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RESEARCH ARTICLE

SERUM TOTAL CALCIUM, MAGNESIUM, POTASSIUM AND PH IN SUDANESE PATIENTS WITH TYPE 2 DIABETES MELLITUS.

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Abstract

This study was carried out to measure serum levels of the calcium, magnesium, potassium and PH in patients with type 2 DM. Sixty samples were collected from patients in period between October to November 2016, chosen randomly from Military hospital and Sixty apparently, healthy individuals as controls, to assess the levels of calcium, magnesium, Potassium and pH in type2 D M.

Serum calcium and magnesium were measured by using automation, Mindray380, potassium by using easylyte and pH by using Cobas b 221, and results were analyzed using statistical of package social science (SPSS), computer program.

The study showed that, the serum levels of magnesium and potassium were significantly decreased, (p-value =0.00) in diabetic patients compared to control group. While the level of PH was significantly increased, (p-value= 0.000) and there was no significant difference between the mean of calcium level in patients and control group. Mean \pm SD cases versus control. (1.43 \pm 0.26versus2.10 \pm 0.29) For magnesium. (3.1 \pm 0.39versus4.10 \pm 0.48) for potassium. (7.99 \pm 0.06 versus 7.40 \pm 0.02) for PH.

(8.77 \pm 1.00 versus 8.79 \pm 0.80, p-value =0.997) for calcium.

There was insignificantly weak positive correlation between serum magnesium in patients used insulin and diabetic patients not used insulin (r= 0.1 / p= 0.627) , while there were no correlations between serum calcium, potassium and PH in diabetic patients used insulin and diabetic patients not used insulin.(r=0.073, p- value= 0.70),(r=0.027 , p- value= 0.888) ,(r=0.08, p-value=0.676) respectively.

It is concluded that; the levels of magnesium and potassium are significantly decreased in patients with type 2 DM, and the level of PH is significantly increased and there is no significant difference in the level of calcium in type 2 diabetic patients compared to control group.

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Introduction:-

Diabetes mellitus is characterized by hyperglycemia due to absolute or relative deficiency of insulin⁽¹⁾, leading to impaired metabolism of carbohydrates, proteins, fats, water and electrolytes. The persistence of these metabolic disturbances lead to permanent and irreversible functional and structural changes in the cells of the body which in

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turn lead to the development of “diabetic complications”, characteristically affecting, the cardiovascular system, eye, kidney and nervous system mainly⁽²⁾. A relationship between DM and minerals is frequently reported. Alteration in the metabolism of trace elements like calcium, magnesium is associated with DM⁽³⁾. Trace elements are accepted as essential for optimum health, because of their diverse metabolic characteristic and functions⁽⁴⁾. Trace elements participate in production of reactive oxygen species (ROS), which contribute to oxidative stress. Oxidative stress contributes to the pathogenesis of many diseases including DM. Chronic complications of diabetes mellitus can be divided into vascular and nonvascular complications. The vascular complications of DM are further subdivided into micro vascular (retinopathy, neuropathy, nephropathy) and macro vascular complications coronary artery disease, peripheral arterial disease, cerebrovascular disease⁽⁵⁾. Several of the complications of diabetes may be related to increased intracellular oxidants and free radicals⁽⁶⁾.

Magnesium, calcium and potassium are an essential element involved in glucose homeostasis. It is a cofactor for various enzymes in carbohydrate metabolism. It is also involved at multiple levels in insulin secretion, binding and activity. Reduced level of magnesium has been documented in type 2 DM^(3, 4,7 and 8). Hypomagnesaemia may have negative impact on glucose homeostasis and insulin sensitivity in type 2 DM patients⁽⁹⁾. Hypomagnesaemia may also have some effect in the development of diabetic complications with other risk factors⁽¹⁰⁾. The present study was designed to evaluate the serum levels of potassium; magnesium and calcium in type 2 DM.

Material and methods:-

Study Population The study was carried out at College of Medical laboratory Science and the subjects were recruited from military hospital in Khartoum from period between October to November 2016. A total of 60 type 2 DM and 60 apparently, healthy individuals as controls were enrolled in this study. The study was approved by hospital's ethics committee. Informed consent was obtained from patients before blood sampling.

Inclusion criteria:-

Sudanese patients with type 2 DM and apparently healthy volunteers (matches age and sex with the cases) were included.

Exclusion criteria: patients with hypertension, renal disease, heart disease and other disease related to pH imbalance were excluded.

Blood sample and analysis:

About 2ml of venous blood was collected from the antecubital vein by taking aseptic precautions. Care was taken to prevent venous stasis during the sample collection. The blood was allowed to clot and the serum was separated by centrifugation. The estimation of the parameters was carried out within 4-6 hrs. The samples were analyzed for serum calcium and magnesium by using automation, Mindray 380⁽¹¹⁾, potassium by Electrolyte analyzer (easlyte) and pH by using Cobas b 221⁽¹²⁾. The internal control sera of two different levels were used to calibrate the instruments.

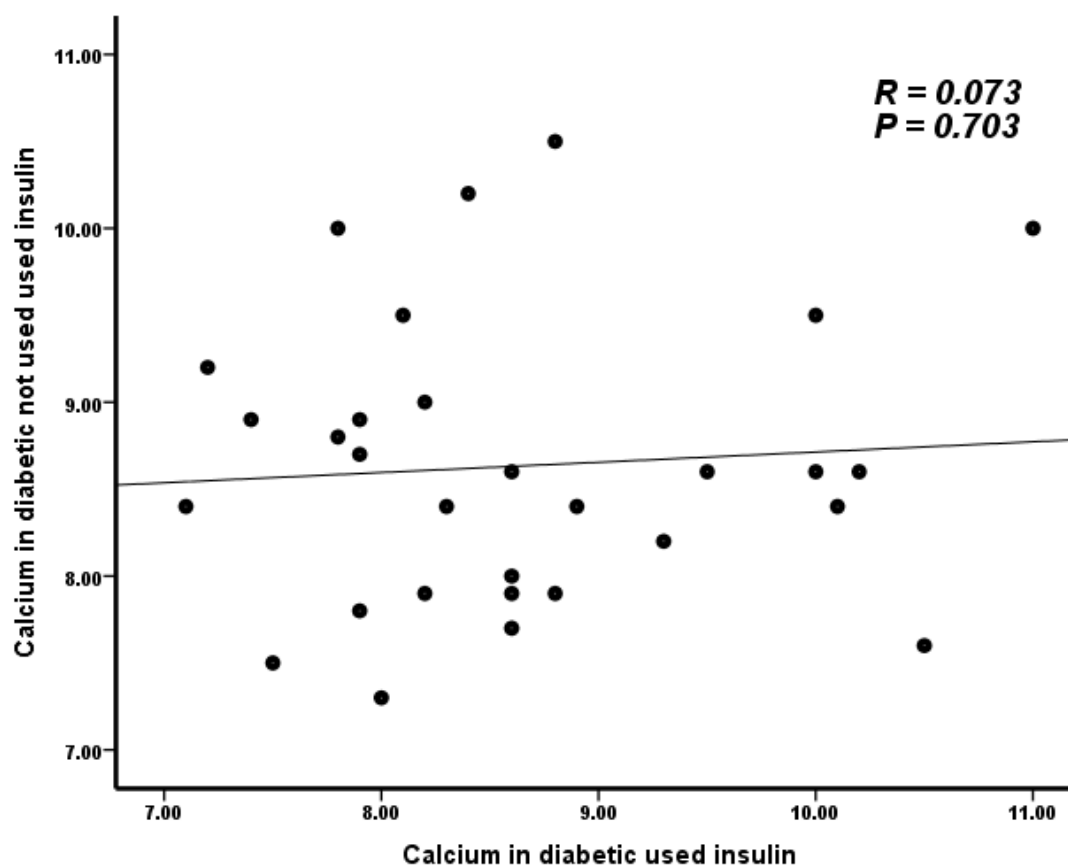
Data was analyzed using SPSS computer program, the mean and standard deviation were obtained and the independent 't.test' used for comparison (p value of ≤ 0.05) was considered significant.

Results:-

In comparison with the controls, diabetic patients (type2) had significantly lower in means serum magnesium and potassium (1.43 ± 0.26 versus 2.10 ± 0.2951 mg/dL), (3.1 ± 0.39 versus 4.10 ± 0.48 mmol/L) p value < 0.05 respectively. There was significant increase in mean of PH in type 2DM compared to control group (7.99 ± 0.06 versus 7.40 ± 0.02) p value < 0.05 . There was insignificant difference in mean serum calcium compared to control group (8.77 ± 1.00 versus 8.79 ± 0.80 , p-value = 0.997) p-value ≥ 0.05 as in table 1.

Table (1):- means comparisons of serum calcium, magnesium, potassium and PH in type 2 diabetes mellitus compared to control group.

Variable	Patients (mean \pm SD) N=60	Control (mean \pm SD) N=60	P-value
Calcium (mg/dL)	8.77 \pm 1.00	8.79 \pm 0.80	0.997
Magnesium(mg/dL)	1.43 \pm 0.26	2.10 \pm 0.29	0.000
Potassium (mmol/L)	3.10 \pm 0.39	4.17 \pm 0.48	0.000
PH	7.99 \pm 0.06	7.40 \pm 0.02	0.000

**Figure (1):-** A scatter plot shows the correlation between calcium level in diabetic patients used insulin and diabetic patients not used insulin ($r=0.073$, $p\text{-value}=0.703$).

There is no correlation between calcium level in diabetic patients used insulin and diabetic patients not used insulin.

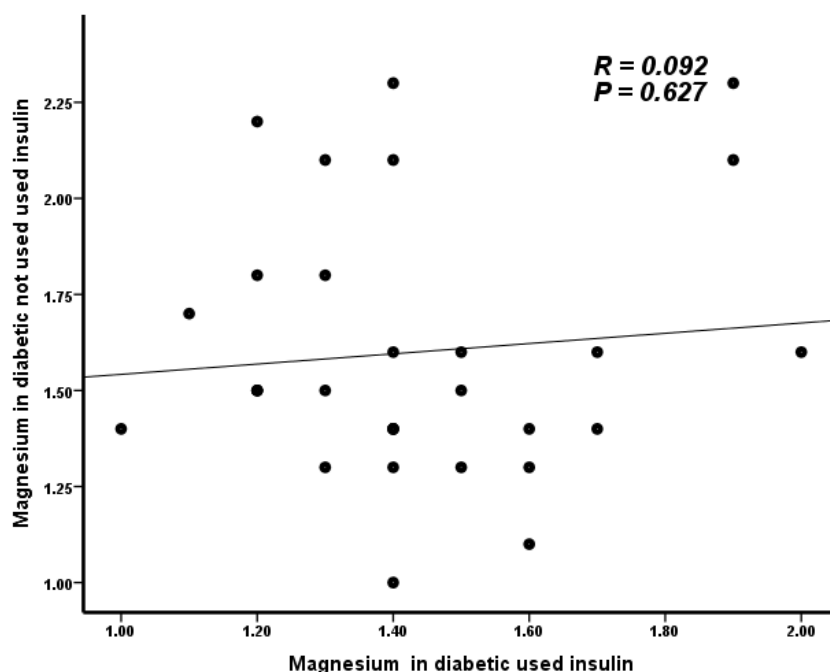


Figure (2):- A scatter plot shows the correlation between magnesium level in diabetic patients used insulin and diabetic patients not used insulin ($r=0.092$, $p\text{-value}=0.627$).

There is weak positive correlation between magnesium level in diabetic patients used insulin and diabetic patients not used insulin.

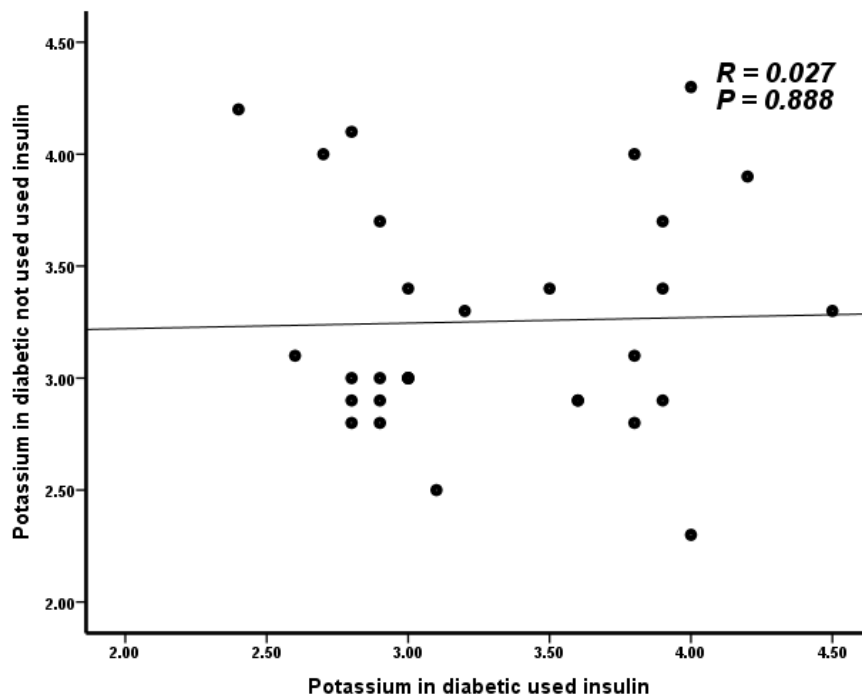


Figure (3):- A scatter plot shows the correlation between Potassium level in diabetic patients used insulin and diabetic patients not used insulin ($r=0.027$, $p\text{-value}=0.888$).

There is no correlation between potassium level in diabetic patients used insulin and diabetic patients not used insulin.

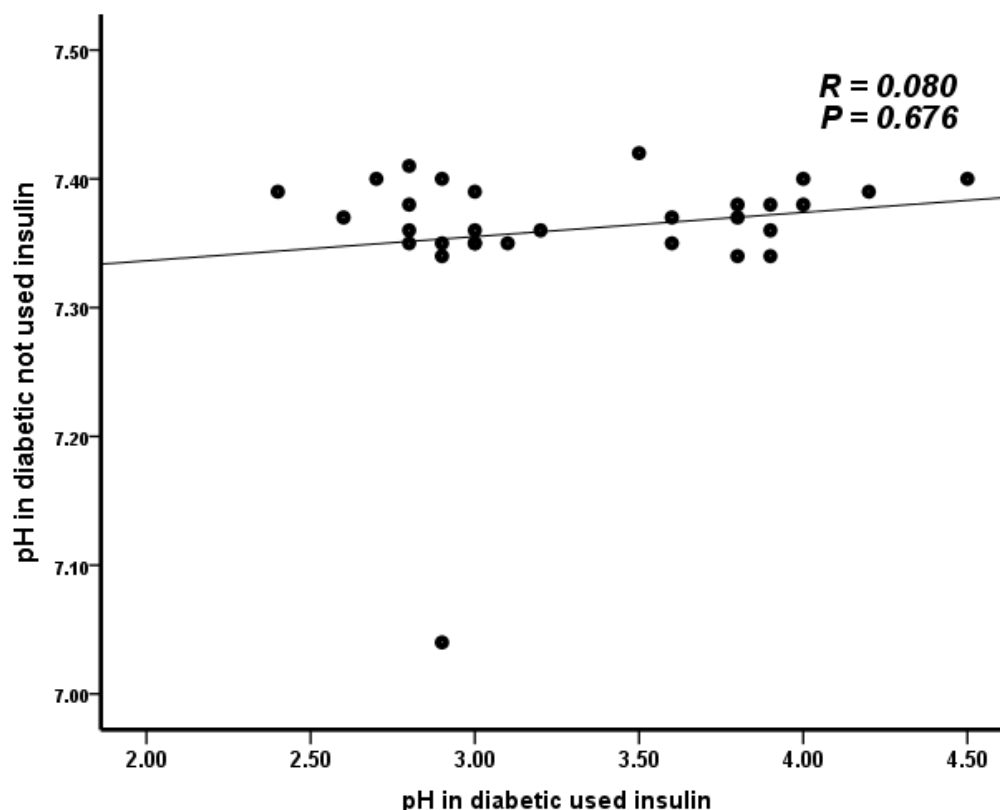


Figure (4):- A scatter plot shows the correlation between pH level in diabetic patients used insulin and diabetic patients not used insulin $r=0.080$, $p\text{-value}=0.676$).

There is no correlation between pH level in diabetic patients used insulin and diabetic patients not used insulin.

Discussion:-

A relationship between DM and minerals is frequently reported. Alteration in the metabolism of trace elements like calcium, magnesium potassium is associated with DM⁽³⁾. Trace elements are accepted as essential for optimum health, because of their diverse metabolic characteristic and functions⁽⁴⁾. Trace elements participate in production of reactive oxygen species (ROS), which contribute to oxidative stress. Oxidative stress contributes to the pathogenesis of many diseases including DM.

Results in this study found that, the serum levels of magnesium and potassium were significantly decreased in diabetic patients compared to control group. This results agree with another results carried by many authors^(13, 14), which finding confirmed that, there were significantly decreased in mean of serum magnesium and potassium in diabetic patients compared to control group, ($p\text{-value} = 0.00$). Also this study was in agreement with another study done by (Puri *et al.*, 2013), which showed hypomagnesaemia and hypokaleamia in diabetic patients and this may be a possible risk factor in development and progress of diabetic complications.

Also the results agree with another result which showed, Hypomagnesemia has been reported to occur at an increased frequency among patients with type 2 diabetes compared with their counterparts without diabetes⁽¹⁵⁾. Hypomagnesemia has been linked to poor glycemic control, coronary artery diseases, hypertension, diabetic retinopathy, nephropathy, neuropathy, and foot ulcerations. This study in agreement with another study, which finding confirm that, hypokalemia may reduce $\text{Na}^+\text{-K}^+\text{-2Cl}^-$ co-transport activity, the associated potassium extrusion through the potassium channel ROMK, and resultant diminution of the favorable trans membrane voltage that is required for paracellular Mg reabsorption. In addition, there is evidence to suggest that cellular potassium depletion may diminish Mg reabsorption at the DCT by yet unclear mechanisms.⁽¹⁶⁾

The result showed, the level of PH was significantly increased ($p\text{-value} < 0.05$) and there was no significant difference between the mean of calcium level in patients and control group ($p\text{-value} > 0.05$).

This result disagreed with another result, which showed Diabetes Mellitus is known to have its effect on almost all body system through alterations in structural and biochemical changes in tissues, alteration in calcium flux may adversely affect the insulin secretion as it is a calcium dependent process.⁽¹⁷⁾

There was insignificantly weak positive correlation between serum magnesium in diabetic patients used insulin and diabetic patients not used insulin ($r = 0.1$, $p = 0.627$). This result in agreement with result carried by researchers at the Institute of Internal Medicine, University of Palermo wrote, "Intracellular magnesium concentration has also been shown to be effective in modulating insulin action (mainly oxidative glucose metabolism). A poor intracellular Mg concentration, as found in noninsulin-dependent diabetes mellitus (NIDDM) and in hypertensive patients, may result in a defective tyrosine-kinase activity at the insulin receptor level."⁽¹⁸⁾ There were no correlations between serum calcium, potassium and PH in diabetic patients used insulin and diabetic patients not used insulin. ($r = 0.073$, p -value = 0.70), ($r = 0.027$, p -value = 0.888), ($r = 0.08$, p -value = 0.676) respectively.

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