



Original Article

Assessment of plasma insulin, c-peptide, and blood pressure parameters of type 1 and type 2 diabetes mellitus and diabetic complications

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ABSTRACT

Background: Regardless of the type of diabetes mellitus, there is always a Beta-cell dysfunction leading to absolute insulin deficiency in type 1 diabetes mellitus or associated with insulin resistance in case of type 2 diabetes mellitus.

Materials and Methods: A total of 267 subjects consisting of 164 diabetic patients and 103 non-diabetic apparently healthy individuals were analysed. The plasma insulin and c-peptides levels were determined using enzyme link immunosorbent assay, while plasma glucose level was determined using standard spectrophotometric method.

Results: The biochemical results showed that the mean plasma glucose of Type 1 diabetes (213.65±20.35) and Type 2 diabetes (218.78±7.85) were significantly (P<0.05) higher than that of non-diabetic control (81.88±17.22) mg/dl; the mean plasma glucose and the systolic reading of the Diabetes Mellitus with Nephropathy, hypertension, coronary artery disease, neuropathy, and retinopathy patients were significantly (p<0.05) higher than the control subjects. Among diabetic hypertensive patients mean insulin and c-peptide levels were significantly (p<0.05) lower, while the mean insulin level was insignificantly (p>0.05) lower in diabetic patients with neuropathy or coronary artery disease. No significant (p>0.05) differences was observed in the mean plasma c-peptide level, and diastolic reading of diabetic patient with neuropathy. There were no significant (p>0.05) differences in the mean plasma c-peptide level, systolic and diastolic readings of Diabetic patients with coronary heart disease or retinopathy.

Conclusion: There were significant differences in the blood pressure parameters in both the diabetes mellitus and diabetic complications in this study.

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INTRODUCTION

Diabetes mellitus (“Diabetes”) is a global public health issue which contributes to the large burden of diseases such as cardiovascular disease, chronic kidney disease, and premature mortality and disability.¹

Diabetes mellitus (DM) is a common endocrine metabolic disorder, characterised by hyperglycaemia resulting from variable interaction of hereditary and environmental factors, and is due to the combination of insulin resistance [impairment in insulin-mediated glucose disposal] and defective secretion of insulin by pancreatic β -cells or both.² Insulin is the principal hormone that regulates the uptake of glucose from the blood into most cells (primarily

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muscles and fatty cells but not central nervous system cells). Therefore, deficiency of insulin or the insensitivity to its receptors plays a central role in all forms of Diabetes mellitus. Insulin is released into the blood by beta cells (B-cells) found in the Islets of Langerhans in the pancreas, in response to rising levels of blood glucose after a meal. Insulin is used by about two-third of the body cells to absorb glucose from the blood for use as fuel, for conversion to other needed molecules or for storage as glycogen in the liver and muscle cells. The hormone glucagon acts in an opposite manner to insulin. It stimulates the breakdown of stored glycogen, liver gluconeogenesis and hepatic lipolysis.³

Higher insulin levels increase many anabolic (building up) processes such as cell growth and duplication, protein synthesis and fat storage. If the amount of insulin available is insufficient, or insulin insensitivity or resistance, or insulin itself is defective, then, glucose will not be absorbed properly by those body cells that require it nor will it be stored appropriately in the liver and muscle cells. The net effect is persistent high levels of blood glucose, poor protein synthesis and other metabolic derangements such as acidosis.³ Regardless of the type of diabetes mellitus; there is always a Beta-cell dysfunction. Type 1 DM is characterized by β -cell destruction caused by an autoimmune process, usually leading to absolute insulin deficiency⁵ which eventually results in decreased insulin secretion and a corresponding decrease in C-peptide level which is an index for endogenous insulin secretion and Beta cell function. Type 2 DM is associated with insulin resistance and initially has normal or elevated levels of c-peptide, which can decrease over the course of the disease.⁶ Hypertension occurs two to three times more often with diabetes mellitus than those without diabetes and is a strong risk factor for cardiovascular disease.⁷ Therefore, the assessment of plasma insulin, c-peptide, and blood pressure parameters of type 1 and type 2 diabetes mellitus will improve the management of diabetes mellitus and diabetic complications.

MATERIALS AND METHODS

The study was carried out in Irrua Specialist Teaching Hospital in Edo central and Edo North Senatorial Districts of Edo state, Nigeria, located between approximately Latitude 050 44'N- 070 34'N and Longitude 050 04'E- 060 43'E, covering an estimated area of 20,000 km².

Ethical Approval was obtained from the Research and Ethics committee of Irrua Specialist Teaching Hospital Irrua for this study. Also verbal consent to participate in the study was obtained from the control subjects as questionnaires were given to them to fill the required personal information and data that were necessary for the study (ISTH/ETHICS COM/7). A total number of 267 subjects consisting of 164 Diabetes mellitus subjects within the age range of 23 to 83 years; and 103 apparently healthy individuals within the age range of 20 to 53 years as controls were used for this study.

This was obtained using the 'precise prevalence' formula described by Araoye et al.⁸

A total number of 267 subjects were recruited for this study, of which 164 are diabetes mellitus subjects (type 1- 24 and type 2- 140) and 103 apparently healthy subjects as control group. The diabetic subjects were recruited from both in-patients and out-patients attending diabetic clinic of Irrua Specialist Teaching Hospital, which serves as medical centre for the study location. The selection of diabetic subjects were initially based on the physician's provisional diagnosis and then confirmed by the fasting plasma glucose of more than 126mg/dl or random blood sugar of more than 200mg/dl. The criteria used for separating Type 1 DM from Type 2 DM subjects were based on; first, the clinical classification that included the patients history, age of onset of the DM (< 35 years) and total dependence on insulin therapy alone to achieve normal plasma glucose concentration; and second, the laboratory classification using fasting C-peptide levels of less than 0.38ng/ml (approximately 0.4ng/ml) for Type 1 DM.⁹ The known DM subjects were already on drugs such as insulin and some oral hypoglycaemic agents. Their thyroid conditions were not known. The control subjects were selected from staff and students of Irrua Specialist Teaching Hospital and Ambrose Alli University, Ekpoma respectively who are apparently healthy, and non-diabetic.

ANALYTICAL METHODS

The plasma glucose was determined using the Oxidase-peroxidase method as described by Barham.¹⁰ Plasma insulin was determined using Enzyme Linked Immunosorbent Assay (ELISA).¹¹ Plasma C-peptide was determined using DRG C-peptide ELISA Kit.¹²

RESULTS

Table 1 shows that the mean plasma glucose and the systolic reading of the Diabetes Mellitus with nephropathy (DM-NEPHR), patients were significantly ($p < 0.05$) higher than the control subjects; while the mean insulin, and c-peptide levels were insignificantly ($p > 0.05$) lower in patients with DM-NEPHR than in the control group.

The mean plasma glucose, systolic and diastolic readings of the Diabetic hypertensive patients were significantly ($p < 0.05$) higher than those of control subjects; while the mean insulin and c-peptide levels were significantly ($p < 0.05$) lower than those of the control subjects. The mean plasma glucose and the systolic reading of the Diabetes Mellitus with neuropathy (DM-NEUR) patients were significantly ($p < 0.05$) higher than the control subjects; while the mean insulin level was insignificantly ($p > 0.05$) lower in patients with DM-NEUR than in the control group. There were no significant ($p > 0.05$) differences in the mean plasma c-peptide level, and diastolic reading of DM-NEUR patients when compared with the control group. The mean

Table 1: Comparisons of the mean plasma insulin, c-peptide, glucose concentrations and blood pressure parameters of diabetes mellitus, diabetic complications and control group using analysis of variance [ANOVA]

GROUPS	GLUCOSE Mg/dl	INSULIN Miu/ml	C-PEPTIDE ng/ml	SYSTOLE MmHg	DIASTOLE MmHg
CONTROL (N=103)	81.88±17.22a	13.43±12.82a	9.01±5.95a	115.0±10.69a	73.75±5.18a
TYPE2DM (N=139)	218.78±92.66b	7.50±12.27b	5.68±6.16b	144.63±30.0b	83.81±24.2a
TYPE1 DM (N=23)	213.65±97.55b	6.86±6.91b	4.29±7.22b	129.33±25.7ab	80.67±18.3a
DM-NEPHR (N=30)	233.93±100.3b	10.18±21.7ab	8.70±6.95a	143.63±30.6b	83.25±9.79a
DM-CHD (N=23)	253.61±120.3c	6.28±8.32b	7.55±7.78ab	139.71±32.7ab	79.71±16.77a
DM-NEUR (N=8)	266.25±93.26c	7.17±5.79ab	9.48±8.12ab	146.86±15.5bc	83.71±11.97a
DM-RETIN (N=5)	214.40±98.45b	9.96±12.19ab	4.66±6.79b	121.25±16.5ab	72.50±5.0a
DM ONLY (N=64)	210.14±81.78b	5.56±4.56b	3.63±5.22b	125.0±12.8ab	76.00±6.28a
F-value	29.03	3.36	4.97	4.29	1.71
P-value	0.000	0.010	0.000	0.000	0.100
Remarks	S	S	S	S	NS

plasma glucose levels of Diabetic patients with coronary heart disease (DM-CHD) were significantly ($p<0.05$) higher than those of control subjects; while the mean plasma insulin level was significantly ($p<0.05$) lower in Diabetic coronary heart disease, when compared with the control group. There were no significant ($p>0.05$) differences in the mean plasma c-peptide level, systolic and diastolic readings of Diabetic patients with coronary heart disease, when compared with those of control subjects. The mean plasma glucose levels of Diabetic retinopathy patients were significantly ($p<0.05$) higher than those of control subjects. There were no significant ($p>0.05$) differences in the mean plasma insulin, c-peptide, systolic and diastolic readings of Diabetic Retinopathy patients, when compared with those of control subjects.

DISCUSSION

The results obtained from the study showed significant ($P<0.05$) differences between the DM and non-diabetic control subjects in the mean levels of plasma glucose, insulin, and C-peptides. The plasma glucose levels were significantly ($P<0.05$) higher in DM and diabetic complications than the control subjects. This is in line with the definition of DM by Irvine,¹³ that DM is a group of metabolic disorders that results in hyperglycaemia due to decreased insulin production or inefficient insulin utilization. There were significant [$p<0.05$] decreases in the plasma insulin and C-peptide levels for the DM and diabetic complications when compared with the control subjects. These are expected, as hyperglycaemia is due to decreased insulin production in type 1 DM and inefficient insulin utilization in type 2 DM.¹³ Regardless of the type of diabetes mellitus, there is always a Beta-cell dysfunction. Type 1 DM is characterized by β -cell destruction caused by an autoimmune process, usually leading to absolute insulin deficiency⁵ which eventually results in decreased insulin secretion and a corresponding decrease in C-peptide level which is an index for endogenous insulin secretion and Beta

cell function. It also results in fasting hyperglycaemia.¹⁴ Type 2 DM is associated with insulin resistance and initially has normal or elevated levels of c-peptide, which can decrease over the course of the disease.⁵ Beta-cell functions, as evaluated from plasma c-peptide measurements, is found in all insulin dependent diabetic patients the first months of the disease, and in about 15% of patients with more than 15 years of treatment.¹⁵ The beta-cells are capable of motivating the secretory activities in response to changes in blood glucose. Even a normal residual insulin secretion is of metabolic significance. The systolic blood pressure levels were significantly ($P<0.05$) higher in DM and diabetic complications than the control subjects. The diastolic readings of the Diabetic hypertensive patients were also significantly ($p<0.05$) higher than those of control subjects. This is in line with the report of Kaplan et al.,⁷ that hypertension occurs two to three times more often with diabetes mellitus than those without diabetes and is a strong risk factor for cardiovascular disease.⁷

CONCLUSIONS

In conclusion, the study confirmed a significant decrease of insulin and c-peptide levels in type 1 diabetes and type 2 diabetes mellitus. The study further revealed a significant decrease in levels of insulin and c-peptides in diabetic complications—diabetic nephropathy, diabetic hypertension, diabetes with coronary heart disease and diabetic neuropathy except for diabetic retinopathy. There were also significant differences in the blood pressure parameters in both the diabetes mellitus and diabetic complications in this study.

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Conflict of Interest: None

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