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Study on association of possible link of ions and insulin resistance in hypertension and diabetes mellitus

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Abstract

To authenticate doubts relating to influence of altered state of some ions in insulin resistance and hypertension we analysed some biomolecules; glucose, insulin, glycated hemoglobin, magnesium, zinc, sodium, potassium and copper from diabetics, non-diabetics and hypertensives. Adopting spectroscopic and immunoassay methods values obtained were statistically evaluated by Anova (Analysis of variance). We observed identical pattern in glucose concentration, glycated hemoglobin and insulin levels among hypertensive and non-hypertensive subjects. However, an aggregated insulin response to glucose was elevated significantly (34.5±3.2 vs 20±2.3 µIU/mL, $P<0.05$). Zinc and magnesium levels were inversely correlated with HbAIc in insulin dependent diabetics and Non-insulin dependent diabetic ($P<0.05$). We observed Values increasing in tandem relationship with hypertension. We conclude that while hypertension and insulin resistance may have differential biochemical precursor, a nexus could be established for the place of ionic interferences in these disorders.

Keywords: Ions; Insulin Resistance; Hypertension Diabetes mellitus

1. Introduction

Observation that there is an association between abnormal glucose metabolism and hypertension has been accorded significant research input with resultant findings that supports clinical recognition [1, 2]. Insulin resistance is identified as a state of reducing action of insulin and considered a specific marker in type 2 diabetics from previous studies [3, 4, 5]. While a consistent pattern exist on observation that insulin resistance may lead to type 2 diabetes and confirmation of insulin resistance in nondiabetic's offspring of type 2 diabetic patients there still exist some doubts. A pertinent unresolved issue in this quagmire is the mechanism underpinning the clinical association in the pathogenesis of diabetes that has not been understood [6, 7]. Research is now veering in the direction of understanding the role elevated insulin can play when there is synergy in glucose intolerance and hypertension. It is now known from previous research that blood pressure levels sometimes corelates positively with circulating insulin level [8].

There is also now awareness that rising insulin levels may contribute to hypertension and cause sodium retention [9]. Diabetes mellitus is now a major metabolic disease that has evaded cure with concomitant complications such as nephropathy, neuropathy, loss of libido and ulceration. Study on trace elements in the body have explained the role played by these ions [10]. They have both regulatory and catalytic functions interacting with enzymes, secretary granules, pro-hormones and biological membranes [11]. Magnesium, zinc and copper are known to play significant roles in metabolism. Zinc enhances the functionality of insulin and magnesium acts as cofactor in enzymes involvement in secretion of insulin [12]. It has been reported in previous studies that a disorder in insulin stimulated glucose transport in human skeletal muscle is responsible for the alteration that causes type 2 diabetic mellitus [13].

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Facts are emerging from previous research works to show that derangement in fatty acid metabolism may result in excessive accumulations of lipids in the liver, muscle and β-cells of the pancreas. Moreover, ectopic lipid deposits is known to be part of precursor in the process of insulin resistance [14]. Excess lipid within myocytes and hepatocytes has been reported to be extensively associated with insulin resistance in diabetics [15]. Moreover, nondiabetic relations of confirmed type 2 diabetics, those having impaired glucose intolerance and those who are obese are susceptible subject for insulin resistance.

This research focus on trace element and evaluation of the probable role they are playing in hypertension and diabetics.

2. Material and methods

Study was carried out at the Diete Cookie Memorial Hospital in Yenagoa, Bayelsa State of Nigeria. Blood samples were collected from 30 patients with hypertension and another 30 patients with diabetes mellitus. Thirty samples were further collected from controls who were normotensive and nondiabetic. All subjects for the study freely gave their consent.

Electrolytes were determined by flame photometry method using corning Flame photometer. Calcium, magnesium, zinc and copper were determined by Atomic Absorption spectroscopy. Enzymes method was used for the determination of glucose using a product of Randox while glycated hemoglobin was assayed by immunoassay method.

3. Results and discussion

Result of trace elements estimated are shown in table 1. Other analytes, glucose, glycated hemoglobin and insulin values are shown in table 2

Table 1 Comparison of Values of trace elements obtained for Hypertension, Diabetes Mellitus with Control

Analyte	Control	Hypertensive	Diabetics
CU(mmol/L)	105±22.4	85±10.3	185±10.3
Mg(mmol/L)	0.53±0.04	0.4±0.02	0.32±0.01
Zn(mmol/L)	13±2.3	9.5±1.32	1.8±0.02
Ca(mmol/L)	2.3±0.4	1.9±0.03	2.0±0.04
Na(mmol/L)	138±8.3	148±12.0	140±12.5
K(mmol/L)	3.8±0.5	4.2±1.1	3.6±0.9

Values are mean ±SEM of triplicate determination P<0.05

Table 2 Values obtained for other Biochemical perameters in Hypertension and Diabetes Mellitus compared with Control

Analyte	Control	Hypertensive	Diabetics
Glucose (mmol/L)	4.3±0.9	6.5±3.3	15±5.8
HbAIC (%)	5.2 ±	4.7±1.2	7.3±2.1
Insulin (μIU/ML)	20.3±2.3	21.3±2.3	34.5±3.2

Value are mean ± SEM of triplicate determination. P<0.05

4. Discussion

Metabolic syndrome is a clinical manifestation that is common. Despite the prevalence rate that is high, the incidence of metabolic syndrome is equally not falling. Although, a generalized criteria is not yet accepted, obesity, hyperglycemia and hypertension are key indicators [16]. Insulin resistance and oxidation stress have been identified as causative factors which have links with changes in trace element metabolism in the body.

In this research, we have evaluated some marker metabolites glucose, insulin and glycated hemoglobin to confirm the diabetes state. Trace elements evaluated includes Cu, Mg Zn, Ca, Na and K. Values obtained from analysis show a derangement in the level of most of these trace elements in hypertension and diabetics when compared with the control subjects. Observed elevation of Cu, Na and K in hypertension and a similar pattern in diabetes mellitus. This observation supports the previous work of [17, 18]. A decrease in Zn level and Mg level were also observed in both hypertension and diabetes in this work.

A unique feature that can be gleamed from this work is that glycated hemoglobin were positively corrected with Cu and inversely correlated with Zn and Mg. Result have shown that diabetes is associated with the alteration in the metabolism of some of these trace elements. Explanation to be offered for reduced Zn concentration could be as a result of elevated level of excretion as it happens in diabetes mellitus. The polyuria, polyphagia and polydipsia in diabetes create elevated osmotic effect in glucosuria [19].

In this study we observed a decrease in the level of magnesium for both hypertensives and diabetics. This was in contrast with earlier work of [20]. Our explanation here may be offered through understanding of the fact that in diabetics impairment of tubular reabsorption of magnesium by glucosuria and hyperglycemia may be contributing factor in the hypomagnesemia that has been observed. Decreased level of magnesium exacerbated the progress of diabetes complications especially in relation with cardiac function, abnormal function of platelets and hypertension as it affects the inositol transport that manifest in intracellular fall [21]. Other complications of reduced magnesium manifest in disordered lipid metabolism, increased inflammation and heart disease.

In the pathogenesis of type 2 diabetes and metabolic syndrome, insulin resistance has been understood to act as a modulator. In the skeletal muscle insulin resistance is shown by decrease in insulin stimulated glycogen synthesis brought about by decreased glucose transport. The metabolic characteristics and relative functions of ions (trace element) are very important in human life. They have multifaceted role acting as catalysts and as regulators interacting with enzymes, biological membranes hormones and pre secretary granules.

5. Conclusion

In conclusion hypertension and diabetics mellitus demonstrates levels of alteration in trace element that contributes to the progress and complications associated with these diseases. Considering the varied complications of diabetics and hypertension, our understanding of the roles of ions (trace elements) in the management of these conditions will strenuously support and enhance health care delivery.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflict of interest.

Satement of ethical approval

Approval for this research was obtained from the Ethical Committees of the Niger Delta University and Diete Cookie Hospital.

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