



Evaluation of Serum Calcium and Zinc in Hypertensive Diabetic Patients Attending University of Portharcourt Teaching Hospital

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DOI ; <https://doi.org/10.55248/gengpi.07.0926.3119>

ABSTRACT

Hypertension is a major cardiovascular illness worldwide with many underlying causes. Diabetic mellitus is one of the diseases of metabolic syndrome. This study was to compare the level of zinc and calcium in hypertensive diabetic. This study consisted of 25 hypertensive diabetic patients and also 25 control subjects matched for age and sex. Serum concentration of zinc was done using atomic absorption spectrophotometer while calcium estimation was achieved using colorimetric method. Result of this study was expressed as mean and standard deviation. There was a significant ($p < 0.05$) increase in the mean values of calcium of the test group (13.8 ± 2.98 mg/dl) when compared with the control group (8.67 ± 1.19 mg/dl). Also, there was a significant decrease ($p < 0.05$) in the mean values of zinc in test group (0.51 ± 0.37 mg/l) when compared with the control group (0.81 ± 0.26 mg/l). The result from this study revealed that hypertensive diabetic participants had low zinc and high calcium levels. The difference of these trace levels may play an important role in the pathogenesis of this disease by the involvement of these elements in the oxidative stress response.

Keywords: Hypertension, Diabetes mellitus, serum calcium, zinc, diabetic patients and pathogenesis.

Introduction

Diabetes mellitus (DM) is a spectrum of metabolic disorders characterized by elevated blood glucose levels. Clinical features similar to diabetes mellitus were described 3000 years ago by the ancient Egyptians. The term "diabetes" was first coined by Aretaeus of Cappadocia (81-133AD). Later, the word mellitus (honey sweet) was added by Thomas Willis (Britain) in 1675 after rediscovering the sweetness of urine and blood of patients (first noticed by the ancient Indians). It was in 1776 that Dobson (Britain) firstly confirmed the presence of excess sugar in urine and blood as a cause of their sweetness. In modern time, the history of diabetes coincided with the emergence of experimental medicine. An important milestone in the history of diabetes is the establishment of the role of the liver in glycogenesis, and the concept that diabetes is due to excess glucose production. The role of the pancreas in pathogenesis of diabetes was discovered by Mering and Minkowski in 1889. Later, this discovery constituted the basis of insulin isolation and clinical use by Banting and Best in 1921. Trials to prepare an orally administrated hypoglycemic agent ended successfully by first marketing of tolbutamide and carbutamide in 1955 (Zajac, et al., 2009).

Hypertension (HTN), also known as high blood pressure (HBP), is a long-term condition in which the blood pressure in the arteries is persistently elevated (Naish, et al., 2014). It can lead to severe health complications and increase the risk of heart disease, stroke, and sometimes death. The English clergyman Stephen Hales made the first published measurement of blood pressure in 1733 (Kotchen, 2011). William Senhouse Kirkes in 1855 and Ludwig Traube in 1856 proposed, based on pathological observations, which elevated blood pressure could account for the association between left ventricular hypertrophy to kidney damage in kidney disease (Cameron, 2000). However, Samuel Wilks observed that left ventricular hypertrophy and diseased arteries were not necessarily associated with diseased kidneys, implying that high blood pressure might occur in people with healthy kidneys; however the first report of elevated blood pressure in a person without evidence of kidney disease was made by Frederick Akbar Mahomed in 1874 using a sphygmograph. Hypertension as a medical entity really came into being in 1896 with the invention of the cuff-based sphygmomanometer by Scipione Riva-Rocci in 1896, which allowed blood pressure to be measured in the clinic.

Blood pressure is the force that blood exerts against the walls of their blood vessels. This pressure is dependent on cardiac output and systemic vascular resistance. Blood pressure is expressed by two measurements, the systolic and diastolic pressures, which are the maximum and minimum pressures, respectively. For most adults, normal blood pressure at rest is within the range of 100–130 millimeters mercury (mmHg) systolic and 60–80 mmHg diastolic. For most adults, high blood pressure is present if the resting blood pressure is persistently at or above 130/80 or 140/90 mmHg. Different numbers apply to children. (Whelton, et al., 2018).

Hypertension is a common problem in individuals with diabetes mellitus. Both hypertension and diabetes may have some underlying causes in common, and they share some risk factors. They also contribute to a worsening of each other's symptoms. The ways of managing both conditions also overlap. Therefore, diabetes leads to hypertension. (Cheung & Li, 2012).

Calcium is the most abundant metal and the fifth-most abundant element in the human body. As electrolytes, calcium ions play a vital role in the physiological and biochemical processes of organisms and cells: in signal transduction pathways where they act as a second messenger; in neurotransmitter release from neurons; in contraction of all muscle cell types; as cofactors in many enzymes; and in fertilization. Calcium ions outside cells are important for maintaining the potential difference across excitable cell membranes, protein synthesis, and bone formation. (Greenwood & Earnshaw, 2019).

Diabetic patients frequently develop electrolyte disorders, especially diabetic ketoacidosis or nonketotic hyperglycemic hyperosmolar syndrome. Such patients show characteristic potassium, magnesium, phosphate, and calcium depletion. In DM and hypertensive patients, cellular calcium depletion occurs. In type 1 DM, not only is there diminishment of pancreatic B-cells, but both intracellular and intra-endoplasmic reticulum (ER) calcium are depleted. In type 2 DM, intra-ER calcium is depleted, which induces ER stress (Seida, et al., 2014).

Zinc is a metallic chemical element. It has the symbol Zn and atomic number 30. Zinc is the 24th most abundant element in the earth's crust and has five isotopes. Zinc is an essential mineral, including to prenatal and postnatal development (Hambidge, et al., 2007). Zinc deficiency affects about two billion people in the developing world and is associated with many diseases. (Prasad, 2003). In children, deficiency causes growth retardation, delayed sexual maturation, infection susceptibility, and diarrhea. Enzymes with a zinc atom in the reactive center are widespread in biochemistry, such as alcohol dehydrogenase in humans. (Maret, 2013).

Zinc is essential for the normal processing and storage of insulin and altered pancreatic insulin content is associated with all forms of diabetes mellitus. Zinc deficiency is common in people with chronic illnesses such as diabetes and chronic kidney disease. People with low zinc levels are also at a higher risk for hypertension. The way in which the kidneys either excrete sodium into the urine or reabsorb it into the body, specifically through a pathway called the sodium chloride cotransporter (NCC) also plays a role in blood pressure control. (Clintoria, et al., 2019)

Research Methodology

Study area

This study was carried out in University of Port-Harcourt Teaching Hospital (UPTH) which is a major tertiary-care teaching and research facility in Rivers State and is located on East West Road, Port Harcourt Rivers State, Nigeria. UPTH has the Coordinates of 4o53'58"N longitude and 6o55'43"E latitude.

Population of the study

This study was carried out in University of Port-Harcourt Teaching Hospital (UPTH) which is a major tertiary-care teaching and research facility in Rivers State and is located on East West Road, Port Harcourt Rivers State, Nigeria. UPTH has the Coordinates of 4o53'58"N longitude and 6o55'43"E latitude.

Sample collection

Four milliliters (4 mls) of venous blood sample was taken from the antecubital vein of every participant into a plain sterile container (no anticoagulant) and was allowed to clot for 45 minutes. Using an applicator stick, the clotted blood was dislodged and then centrifuged at 2,500 revolutions per minute (rpm) for 5 minutes. The serum obtained was carefully picked using an automatic micropipette and transferred into another plain container, after which it was carefully stored at -200C until ready for analysis.

Validity of the Study

The researcher developed the questionnaire, which was then handed over to the project supervisor. The supervisor applied cognitive scrutiny, thoughtfully analyzing systematically and rationally evaluating the significance of the content and statements within the tool. Following this evaluation, the instrument was deemed valid for use in the study.

Method for Data Analysis

The data generated from this work will be analyzed using Statistical Package for Social Sciences (SPSS) version 24 for windows 7. Results will be presented in tables, expressed as mean $\pm$ standard deviation, and analyzed using independent t-test which shall be used to compare the means, and values considered significant at $p < 0.05$ and non-significant at $p > 0.05$.

Results and discussion

Data generated from this study is presented as mean $\pm$ standard deviation.

Table 1: Mean and standard deviation of the test (Hypertensive Diabetic Patients) and control group (Non-hypertensive diabetic patients)

Parameter	Test	Control	p-value
Calcium (mg/dl)	13.8 $\pm$ 2.98	8.67 $\pm$ 1.19	0.000
Zinc (mg/l)	0.51 $\pm$ 0.37	0.81 $\pm$ 0.26	0.011

In table 1, there was a significant ($p < 0.05$) increase in the mean values of calcium of the test group (13.8 $\pm$ 2.98 mg/dl) when compared with the control group (8.67 $\pm$ 1.19 mg/dl). Also, there was a significant decrease ($p < 0.05$) in the mean values of zinc in test group (0.51 $\pm$ 0.37 mg/l) when compared with the control group (0.81 $\pm$ 0.26 mg/l)

Discussion

The result from this study revealed that hypertensive diabetic participants had significantly low mean zinc (Zn) levels than when compared with normal participants. These results were consistent with a previous study done by Saharia and Goswami, (2013) which also showed low levels of Zn in diabetic patients compared to their controls ($P < 0.001$). This finding also concurred with studies done by Saha-Roy et al. (2014) and Masood et al. (2009). Marchesini et al. (2014) explained that low Zn seen in the diabetic population was due to the decreased gastrointestinal absorption and increased urinary excretion. In one study, the Zn levels were reported as similar in diabetic patients that are hypertensive when compared with and control subjects (Zargar et al., 2012). However, a study done by Mamza et al. contradicted this present study by reporting high Zn levels in diabetic patients that are hypertensive (Mamza et al., 2016).

Also, the result from this study revealed high calcium levels in hypertensive diabetics when compared with normal subjects. This report is in contrast with reports obtained from previous studies Nathan et al., 2015, in their works which demonstrated reduced calcium levels in diabetic patients that are hypertensive. Meanwhile some recent works by Arauz-Pacheco et al., (2014) demonstrated high level of calcium in hypertensive patients that are known diabetics. A potentially important role for calcium status in the development of type 2 DM is suggested by case control. In prospective studies, low-calcium intake is consistently found to be inversely associated with incident type 2 DM or the metabolic syndrome (Parving et al., 2013).

Conclusion

The result from this study revealed that hypertensive diabetic patients had low zinc and high calcium levels. The difference of these trace levels may play an important role in the pathogenesis of this disease by the involvement of these elements in the oxidative stress response.

Recommendations

1. It is recommended that hypertensive diabetic patients should be educated to get checked regularly for trace elements and electrolytes abnormalities.
2. The study also advised that there should be increased consumption of food rich in Zinc such as Shellfish, Meat, Eggs, Whole grains, Cashews, Milk etc so as to improve glucose levels in people with diabetes.
3. It also advised that calcium channel blockers be used as its use is associated with lower fasting serum glucose levels.

References

- Arauz-Pacheco, C., Parrott, M.A. & Raskin, P. (2014). The treatment of hypertension in adult patients with diabetes (technical review). *Diabetes Care* 25,134–147
- Cheung, B. M. Y., & Li, C. (2012). Diabetes and hypertension: Is there a common metabolic pathway. *Journal of medicine* 5(2), 9-15.
- Greenwood, N. N. & Earnshaw, Alan. (2019). *Chemistry of the Elements*. 112.
- Hambidge, K. M. & Krebs, N. F. (2007). Zinc deficiency: a special challenge. *Journal of Nutrition*. 137(4), 1–5.
- Kotchen, T.A. (2011). Historical trends and milestones in hypertension research: a model of the process of translational research. *Hypertension*. 58 (4), 22–38.

- Mamza, Y.P., Abdullahi, Z.A., Gali, R.M., Mshelia, D.S., Genesis, R.Y. & Habu, S.A. (2016). Status of serumzinc and magnesium among type 2 diabetic subjects in Maiduguri. *Journal of Dental Medical Science*.15 (2), 66–70.
- Marchesini, G., Bugianesi, E., Ronchi, M., Flamia, R., Thomaseth, K. & Pacini G. (2014). Zinc supplementation improves glucose disposal in patients with cirrhosis. *Metabolism*. 47,2–8.
- Maret, Wolfgang. (2013). Zinc and the Zinc Proteome. *Metallomics and the Cell. Metal Ions in Life Sciences*. 479–501.
- Masood, N., Baloch, G.H., Ghori, R.A., Memon, I.A., Memon, M.A. (2009). Serum zinc and magnesium in type-2 diabetic patients. *Journal of Coll Physicians Surg Pak*. 19(3),3–6.
- Naish, J. & Court, D.S. (2014). *Medical sciences*. 562.
- Nathan, K.M., Heaney, R.P. & Recker, R.R. (2015). Calcium intake and body weight. *Journal of Clinical Endocrinology Metabolism*. 85(5),4635–4638.
- Parving, H.H., Andersen, A.R. & Smidt, U.M. (2013). Diabetic nephropathy and arterial hypertension. *Diabetologia*. 24,10–12.
- Saha-Roy S, Swati B, Choudhury Kanika M, Santasmita L, Aruna B, Gargi S, et al. (2014). Status of serum magnesium, zinc and copper in patients suffering from type-2 diabetes mellitus. *J Drug DelivTher*. 4(1),10–21.
- Whelton, P.K., Carey, R.M., Aronow, W.S., Casey, D.E., Collins, K.J., DePalma, S.M., Gidding, S. (2018). Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. 71(6), 13–115.
- Zajac, J., Shrestha, A., Patel, P., & Poretsky, L. (2009). The main events in the History of Diabetes Mellitus. *Principles of diabetes mellitus. Journal of internal medicine*. 13(5), 3-16.
- Zargar, A.H., Shah, N.A., Masoodi, S.R., Laway, B.A., Dar, F.A., Khan, A.R., et al. (2012). Copper, zinc, and magnesium levels in non-insulin dependent diabetes mellitus. *Postgrad Med J*. 74(3),5–8.