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Study the relationship of osteopontin with blood pressure in type II diabetics without and with renal failure

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Abstract
Elevated serum levels of Osteopontin(OPN) have been associated with Diabetic Nephropathy. The study aims to investigate the relationship between OPN serum levels and blood pressure in Type 2 diabetes mellitus(T2DM) with and without Renal Failure. Methods: In this study, we measured serum levels of (OPN), Electrolytes(Na+ , k+), serum Phosphorous level(PO4), and Blood Pressure in 50 Patients among them, 25 diabetic patients without Renal Failure and 25 with Renal Failure and 30 control subjects. Results: This study has found that serum OPN levels(ng/mL) were higher in T2DM without and with Renal Failure than in the control group(6.219+0.732 vs4.611+1.296)(7.497+1.758 vs4.611+1.296)sequentially. The levels of DBP(mmHg) non-significant difference between T2DM without Renal Failure and in the control group (82.8+15.14 vs86+10.03) and it was Lower in T2DM with Renal Failure than in the control group (68.28+14.34 vs86+10.03). The SBP(mmHg) in the three groups showed no significant difference (129.3+12.58vs128.4+19.72vs136.9+15.24). As for MAP non-significant difference between T2DM without Renal Failure and in the control group(98+15.84vs100.4+9.65) and it was Lower in T2DM with Renal Failure than in the control group (91.16+12.98 vs100.4+9.65). Conclusions: Serum OPN levels significantly increased in T2DM without and with Renal Failure patients comparison to healthy subjects. The blood pressure is represented by the DBP and MAP were significantly in T2DM without Renal Failure patients than in controls.

Introduction:

Diabetes mellitus (DM) has a large impact on mortality, morbidity, and total healthcare expenditures. These results are primarily attributable to diabetes patients' high frequency of progressive kidney impairment, which makes diabetic nephropathy the main factor causing end-stage renal disease [1]. High blood glucose levels brought on by insulin resistance, insufficiency, or both are the hallmarks of DM, a metabolic illness [2].

T2DM, which affects almost one in ten persons worldwide, has a devastating impact on healthcare systems. According to current estimates, 37% of diabetic patients also have stages 1-4 of chronic kidney disease (CKD), and 38% of instances of end-stage renal disease are brought on by diabetes. Patients who have both T2D and CKD are also more likely to pass

away from reasons other than renal failure. This risk is increased in older persons with CKD, who have a 13-fold higher risk of dying from any cause and a 6-fold higher risk of dying from cardiovascular disease (CV) than from renal failure [3]. To lessen the medical and financial burden associated with this chronic condition, it is crucial to emphasise early identification and treatment [4].

Although microalbuminuria continues to be the gold standard diagnostic for the early diagnosis of diabetic nephropathy (DN), some restrictions mean that it is not a reliable indicator of the likelihood of developing DN. Several indications of glomerular or tubular dysfunction might precede microalbuminuria, indicating that microalbuminuria arises after considerable renal damage. For instance, not all diabetics with microalbuminuria will develop End Stage Kidney Disease (ESKD), and 30% may have normoalbuminuria [5].

OPN is a 44-kDa multifunctional secreted, phosphorylated glycoprotein that was first found in bone and is involved in a number of biological processes including biomineralization, chronic inflammation and tissue remodelling [6]. Later, it was found that OPN had a wider dispersion. In adults, OPN expression is often only found in the kidney, bone, and epithelium linings. It is also produced in bodily fluids such as milk, blood, and urine. In contrast to its limited distribution in normal tissue, OPN is noticeably increased in areas of inflammation and tissue remodelling [7]. In several kidney disease models, increased OPN expression is also linked to increased macrophage influx [8-9]. Furthermore, the extent of OPN up-regulation in tubules correlates with the degree of macrophage accumulation and the severity of tubulointerstitial fibrosis and renal dysfunction [10].

The study's objectives included determining the serum levels of OPN and blood pressure in Iraqi T2DM patients and controls without and with renal failure, as well as looking into the connections between OPN and blood pressure and a few other indicators that help with the diagnosis of T2DM with and without renal failure.

Materials and Methods

The participants in this study included 50 T2DM patients (equal numbers of men and women), whose ages ranged from 30-75 years. The subjects were divided into two groups: 25 patients with T2DM without renal failure group, 25 patients with T2DM with renal failure group, and 30 controls had the same gender and age as the patient groups. The controls were selected people without diabetes disease who also had no history of smoking or drinking alcohol. The present case-control research was carried out between October 2022 and March 2023 at Al Haditha General Hospital and Al Ramadi Teaching Hospital/Dialysis Unit. Based on positive protein in urine tests, kidney function tests, and clinical signs of diabetic nephropathy, the individuals were identified as having renal failure.

After a 12-hour fasting, blood samples from type 2 diabetic patients and the healthy group were collected in the early morning (8–10.30 A.M.). We withdrew 5 ml of blood from each participant and placed it in a gel tube. Next, the centrifugation process was completed at a speed of 3000xg. After the centrifugation, we obtained serum that was divided into two parts. The first part was used to estimate the vital variables (K+, Na+, and PO_4) and the second part was distributed into Eppendorf's tubes and they were transported for storage in a freezer at -20 C° until use for estimation of OPN.

OPN (ng/mL) was evaluated using the enzyme-linked immunosorbent assay (ELISA) technique, electrolytes (Na+, k+) (mEq/L) in the blood were analysed using an automated analyzer, and serum phosphorus (PO4) levels (mg/dL) were measured using enzymatic colorimetric techniques.

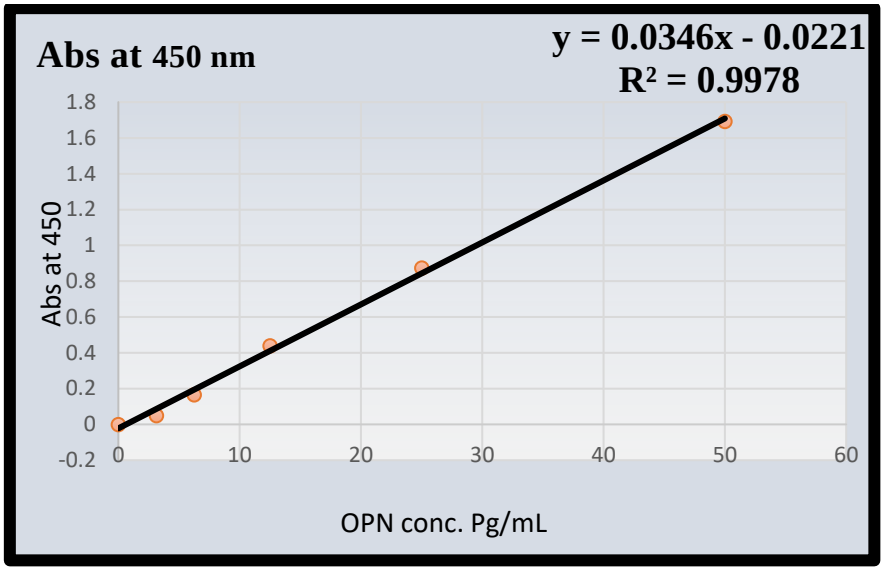

Fig. 1 Standard Curve of OPN.

Statistics

We used GraphPad Prism 7 to analyse our data. The data were presented using the mean, standard error of the mean (SEM), and standard deviation (SD) values. To assess how distinct means varied from one another, a student's t-test was used. Pearson correlation coefficients were used to analyse bivariate relationships. The correctness of the inquiry was evaluated using the area under the ROC curve. The significance threshold was set at P 0.05.

Result

Serum OPN levels (ng/mL) were higher in T2DM patients with Renal Failure than in the control group (7.497 vs. 4.116) and in T2DM patients without Renal Failure than in the control group (6.219 vs. 4.116), according to Table 1's standard experimental characteristics of the subjects (Fig. 1). DBP (mmHg) differences between the T2DM without Renal Failure group (82.8 vs. 86) were not statistically significant. Compared to the control group, and were lower in T2DM with Renal Failure (68.28 vs. 86), as shown in Fig. 2. As indicated in Fig.3, the SBP (mmHg) was not significantly different between the control group (128.4 vs 129) and the groups with and without renal failure (136.9 vs 129). As demonstrated in Fig.4, the MAP was non-significant in the T2DM without Renal Failure group compared to the control group (98 vs. 100.4) and lower in the T2DM with Renal Failure group compared to the control group (91.16 vs. 100.4).

Table 1: Clinical and Biochemical Parameter of T2DM without and with Renal Failure patients and control.

parameter	Controls		T2DM without Renal Failure		T2DM with Renal Failure		Sig.
	Mean	SD	Mean	SD	Mean	SD	
Age years	53.6	11.83	55.28	9.779	56.96	10.75	a , a , a
Osteopontin ng/mL	4.611	1.296	6.219	0.732	7.497	1.758	a , b , c
K Ions mEq/L	4.113	0.4337	4.154	0.2718	4.467	0.8426	a , a , b
Na Ions mEq/L	135.8	25.12	138.3	2.622	125.4	2.676	a , a , b
PO_4 Ions mg/dL	4.7	1.174	4.964	1.446	4.603	2.345	a , a , a
SBP mmHg	129.3	12.58	128.4	19.72	136.9	15.24	a , a , b
DBP mmHg	86	10.03	82.8	15.14	68.28	14.34	a , a , b
MAP mmHg	100.4	9.658	98	15.84	91.16	12.98	a , a , b

Note: Similar letters mean no significant difference between the groups at a level of less than 0.05, and various letters mean the existence of a significant difference at a level of less than 0.05.

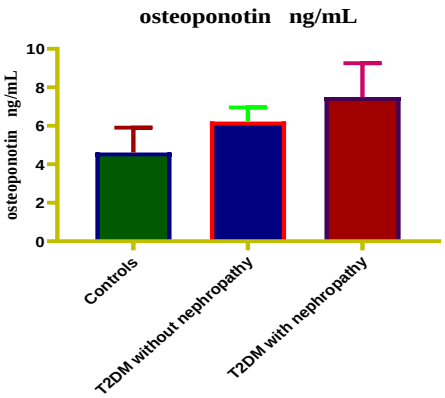

Fig. (1): Mean+ S.D for Osteoponotin in Control and Patients

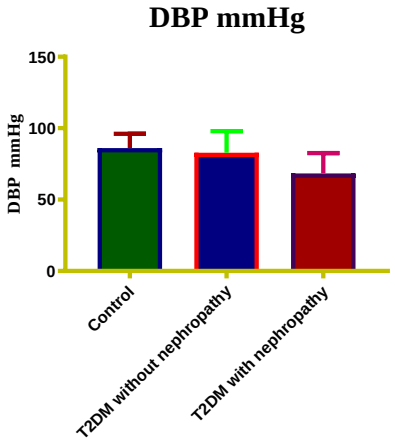

Fig. (2): Mean + SD of DBP Ions in Control and Patients

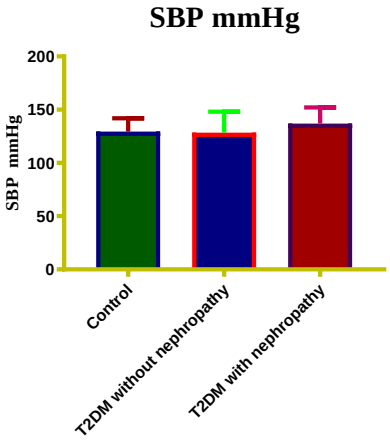

Fig. (3): Mean + SD of SBP Ions in Control and Patients

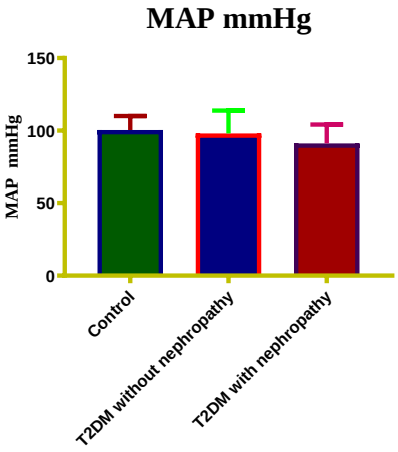

Fig. (4): Mean + SD of MAP Ions in Control and Patients

According to Table 1, there was no discernible difference in age between the three research groups (55.28 vs 53.6, 56.96 vs 53.6). Additionally, the serum level of K+ (mEq/L) was greater in T2DM with Renal Failure than in the control group (4.467 vs. 4.113) and was non-significantly different from the control group in T2DM without Renal Failure (4.154 vs. 4.113). The blood level of Na+ (mEq/L) was lower in T2DM with Renal Failure than in the control group (125.4 vs 135.3) and was not statistically different from T2DM without Renal Failure (138.3 vs 135.3). As shown in Fig. 7, there was no discernible change in the serum level of PO4 between the T2DM groups with and without renal failure (4.964 vs. 4.7, then 4.603 vs. 4.7).

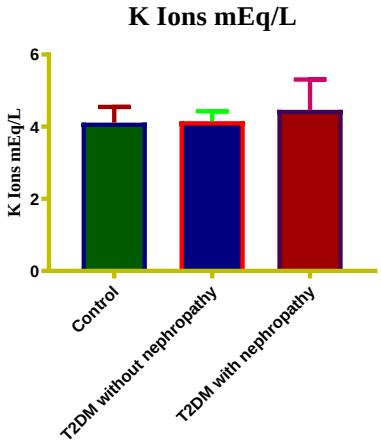

Fig. (5): Mean + SD of K Ions in Control and Patients

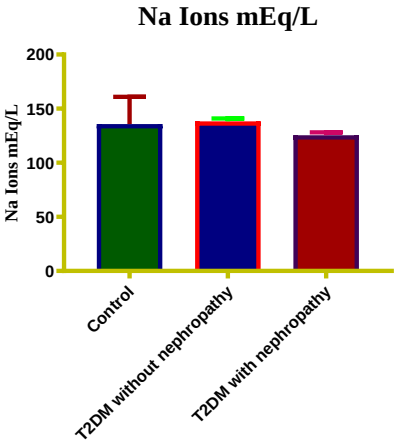

Fig. (6): Mean + SD of Na Ions in Control and Patients

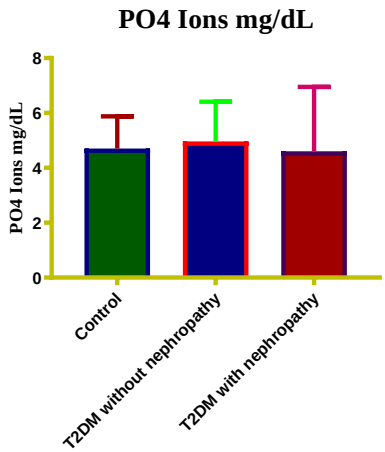

Fig. (7): Mean + SD of PO4 Ions in Control and Patients

The findings of this study's investigation into the associations between OPN in T2DM without Renal Failure and other factors are shown in table 2.

Table 2: Correlation of OPN with other Variables in T2DM without Renal Failure.

Parameter	r (Osteopontin ng/mL)	p-value
Osteopontin ng/mL	1.000	0.000
Age years	0.08	0.59
SBP mmHg	-0.11	0.42
DBP mmHg	-0.12	0.38
MAP mmHg	-0.13	0.34

K Ions	mEq/L	0.19	0.17
Na Ions	mEq/L	-0.19	0.17
PO_4 Ions	mg/dL	0.13	0.35

Insignificant associations between OPN and Age, SBP, DBP, MAP, K+, Na+, and PO4 were found in the study's data.

While the findings of the investigation into the relationships between OPN in T2DM, Renal Failure, and other factors are shown in table 3.

Table 3: Correlation of OPN with other Variables in T2DM with Renal Failure.

Parameter	r (Osteopontin ng/mL)	p-value
Osteopontin ng/mL	1.000	0.000
Age years	0.32	0.24
SBP mmHg	0.14	0.06
DBP mmHg	-0.44	0.02
MAP mmHg	-0.30	0.003
K Ions mEq/L	0.44	0.004
Na Ions mEq/L	-0.65	0.54
PO_4 Ions mg/dL	0.09	0.006

Insignificant associations between OPN and Age, SBP, Na+, and PO4 were found in the study's data.While a positive correlation of OPN with K+ (r = 0.44, P0.004) was discovered, as indicated in table 3 and Fig. 10, a significant negative correlation of OPN with DBP and MAP (r = -0.44, P 0.02) and (r = -0.30, P0.003), respectively, was also found.

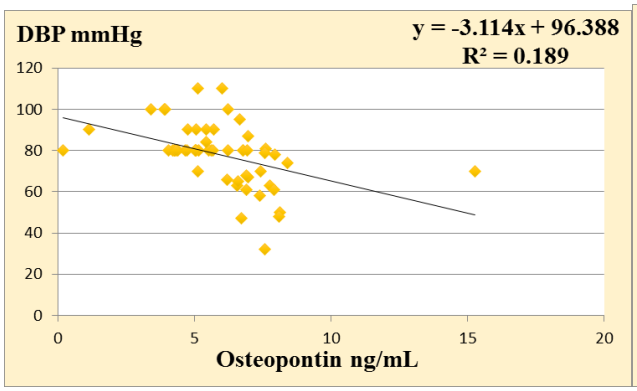

Fig. 8 Correlation between OPN with DBP

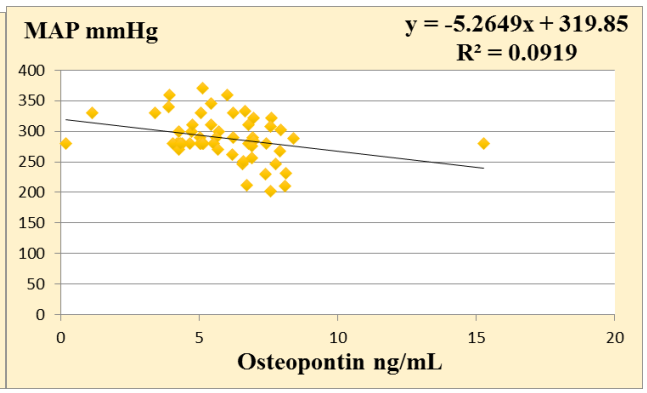

Fig. 9 Correlation between OPN with MAP

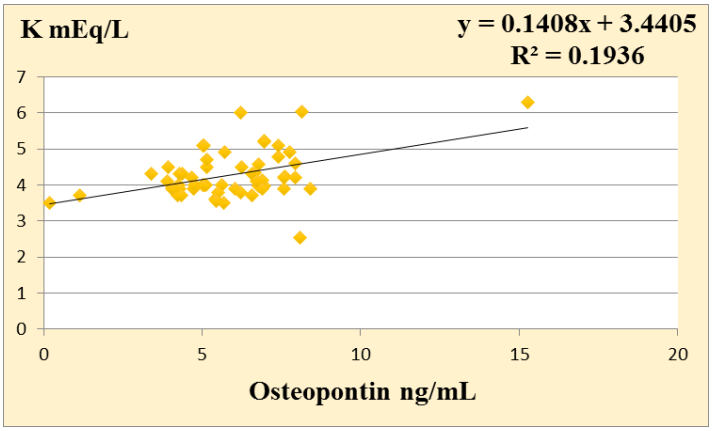

Fig. 10 Correlation between OPN with K^+ Ions

Receiver Operating Characteristic Curve Analysis

When a test or biomarker has a continuous range of test results, the diagnostic effectiveness of the test or biomarker is assessed using a statistical approach known as the ROC curve. The area under the curve (AUC) of the ROC analysis, which permits the dichotomization of continuous data, identifies the ideal cut-off values. It is possible to infer that the speculative AUC result is significant if the test value is greater than the Table value (0.5) and some of the analysed parameters have some importance for predicting T2DM without and with renal failure.

Table 4: ROC Curve for Studied Parameters in T2DM without Renal Failure.

T2DM without Renal Failure. Parameter	AUC	Std. Error	95% confidence interval	P-value
Osteopontin ng/mL	0.9180	0.03663	0.8462 to 0.9898	<0.0001
K Ions mEq/L	0.5813	0.07888	0.4267 to 0.7358	0.3085
Na Ions mEq/L	0.692	0.07278	0.5493 to 0.8347	0.0149
PO_4 Ions mg/dL	0.5467	0.07965	0.3906 to 0.7028	0.5541
SBP mmHg	0.5607	0.07929	0.4053 to 0.7161	0.4418
DBP mmHg	0.5913	0.07796	0.4385 to 0.7441	0.2469
MAP mmHg	0.59	0.07793	0.4373 to 0.7427	0.2539

The OPN parameter is one of the most valid criteria and represents an excellent strategy to differentiate between healthy individuals and T2DM patients without renal failure, with values [AUC= 0.9180 P < 0.0001, 95% confidence interval (CI): 0.8462 to 0.9898 and SE: 0.03663], while the Na+ value is a very important parameter, its value is [AUC=0.692 P 0.0149, 95% confidence interval (CI): 0.5493 to 0.8347 and SE: 0.07278] as shown in Table 4. Finally, K+, PO4, SBP, DBP and MAP were among the factors with the lowest predictive validity for T2DM without renal failure [AUC=0.5813 P 0.3085, 95% confidence interval (CI): 0.4267 to 0.7358, SE: 0.07888] , [AUC= 0.5467 P 0.5541, 95% confidence interval (CI): 0.3906 to 0.7028 and SE: 0.07965], [AUC=0.5607 P 0, 4418, 95% confidence interval (CI): 0.4053 to

0.7161 and SE: 0.07929] , [AUC= 0.5913 P 0.2469, 95% confidence interval (CI): 0.4385 to 0.7441 and SE: 0.2469], [AUC= 0.59 P 0.2539, 95% confidence interval (CI): 0.4373 to 0.7427 and SE: 0.2539], as Figure 4.

Table 5: ROC Curve for Studied Parameters in T2DM with Renal Failure.

T2DM with Renal Failure				
Parameter	AUC	Std. Error	95% confidence interval	P-value
Osteopontin ng/mL	0.9880	0.01090	0.9666 to 1.000	<0.0001
K Ions mEq/L	0.6493	0.07585	0.5007 to 0.798	0.0583
Na Ions mEq/L	0.9667	0.03277	0.9024 to 1.031	<0.0001
PO_4 Ions mg/dL	0.542	0.086	0.3735 to 0.7105	0.5944
SBP mmHg	0.6607	0.07545	0.5128 to 0.8086	0.0417
DBP mmHg	0.8467	0.05649	0.7359 to 0.9574	<0.0001
MAPmmHg	0.6953	0.07444	0.5494 to 0.8412	0.0133

The parameters OPN, Na+, and DBP demonstrated high validity and effectively distinguished between individuals without health issues and patients with Type 2 Diabetes Mellitus (T2DM) and Renal Failure. The area under the curve (AUC) values for these parameters were 0.9880 ($p < 0.0001$, 95% confidence interval [CI]: 0.9666 to 1.000, standard error [SE]: 0.01090) and 0.9667 ($p < 0.0001$, 95% CI: 0.9024 to 1.031, SE: 0.03277), respectively. The area under the curve (AUC) was found to be 0.8467, with a statistically significant p-value of less than 0.0001. The 95% confidence interval (CI) for the AUC ranged from 0.7359 to 0.9574, and the standard error (SE) was calculated to be 0.05649. These results are shown in Table 5. The parameters of SBP, MAP, and K+ have significant importance in this study, as shown by their respective values: SBP has an area under the curve (AUC) of 0.6607, with a p-value of 0.0417. The 95% confidence interval (CI) for SBP ranges from 0.5128 to 0.8086, and the standard error (SE) is 0.07545. Similarly, MAP has an AUC of 0.6953, with a p-value of 0.0133. The 95% CI for MAP ranges from 0.5494 to 0.8412, and the SE is 0.07444. The area under the curve (AUC) value of 0.6493, with a corresponding p-value of 0.0583, was obtained. The 95% confidence interval (CI) for the AUC ranged from 0.5007 to 0.798, with a standard error (SE) of 0.07585. These results are shown in Table 5. Ultimately, it was found that PO4 exhibited the lowest level of predictive validity for the development of Type 2 Diabetes Mellitus (T2DM) with Renal Failure. The area under the curve (AUC) was calculated to be 0.542, with a p-value of 0.5944. The 95% Confidence Interval (CI) ranged from 0.3735 to 0.7105, and the standard error (SE) was determined to be 0.086, as shown in table 5**.**

Discussion

In the present study, it was observed that the serum levels of osteopontin (ng/ml) there was a statistically significant increase in the group with Type 2 Diabetes Mellitus (T2DM) accompanied by Renal Failure (7.497 ± 1.758 ng/ml) compared to the group with T2DM without Renal Failure (6.219 ± 0.732 ng/ml) and the control group (4.611 ± 1.296 ng/ml) (p value < 0.0001). The results align with the research conducted by Yan et al. (2012), which revealed a notable increase in plasma levels of osteopontin (OPN) among individuals with type 2 diabetes mellitus (T2DM) in comparison to the control group. Furthermore, the study

identified a strong association between OPN levels and the severity of nephropathy. In their study, Al-Rubeaan et al. investigated the diagnostic profile of pro-inflammatory cytokines. Their findings revealed that serum osteopontin emerged as the most crucial cytokine, demonstrating significant diagnostic value. Specifically, it exhibited excellent diagnostic value for patients with macroalbuminuria and good diagnostic value for patients with microalbuminuria [11].

The results presented in this study align with prior research on the role of osteopontin in individuals with both type 1 and type 2 diabetes, as well as the involvement of IL-18 in Japanese patients with type 2 diabetes [12]. Prior studies have shown that advanced glycation end products and angiotensin II can induce the production of osteopontin (OPN) in many cell types, such as mesangial cells and podocytes. Additionally, these substances may trigger localised cellular responses, including cell spreading, adhesion, and proliferation [13].

Our conclusion is that OPN increases in patients with T2DM because it has been suggested that OPN may play an important role in the development of insulin resistance by increasing macrophage accumulation in adipose tissue and promoting the formation of inflammation. Furthermore, it has been reported that OPN levels increase on the vascular wall of diabetic individuals, which may cause cell growth by increasing OPN release [14], it also increases in T2DM with renal failure patients and to a greater extent, implying that OPN levels are related to renal function in T2DM patients. By producing an effect of macrophage-derived chemokine, OPN may cause renal function damage and renal failure. In turn, renal failure may cause an increase in the plasma OPN level [15] OPN inhibition could be a novel therapeutic strategy for these patients.

Diastolic and systolic blood pressure are two distinct parameters used to assess an individual's blood pressure. Systolic blood pressure (SBP) and diastolic blood pressure (DBP), together with mean arterial pressure (MAP), exhibited no statistically significant differences across all categories. However, it was observed that DBP and MAP were comparatively lower in individuals with Type 2 Diabetes Mellitus (T2DM) accompanied with Renal Failure. In the context of community-based investigations, it has been shown that lower diastolic blood pressure (DBP) has a more significant impact on the overall risk of death. Comparable results have been seen in individuals undergoing hemodialysis, whereby the joint assessment of systolic blood pressure (SBP) and diastolic blood pressure (DBP) has contrasting impacts on the probability of overall death. The underlying pathophysiological mechanism for this association remains unclear; nevertheless, a low diastolic blood pressure (DBP) has been suggested as a potential indicator of diminished general health, heightened arterial stiffness, and reduced coronary circulation [16].

Our investigation revealed a significant correlation between osteopontin and both diastolic blood pressure (DBP) and mean arterial pressure (MAP) in individuals with Type 2 Diabetes Mellitus (T2DM) and Renal Failure.

there was no statistically significant disparity in terms of age across all the groups. In the present study, it was observed that the levels of K^+ were found to be considerably elevated weakly in the group of individuals with Type 2 Diabetes Mellitus (T2DM) and Renal Failure (mean ± standard deviation: 4.467 ± 0.842 mEq/L) as compared to the group of individuals

with T2DM but without Renal Failure (mean ± standard deviation: 4.154 ± 0.271 mEq/L) as well as the control group (mean ± standard deviation: 4.113 ± 0.433 mEq/L) (p value = 0.05). This aligns with the findings of Natale et al. [17]. Hyperkalaemia is a common electrolyte abnormality caused by decreased renal potassium excretion in chronic kidney disease (CKD) patients. With chronic kidney disease, high levels of potassium (a body salt) can accumulate. High potassium levels are possible in patients with severe kidney failure.

H. Huang et al. demonstrated that Hyponatremia has been recognised as a risk factor in individuals with chronic kidney disease (CKD). Our study findings align with this, as we observed a decrease in sodium levels in the group of individuals with Type 2 Diabetes Mellitus (T2DM) and Renal Failure (mean ± standard deviation: 125.4 ± 2.676 mEq/L), compared to the group with T2DM without Renal Failure (mean ± standard deviation: 138.3 ± 2.622 mEq/L) and the control group (mean ± standard deviation: 135.8 ± 2.512 mEq/L) (p-value = 0.01) [18]. low sodium concentration is a risk factor for current blood glucose levels, as well as interdialytic weight gain, malnutrition, and inflammation [19].

In the present investigation, no statistically significant disparity was seen in the phosphorous serum levels across the groups. This finding aligns with the results of the two aforementioned investigations. The user did not provide any text to rewrite. The user provided a numerical reference [20][21].

Conclusions

Individuals diagnosed with type 2 diabetes, regardless of the presence or absence of renal failure, had elevated levels of osteopontin compared to the control group. A negative association has been shown between the levels of osteopontin (OPN) and both diastolic blood pressure (DBP) and mean arterial pressure (MAP) in individuals with type 2 diabetes mellitus (T2DM) and renal failure. The most affected variable, other than OPN and blood pressure, is the sodium level in T2DM with Renal Failure due to kidney problems, which causes fluid accumulation in the body and thus hyponatremia. However, more investigation is necessary to explore the involvement of OPN in Type 2 Diabetes Mellitus (T2DM) both in the absence and presence of Renal Failure, as well as to elucidate the connection between OPN and blood pressure. Additional research with bigger sample sizes is necessary due to the limited sample size of the current study.

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دراسة علاقة الاوستيوبونتين مع ضغط الدم في مرضى السكري من النوع الثاني مع وبدون اعتلال الكلى

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الخلاصة:
الخلفية: ارتبطت مستويات المصل المرتفعة من (OPN) باعتلال الكلية السكري. كان الهدف من الدراسة هو دراسة العلاقة بين مستويات مصل OPN وضغط الدم في مرض السكري من النوع 2 (T2DM) مع وبدون الفشل الكلوي. الطرق: في هذه الدراسة، قمنا بقياس مستويات المصل (OPN)، الشوارد (+Na، +k) مستوى الفوسفور (PO4) وضغط الدم لدى 50 مريضا منهم، 25 مريضا بالسكري بدون فشل كلوي و 25 مصابين بالفشل الكلوي و 30 مجموعة الاصحاء. النتائج: وجدت هذه الدراسة أن مستويات OPN في الدم (نانوغرام / مل) كانت أعلى في T2DM بدون أو مع الفشل الكلوي عنها في مجموعة الاصحاء (6.219 + 0.732 مقابل 4.611 + 1.296) (7.497 + 1.758 مقابل 4.611 + 1.296) على التوالي. كانت مستويات DBP (mmHg) غير ذات دلالة إحصائية بين T2DM بدون الفشل الكلوي عنها في مجموعة الاصحاء (82.8 + 15.14 مقابل 86 + 10.03) وكانت أقل في T2DM مع الفشل الكلوي مقارنة بمجموعة الاصحاء (68.28 + 14.34 مقابل 86 + 10.03). لم يظهر ضغط الدم الانقباضي (mmHg) في ثلاث مجموعات أي اختلاف كبير (129.3 + 12.58)128.4 + 19.72 vs136.9 أما بالنسبة لـ MAP، فرق غير مهم بين T2DM بدون فشل كلوي مقارنة بمجموعة الاصحاء (98 + 15.84)100. 4+9.65vs وكان أقل في T2DM مع الفشل الكلوي منه في مجموعة الاصحاء (91.16+12.98 مقابل 100.4+9.65).الاستنتاجات: مستويات OPN في المصل زادت بشكل ملحوظ في T2DM بدون ومع مرضى الفشل الكلوي مقارنة بالأشخاص الأصحاء. تم تمثيل الضغط بواسطة DBP وMAP بشكل ملحوظ في T2DM دون مرضى الفشل الكلوي مقارنة بالاصحاء.