized by a decrease in kidney function manifested as evidenced by kidney disease or an estimated-glomerular filtration rate (eGFR) of less than (60)mL per minute per 1.73m^2 of body surface area for three or more months. Low levels of 25-hydroxyvitamin D and vitamin D deficiency kidney disease are both a contributor to kidney disease. A study of the connections between vitamin D and a number of biochemical parameters such as concentration of Urea, PTH, Creatinine, eGFR, K+, Na+, Ca++, Mg++ and P in the serum. This study aims to examine concentrations of (OH) vitamin D level in CKD (pre-dialysis and post-dialysis). And this study aimed to find out receiver operating characteristic curve (ROC) each of vitamin D3, Urea, Creatinine and calcium pre and post dialysis. The study also aimed to identify the correlation between vitamin D and biochemical parameters. The mean of serum vit.D concentrations was lower in both groups: pre-dialysis (17.671±2.323)ng/ml, post-dialysis (15.543±1.731) ng/ml and there was highly significantly differences between these groups. There was a highly significant differences in concentrations of urea, creatinine, PTH, eGFR, Na+, K+, Ca++, Mg++ and p with CKD. Vitamin D had a significant negative correlation with BMI (p=0.038) in CKD patients, the p value (p≤0.05). vitamin D3 and Creatinine were shown to have a negative connection (P=0.001).

Resumen

Enfermedad renal crónica (ERC): se caracteriza por una disminución de la función renal que se manifiesta como una enfermedad renal o una tasa de filtración glomerular estimada (TFGe) inferior a (60) ml por minuto por 1,73 m2 de superficie corporal durante tres o más meses. Los niveles bajos de 25-hidroxivitamina D y la enfermedad renal por deficiencia de vitamina D contribuyen a la enfermedad renal. Un estudio de las conexiones entre la vitamina D y una serie de parámetros bioquímicos como la concentración de urea, PTH, creatinina, eGFR, K+, Na+, Ca++, Mg++ y P en el suero. Este estudio tiene como objetivo examinar las concentraciones de (OH) vitamina D en la ERC (prediálisis y posdiálisis). Y este estudio tuvo como objetivo conocer la curva característica operativa del receptor (ROC) de cada vitamina D3, urea, creatinina y calcio antes y después de la diálisis. El estudio también tuvo como objetivo identificar la correlación entre la vitamina D y los parámetros bioquímicos. La media de las concentraciones séricas de vit. D fue menor en ambos grupos: prediálisis (17,671±2,323)ng/ml, postdiálisis (15,543±1,731) ng/ml y hubo diferencias muy significativas entre estos grupos. Hubo diferencias muy significativas en las concentraciones de urea, creatinina, PTH, eGFR, Na+, K+, Ca++, Mg++ y p con ERC. La vitamina D tuvo una correlación negativa significativa con el IMC (p=0,038) en pacientes con ERC, el valor de p (p≤0,05). Se demostró que la vitamina D3 y la creatinina tienen una conexión negativa (P = 0,001).

Introduction

For one to stay in excellent health, vitamin D is required. Most people need sunshine exposure UVB (290–315 nm) to get enough vitamin D to meet their needs; its sources include skin production and dietary consumption[1]. Vitamin D is a fat-soluble secosteroid that comes in two forms: (vitamin D2 and vitamin D3). When compared to vitamin D3, vit. D2 has a methyl group at C24 and a side-chain double bond between C22 and C23[2]. Both the epidermis and dermis both contain 7-dehydrocholesterol (DHC), Which absorbs UVB photons and causes them to transform into pre-vitamin D3(no biological effect), when UVB radiation (280–315 nm) passes through these skin layers[3,4]. It takes a two-step enzymatic hydroxylation process to convert of vitamins D2 and D3 into active compounds (regardless of source)[4]. The first is converted to 25OHD in the liver by 25-hydroxylase and the second is converted to 1,25- dihydroxyvitamin D (1,25(OH)2D) in the kidney by 1-α-hydroxylase[5]. The active hormone is created by 25-hydroxylation and 1α-hydroxylation, while 24-hydroxylation is involved of vitamin D inactivation and catabolism. All hydroxylation processes are completed by Cytochrome P450 (CYP) enzymes, although CYPs are mostly associated with drug catabolism in the liver and oxidation/reduction reactions, they are considered as responsible in the metabolism of vitamin D[6]. The final step in synthesis the active vitamin D3 occurs in the proximal tubules of the kidney, which is mediated by the enzyme 1-α-hydroxylase. 25OHD3 is absorbed into tubule cells and metabolized (1-alpha-hydroxylation) by megalin and cubilin, which are transmembrane proteins found in renal tubules and act as surface receptors for VDBP in tubules, 25OHD3; which is then undergoes 1-α-hydroxylation[7].

Renal hydroxylation, in contrast to hepatic hydroxylation, is highly regulated by serum levels of calcium, phosphorus, parathormone (PTH) and FGF-23, as well as by active vitamin D itself[8]. Most bodily cells include the vitamin D receptor (VDR), which is how calcitriol works[9].

Low levels of 25(OH)D are present in a sizeable segment of the general population, but most people with chronic illnesses, particularly those with chronic kidney disease (CKD), have deficiencies[10]. Vitamin D is crucial for the development and maintenance of a healthy skeleton by increasing calcium absorption. Vitamin D deficiency leads to rickets in children and osteomalacia and osteoporosis in adults, Age-related health issues might result from Vitamin D deficiency[11]. The prevalence of CKD is an escalating public health concern in both industrialized and developing nation. Haemodialysis, influences the transport of water through the erythrocyte membrane and induces morphologic and functional modifications[12]. A recent study in adult hemodialysis patients found that bioavailable 25(OH)D, the fraction that is not bound to DBP, was better correlated with measures of mineral metabolism than total 25(OH) D concentrations[13]. CKD is a physiological change that produces loss of kidney function and end-stage kidney disease[14]. The majority of dialysis patients are deficient in vitamin D, including those who are 1, 25-dihydroxyvitamin D and the less active 25-hydroxyvitamin D, as well as other abnormalities associated with CKD[15].

Materials and methods

Subject for study

A questionnaire is used to gather information about the patient including name, home address, age, sex, height, weight, whether or not the patient is a smoker, whether or not he has chronic diseases, history of chronic kidney disease, is the patient undergoing dialysis, whether vitamin D was taken and how long it was taken. A total of 60 cases with CKD (30 pre and 30 post dialysis) equally distributed men and women were included in the study, along with 30 vitamin D3 control cases. The volunteers, patients and control ranged in age from 40 to 70. A venous blood sample was taken (5ml) predialysis and (5ml) postdialysis, the blood samples were separated into two aliquots, with (2ml) going into (EDTA) for DNA extraction and (3ml) used for lab for analysis. This cross-sectional study was carried out at dialysis unit (synthetic kidney center) affiliated to Al-Ramadi Teaching Hospital, office Al-Mawla media lab. Biological analyzes were carried out in the laboratory of the artificial kidney center and al-mawla medical laboratory during the period from 1st December 2021 to the end of June 2022.

Determination of Vitamin D3 ELISA

The ELISA is based on the competitive binding enzyme immunoassay technique. An antibody specific to Vitamin D3 has been pre-coated on the microtiter plate included in this kit. During the reaction, a predetermined amount of (biotin labeled) Vitamin D3 and Vitamin D3 from the sample or standard competes for sites on a pre-coated Monoclonal antibody specific to Vitamin D3. The plate is cleaned of Extra conjugates as will as unbound samples or standards. Then each microplate well is filled with an incubation solution containing an avoid in coupled to Horseradish Peroxidase (HRP). Then, each well receives a (TMB) substrate solution. By the adding a sulphuric acid solution, the enzyme substrate reaction is stopped and the color change is then detected spectrophotometrically at a wavelength of (450 nm ± 2 nm). After that, by contrasting the O.D. of the samples, the amount of vitamin D present is calculated. The sample to the standard curve.

Determination of Electrolytes (Na+/K+/Ca++) by SmartLyte® Plus Electrolyte Analyzer

The SmartLyte® Plus is an automated, microprocessor-controlled analyzer that measures sodium, potassium, calcium, chloride and lithium in Serum, Sodium heparin

Plasma, venous whole Blood, as well as sodium, potassium and chloride in pre-diluted Urine samples.

Determination of Magnesium and Phosphorus

In an alkaline solution, Magnesium and Xylidyl Blue combine to generate a colorful chemical. The ratio of the sample's magnesium concentration to the color intensity that results. GEDTA is used to stop calcium from being interfered with.

Phosphate and ammonium molybdate react in sulfuric acid solution to generate a yellow phosphorus molybdate complex. At 340 nm, multiple Maximum complex absorption peaks. It varies in accordance with the sample's inorganic phosphate concentration.

Determination of Urea and Creatinine

$Urea + 2H2O < \overset{Urease}{} >2\ NH4^{+} + CO3^{2-}$

$NH4^{+}+2\text{-}Oxoglutarate+NADH<\overset{GLDH}{}>L\text{-}Glutamate +NAD+ + H2O$

The amount of Urea in the sample has a direct relationship to the amount of absorbance that decreases as a result of the (GLDH) reaction.

Creatinine appears as an orange (red) colored complex in an alkaline picrate solution. The difference in absorbance during conversion at particular stages is proportional to the creatinine concentration of the sample.

Creatinine + Picric acid→ Creatinine picrate complex

Statistical analysis

The data (Statistical Package) were examined using Excel and statistical analysis system using the statistical package for Social Sciences (SPSS version 28) application. The following statistical data analysis approaches were utilized to analyze and assess the study's findings:

1. The mean and standard deviation (Mean± SD) for each group's parameters were established using descriptive analysis.
2. Analysis of variance (ANOVA).
3. The Pearson correlation test (r) was used to determine the linear correlation between the variables.
4. Plotting of the false positive rate (1-specificity) versus the true positive rate (sensitivity) for all cut-off points is known as a receiver operating characteristic (ROC) study.

The P value for all tests was judged significant if less than 0.05.

Results

The study participants' Demographics and Lab results

This study compared the how clinical parameters varied between people with CKD and controls. Shown in (Table 1). Mean age of the 60 CKD patients was 52.9±9.3years. History of CKDg (year) the mean was 4.73±3.85 years. Pre-dialysis the mean eGFR, serum urea and serum creatinine level were 7.916±3.683 mL/min/1.73 m^2, 184.907±160.068 mg/dl and 7.355±2.503 mg/dl. Post-dialysis the mean eGFR, serum urea and serum creatinine level were 15.300±5.761 mL/min/1.73 m^2, 93.383±88.253 (mg/dl) and 4.304±1.919 mg/dl. The eGFR was <15 mL/min/1.73 m^2 in pre-dialysis and post-dialysis eGFR was≥15 mL/min/1.73 m^2. The mean serum K, P, Ca, Mg, Na, and PTH levels were 133.01±3.13 mmol/l, 5.01±0.79 mmol/l, 2.362±0.557 mg/dl, 1.890±0.499mmol/L, 5.317±1.766 mg/dL and 310.87±214.88 pg/mL in pre-dialysis. The mean serum Na, K, Mg, Ca, P, and PTH levels were 130.86±3.45 mmol/l, 5.68±0.84 mmol/l, 2.659±0.661 mg/dl, 1.085±0.091 mmol/l, 4.471±1.731 mg/dl and 348.41±226.14pg/ml in post-dialysis.

Table 1: characteristics and lab results of the study's participants.

		N=60 patient
Age (year)		52.9±9.3
BMI (Kg/m2)		27.41±5.46
Gender	Male(no,%)	15, 50%
	Female(no,%)	15,50%
Weight (Kg)		74.03±16.39
Height (cm)		164.00±7.62
History of CKDg (year)		4.73±3.85 (1.0-15.0)
CKD stage (eGFR, mL/min/1.73 m^2) G5	Predialysis	7.916±3.683
	Postdialysis	15.300±5.761
Ca++ (mmol/l)	Predialysis	1.890±0.499
	Postdialysis	1.085±0.091
P (mg/dL)	predialysis	5.317±1.766
	Postdialysis	4.471±1.731
PTH (pg/mL)	predialysis	310.87±214.88
	Postdialysis	348.41±226.14

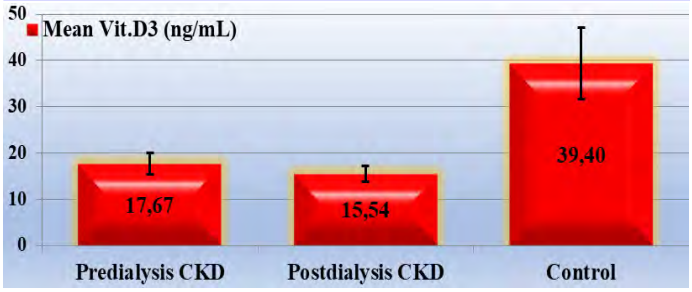
Values are shown as mean and SD or as percentages (%). Abbreviations: (BMI) body mass index, (Ca) calcium, (P) phosphate, (CKD) chronic kidney disease, (eGFR) estimated-glomerular filtration rate, (PTH) parathyroid hormone.

Vitamin D3 (ng/mL)

The mean serum level of vitamin D3 it was significantly higher in patients with CKD predialysis was (17.671±2.323)ng/ml from postdialysis was (15.543±1.731) ng/ml, but the controls (39.397±7.710) ng/ml it was significantly higher than pre-dialysis and post-dialysis, which was highly significantly difference between two independent means pre and post dialysis (p= 0.0001) that decreased, when compared with the

normal control group. Also significant difference between two dependent means (p =0.0001) between pre and post dialysis shown in Figure 1

Figure 1: Mean for Vitamin D3 with CKD and controls pre and post dialysis.



Correlation between Vitamin D3 and variance biochemical parameters studied

Serum vitamin D3 levels had a significant negative correlation with BMI in pre-dialysis (P=0.038). In the post-dialysis group, serum vitamin D3 had a significant (negative) correlation with BMI (P=0.079). There was no-association between low vitamin D3 in (pre and post dialysis) and BMI. The positive correlation with non-significant were with Age (p=0.388), History of CKD (p=0.950) and PTH (p= 0.211) in predialysis group. In postdialysis, the positive correlation with non-significant were with Age (p=0.224), CKD History (p=0.808) and PTH (p=0.340). Figure 2

The correlation of vitamin D level with Urea, Creatinine, eGFR and Na+

In pre-dialysis group Serum vitamin D3 had a nonsignificant negative correlation with urea (p=0.795), eGFR (p=0.598) and sodium Na+ (p=0.272), and shows a non-significant positive-correlation with creatinine (p= 0.503) In post-dialysis a non-significant with positive correlation with urea (p= 0.841) and creatinine (p= 0.094), Serum vitamin D3 had a non-significant negative correlation with eGFR (p= 0.332) and Na+ (p= 0.205). Creatinine and vitamin D3 were shown to have a negative connection (P=0.001). (Figure 3)

The correlation between Vitamin D3 with (K+, Ca++, Mg++ and p)

In pre-dialysis group Vitamin D3 had a non-significant negative correlation with Ca++ (p= 0.554) and shows a non-significant positive correlation with K+(p= 0.410), Mg++(p=0.410) and phosphorus (p= 0.512). A nonsignificant with positive correlation with K+ (p= 0.763), Mg++(p= 0.477) and phosphorus (p= 0.356), Serum vitamin D3 had a non-significant negative correlation with Calcium (p= 0.553) in post-dialysis. Figure 4

Receiver Operator Curve (ROC) Analysis

This study aimed to find out receiver operating characteristic curve (ROC) each of vitamin D3, Urea, Creatinine and calcium pre and post dialysis.

Vitamin D3, Urea, creatinine and Ca++ were chosen as the cut-off points because they had the highest sensitivity and specificity for identifying pre-dialysis (CKD) individuals. The sensitivity for CKD (pre-dialysis) with a cut-off point for Vitamin D3 of 14.1 ng/ml was 97% and the 1-specificity was 90%,the sensitivity for CKD with a cut off point for Urea of 46.7 ng/ml was96.7 % and the1-specificity was 40 %, meanwhile, the sensitivity for CKD with a cut-off point for creatinine of 3.64 ng/ml was 96.7% and the 1-specificity was 23.3% and the sensitivity for CKD with a cut-off point for Calcium of 1.19 ng/ml was 83.3% and the 1-specificity was 58.3%. AUC = Area under the curve. (Figure 5)

Figure 2: Correlation between Vitamin D3 with (A)Age (years), (B) BMI (kg/m2), (C) History of CKD (years) and (D) PTH (pg/mL).

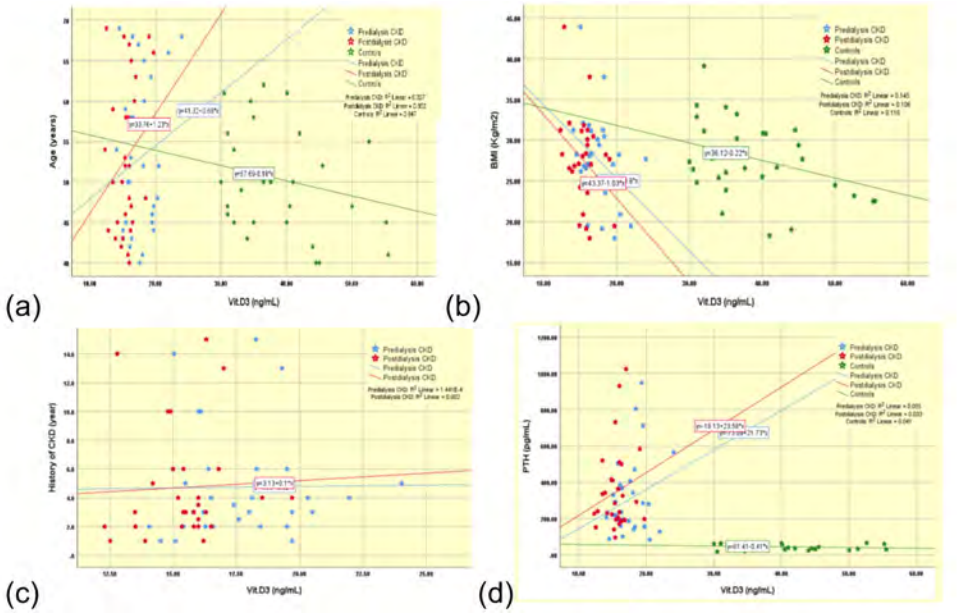


Figure 3: Correlation between Vitamin D3 with (A) Urea (mg/dl), (B) Creatinine (mg/dl), (C) eGFR (ml/min/m2) and (D) Na+ (mmol/L).

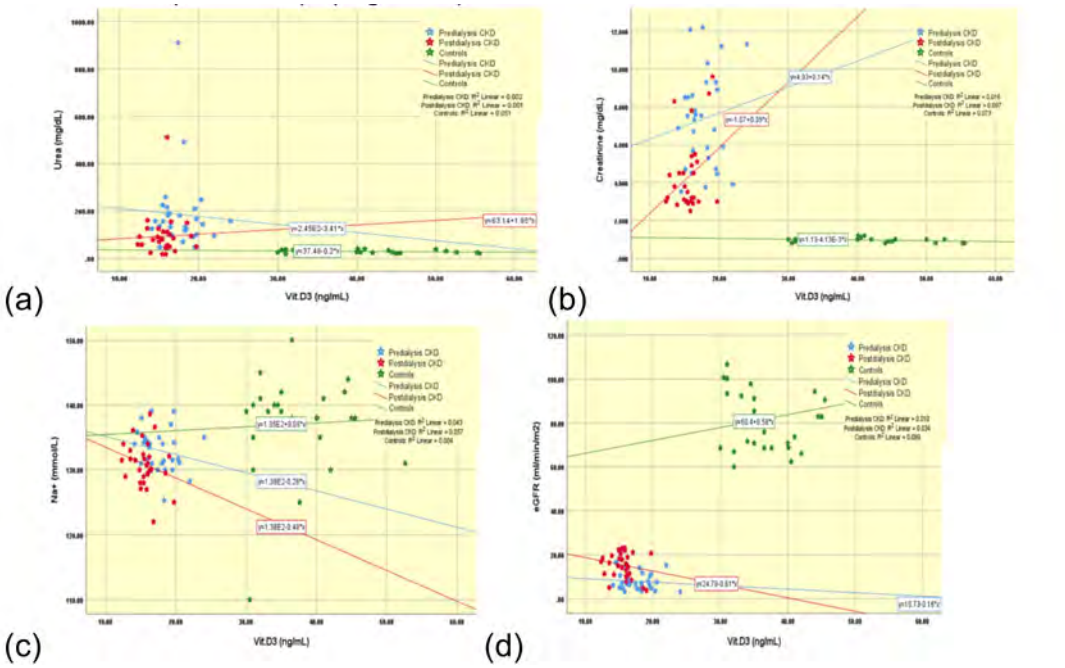


Figure 4: Correlation between Vitamin D3 with (A) K+ (mmol/L), (B) Ca ++ (mmol/l), (C) Mg++ (mg/dl) and (D) p (mg/dl).

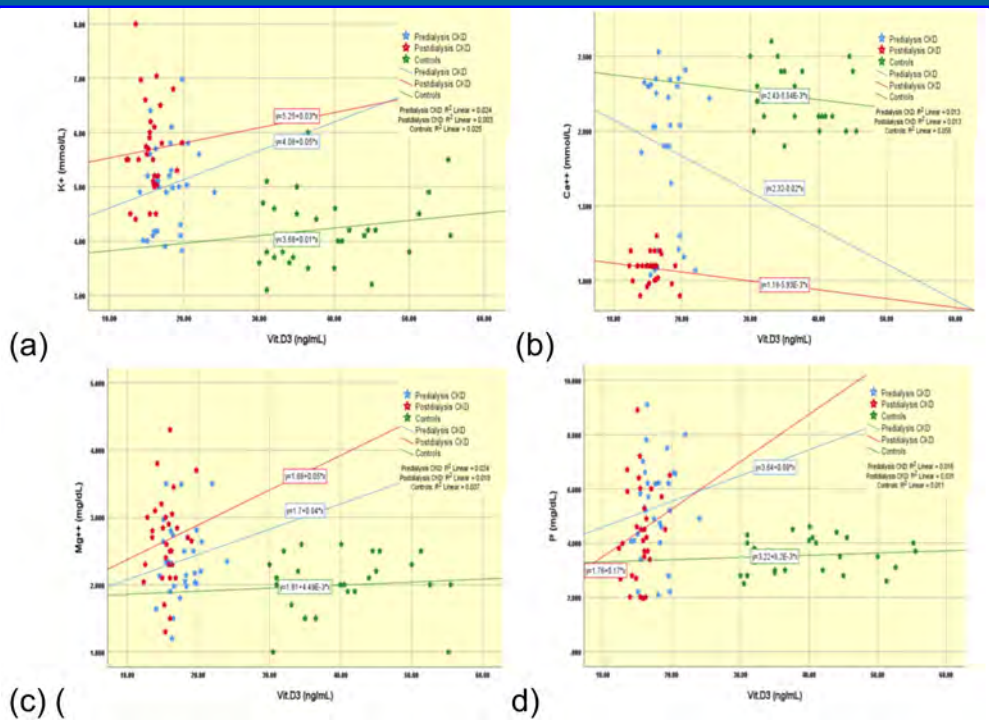


Figure 5: ROC curves for pre dialysis.

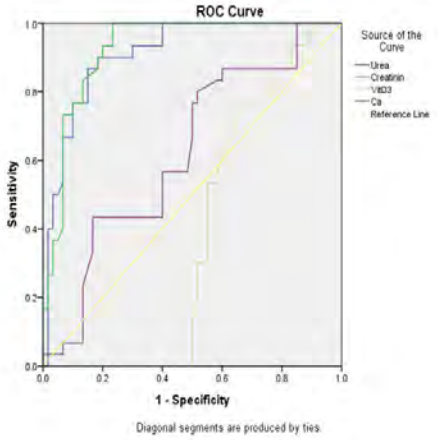


Table 2: Information of ROC curves output for pre dialysis patients.

Variable	AUC	Cut-off point	Sensitivity%	1-Specificity%
Urea	0.912	46.7	96.7	40
Creatinin	0.925	3.64	96.7	23.3
Calcium	0.622	1.19	83.3	58.3
Vitamin D	0.383	14.1	97	90

AUC = Area under the curve

Vitamin D3, Urea, creatinine and Ca++ were the cut-off points selected to identify Post-dialysis (CKD) individuals with the best sensitivity and specificity. The sensitivity for CKD (post-dialysis) with a cut-off point for Vitamin D3 of 14.1 ng/ml was 80% and the 1-specificity was 98.3%, the sensitivity for CKD with a cut-off point for Urea of 52.8 ng/ml was 60% and the1-specificity was 46.7%, meanwhile, the sensitivity for CKD with a cutoff point for creatinine of 2.66 ng/ml was 96.7% and the 1-specificity was.

50% and the sensitivity for CKD with a cut-off point for Calcium of 1.05 ng/ml was 70% and the 1-specificity was 98.3%. (Figure 6)

Figure 6: ROC curves for post dialysis.

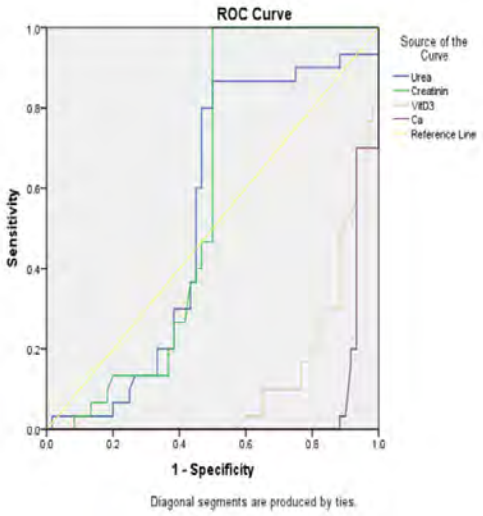


Table 3: Information of ROC curves output for post dialysis patients.

Variable	AUC	Cut-off point	Sensitivity%	1-Specificity%
Urea	0.543	52.8	60	46.7
Creatinin	0.575	2.66	96.7	50
Calcium	0.052	1.05	70	98.3
Vitamin D	0.117	14.1	80	98.3

AUC = Area under the curve

Discussion

In the present study, we compared between vitamin D and a number of biochemical parameters such as concentration of Urea, Creatinine, PTH, eGFR, Na+, K+, Ca++, Mg++ and P in the serum. Vitamin D levels in our study's pre- and post-dialysis samples were, respectively, (17.671±2.323) ng/ml and (15.543±1.731) ng/ml on average. This demonstrates a highly significant difference in the mean vitamin D level before and after dialysis (p=0.0001). The mean(±SD) Na+ levels were (133.01±3.13) mmol/l and (130.86±3.45) mmol/L respectively, in the pre-dialysis and post-dialysis samples. This shows lower significant difference between mean of pre-dialysis and post-dialysis Na+ level (p=0.0001). In predialysis and post-dialysis sample the mean and SD K+ was (5.01±0.79) mmol/L and (5.68±0.84) mmol/L ,Ca++ was (1.890±0.499) mmol/L and (1.085±0.091) mmol/L, Mg++ was(2.362±0.557) mmol/L and (2.659±0.661) mmol/L, phosphorus (p) was (5.317±1.766) mmol/L and (4.471±1.731)mmol/L, PTH was(310.874±214.876) mmol/L and (348.406±226.136) mmol/L. This shows highly significant difference between mean of pre-dialysis and post-dialysis vitamin D level (p=0.0001). The (mean±SD) value of eGFR in CKD patients pre-dialysis was (7.916±3.683) mmol/L, for post-dialysis was (15.300±5.761) mmol/L. This shows lower significant difference between mean of pre-dialysis and post-dialysis eGFR p≤ 0.05 was p=0.0001. The (mean ± SD) value of Urea in CKD patients pre-dialysis was (184.907±160.068) mmol/L, for post-dialysis was (93.383±88.253) mmol/L, the control was (29.503±6.927) mmol/L, Creatinine in CKD patients pre-dialysis was (7.355±2.503) mmol/L, for post-dialysis was (4.304±1.919) mmol/L. The mean serum Urea and creatinine was significantly higher in pre and post dialysis, at p≤ 0.05 was p=0.0001.

The majority of dialysis patients have vitamin D deficits, including those in 1,25-dihydroxyvitamin D (activated vitamin D) and 25-hydroxyvitamin D (less active vitamin D)[15]. Vitamin D insufficiency is common among patients with chronic kidney disease (CKD)[16]. The Kidney Disease Outcome Initiative defines CKD as kidney damage or a glomerular filtration rate (GFR) of 60 mL/min/1.73

m2 for 3 months or more due to any cause[17]. Experts from the Kidney Disease Improving Global Outcomes (KDIGO) and Kidney Disease Outcomes Quality Initiative (KDOQI) have acknowledged the need for vitamin D supplementation in CKD and dialysis patients to prevent SHPT and prevent vitamin D insufficiency and deficiency[18]. Schwarz et al.[19] found no correlation between calcium and the progression of CKD in patients with CKD stage 1 to 5; however, hyperphosphatemia, excess FGF-23, and the calcium-phosphorus product have all been consistently linked to the progression of CKD7. There is less evidence linking calcium disturbances to the decline of kidney function. Our study further supports the notion of a grossly inadequate vitamin D and calcium intake by the adult Austrian population, as we found that both men and women on average consume only 567 mg calcium and approximately 100 IU of vitamin D per day[20]. Calcium (Ca), phosphorus (P) and calcitriol, have been involved in the pathogenesis of renal hyperparathyroidism[21].

Conclusions

Based on our findings, we conclude that: Our findings revealed that vitamin D deficiency was more common in CKD patients than in healthy group. There was a not relationship between age and gender with CKD patients and also between body mass index (BMI) and CKD group. Our finding a significant difference between (Na+, K+, Ca++, P, PTH, eGFR, Urea, Creatinine) and CKD patients. Our finding correlation between Vitamin D3 and eGFR with variance biochemical parameters studied.

Appendix A

Correlations

		Vit.D3	PTH	Urea	Creatinine	eGFR
Predialysis						
Age (years)	R	0.163	-0.093	0.239	-0.102	0.068
	P	0.388	0.624	0.203	0.591	0.721
BMI (Kg/m2)	R	-0.381*	-0.084	0.177	0.305	-0.430*
	P	0.038	0.660	0.348	0.101	0.018
History of CKD(year)	R	0.012	0.337	-0.095	0.031	-0.135
	P	0.950	0.069	0.616	0.870	0.478
Vit.D3 (ng/mL)	R	-	0.235	-0.049	0.127	-0.100
	P	-	0.211	0.795	0.503	0.598
PTH (pg/mL)	R	0.235	-	-0.223	0.067	-0.051
	P	0.211	-	0.236	0.725	0.789
Urea (mg/dL)	R	-0.049	-0.223	-	0.258	-0.248
	P	0.795	0.236	-	0.169	0.187
Creatinine (mg/dL)	R	0.127	0.067	0.258	-	-0.903**
	P	0.503	0.725	0.169	-	0.0001
Na+ (mmol/L)	R	-0.207	0.019	-0.092	0.101	-0.119
	P	0.272	0.921	0.629	0.595	0.530
K+(mmol/L)	R	0.156	-0.201	-0.157	0.140	-0.250
	P	0.410	0.287	0.406	0.460	0.183
Ca++ (mmol/L)	R	-0.112	0.171	-0.113	-0.029	-0.108
	P	0.554	0.367	0.551	0.880	0.570
P (mg/dL)	R	0.125	0.038	0.154	0.337	-0.222
	P	0.512	0.844	0.418	0.069	0.238
Mg++ (mg/dL)	R	0.156	0.171	-0.259	0.064	0.049
	P	0.410	0.367	0.168	0.736	0.796
postdialysis						
Age (years)	r	0.229	-0.075	0.293	-0.052	0.075
	P	0.224	0.696	0.116	0.785	0.694
BMI (Kg/m2)	r	-0.326	-0.094	0.129	0.092	-0.212
	P	0.079	0.622	0.495	0.627	0.261
History of CKD (year)	r	0.046	0.311	-0.123	-0.067	-0.023
	P	0.808	0.094	0.518	0.727	0.906
Vit.D3 (ng/mL)	r	-	0.181	0.038	0.312	-0.183
	P	-	0.340	0.841	0.094	0.332
PTH (pg/mL)	r	0.181	-	-0.235	0.221	-0.121
	P	0.340	-	0.211	0.240	0.525
Urea (mg/dL)	r	0.038	-0.235	-	0.279	-0.317
	P	0.841	0.211	-	0.135	0.088
Creatinine (mg/dL)	r	0.312	0.221	0.279	-	-0.894**
	P	0.094	0.240	0.135	-	0.0001
Na+ (mmol/L)	r	-0.238	0.121	-0.050	0.035	0.023
	P	0.205	0.524	0.792	0.856	0.904
K+ (mmol/L)	r	0.057	-0.277	0.087	-0.041	-0.007
	P	0.763	0.138	0.649	0.829	0.972
Ca++ (mmol/L)	r	-0.113	0.128	0.025	-0.056	-0.060
	P	0.553	0.502	0.895	0.769	0.754
Mg++ (mg/dL)	r	0.135	0.322	-0.186	0.153	-0.203
	P	0.477	0.082	0.325	0.420	0.282
P (mg/dL)	r	0.175	-0.027	0.159	0.111	0.002
	P	0.356	0.889	0.402	0.558	0.990

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