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Acid base disturbances in Type II Diabetes Mellitus

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Abstract:

Aim: To estimate pH, pCO_2, pO_2, bicarbonate (HCO_3^-), Lactate levels in arterial blood of controls and diabetes mellitus type 2 patients. **Material and Method:** 90 subjects above the age of 40 years were participated in the present study, subdivided in **Group 1**: 30 diabetic subjects suffering from diabetes mellitus type 2 as diagnosed by the physician and random plasma glucose < 400 mg/dl. **Group 2**: 30 diabetic subjects suffering from diabetes mellitus type 2 as diagnosed by the physician and random plasma glucose ≥ 400 mg/dl. **Control group**: 30 non-diabetic subjects. Arterial blood samples were collected from radial artery in a heparinised syringe. **Result:** Arterial pH was not significantly increased (>0.05) when Controls (7.405 ± 0.044) were compared with Group 1 (7.38 ± 0.09) but significantly increased (< 0.05) when Controls (7.405 ± 0.044) were compared with Group 2 (7.31 ± 0.11) as well as significantly increased (< 0.05) when Group 1 (7.38 ± 0.09) was compared with Group 2 (7.31 ± 0.11). Arterial pCO_2 was not significantly increased (>0.05) when Controls (39.56 ± 4.50) were compared with Group 1 (36.13 ± 14.20) but significantly increased (< 0.05) when Controls (39.56 ± 4.50) were compared with Group 2 (31.93 ± 9.50) as well as not significantly increased (> 0.05) when Group 1 (36.13 ± 14.20) was compared with Group 2 (31.93 ± 9.50). Arterial pO_2 was not significantly increased (>0.05) when Controls (93.16 ± 5.18) were compared with Group 1 (88.06 ± 7.09) but highly significantly increased (< 0.001) when Controls (93.16 ± 5.18) were compared with Group 2 (81.23 ± 12.96) as well as significantly increased (< 0.05) when Group 1 (88.06 ± 7.09) was compared with Group 2 (81.23 ± 12.96). Plasma HCO_3 was not significantly increased (>0.05) when Controls (22.65 ± 1.58) were compared with Group 1 (20.99 ± 6.72) but significantly increased (< 0.05) when Controls (22.65 ± 1.58) were compared with Group 2 (16.95 ± 5.69) as well as significantly increased (<0.05) when Group 1 (20.99 ± 6.72) was compared with Group 2 (16.95 ± 5.69). Serum lactate was not significantly increased (>0.05) when Controls (1.14 ± 0.38) were compared with Group 1 (1.99 ± 1.21) but significantly increased (<0.05) when Controls (1.14 ± 0.38) were compared with Group 2 (2.68 ± 2.56) as well as not significantly increased (> 0.05) when Group 1 (1.99 ± 1.21) was compared with Group 2 (2.68 ± 2.56). **Conclusion:** Higher degree of hyperglycemia is significantly associated with acid base and electrolyte imbalance in type 2 diabetes mellitus patients.

Keywords : Type II Diabetes Mellitus, pH, pCO_2, pO_2, bicarbonate, lactate

Introduction:

The worldwide prevalence of diabetes mellitus [DM] has risen dramatically over the past two decades. Based on current trends, >360 million individuals will have diabetes by the year 2030.[1] India is first among top 10 countries with highest prevalence of diabetes. With an increasing incidence worldwide, DM will be a leading cause of morbidity and mortality for the foreseeable future.[1] Diabetes mellitus refers to a group of common metabolic disorders that share the phenotype of hyperglycemia. A random plasma glucose concentration ≥ 200 mg/dl accompanied by classic symptoms of DM (polyuria, polydipsia, weight loss) is sufficient for the diagnosis of DM.[1]

Type 2 DM is characterized by impaired insulin secretion, insulin resistance, excessive hepatic glucose production, and abnormal lipid metabolism. In diabetes lipid catabolism increases and is diverted to ketone body formation. Reduced insulin levels, in combination with elevations in catecholamines and growth hormone, increase lipolysis and the release of free fatty acids. Normally, these free fatty acids are converted to triglycerides or VLDL in the liver. However, in Diabetic ketoacidosis, hyperglucagonemia alters hepatic metabolism to favor ketone body formation, through activation of the enzyme carnitine palmitoyl transferase I. This enzyme is crucial for regulating fatty acid transport into the mitochondria, where beta oxidation and conversion to ketone bodies occur. Accumulation of ketone bodies i.e. β hydroxybutyrate and acetoacetate, results in high anion gap metabolic acidosis. Increased lactic acid production also contributes to the acidosis.[1] Lactic acidosis, an acute complication of DM, occurs due to increased rate of anaerobic glycolysis and/or impairment of citric acid cycle.[2]

Materials and Methods:

This study was carried out in the Department of Biochemistry in collaboration with Department of Medicine. The study protocol was approved by the Institutional Ethics Committee of the institute. A total number of 90 subjects above the age of 40 years were participated in the present study. Detailed medical history and relevant clinical examination data and written consent were obtained from all subjects by explaining the study procedure. A total number of 90 subjects above the age of 40 years were participated in the present studies which are further subdivided in to 3 groups; **Group 1:** 30 diabetic subjects above the age of 40 years suffering from diabetes mellitus type 2 as diagnosed by the physician and random plasma glucose < 400 mg/dl. **Group 2:** 30 diabetic subjects above the age of 40 years suffering from diabetes mellitus type 2 as diagnosed by the physician and random plasma glucose ≥ 400 mg/dl. **Control group:** 30 non-diabetic subjects. Arterial blood samples were collected from radial artery in a heparinised syringe. Samples were carried to the laboratory on ice pack and processed immediately for estimation of pH, pCO_2, pO_2, bicarbonate (HCO_3^-) and lactate levels in arterial blood. Statistical analysis was done using ANOVA (one way analysis of variance) test by the Graph Pad Prism software.

Observations and Results:

Table-1: Comparison of arterial pH, partial pressure of carbon dioxide, partial pressure of oxygen, bicarbonate levels in all groups

Parameter	Control (mean±SD)	Group 1 Cases (mean±SD)	Group 2 cases (mean±SD)
Arterial pH	7.405 ±0.044	7.38 ± 0.09	7.31 ± 0.11
Arterial pCO_2 mmHg	39.56 ± 4.50	36.13±14.20	31.93±9.50
Arterial pO_2 mmHg	93.16 ± 5.18	88.06 ± 7.09	81.23±12.96
Plasma HCO_3^- mmol/L	22.65 ± 1.58	20.99 ± 6.72	16.95±5.69
Plasma Lactate mmol/L	1.14 ± 0.38	1.99 ± 1.21	2.68 ± 2.56

Table-2: Significance of arterial pH, pCO_2, pO_2, HCO_3- levels in all groups

Parameter	Control vs group 1	Control vs group 2	Group 1 vs group 2
Arterial pH	>0.05 (NS)	< 0.05 (S)	< 0.05 (S)
Arterial pCO_2 mmHg	>0.05 (NS)	< 0.05 (S)	>0.05(NS)
Arterial pO_2 mmHg	>0.05 (NS)	< 0.001 (HS)	< 0.05 (S)
Plasma HCO_3^- mmol/L	>0.05 (NS)	< 0.05 (S)	< 0.05 (S)
Plasma Lactate mmol/L	>0.05 (NS)	< 0.05 (S)	>0.05(NS)

NS-Not significant, S-Significant, HS-Highly Significant

Discussion:

Diabetes mellitus refers to a group of common metabolic disorders that share the phenotype of hyperglycemia. Classic symptoms of DM are polyuria, polydipsia and weight loss. Diabetes is caused by a complex interaction of genetics, environmental, immunologic and lifestyle factors.[1] Approximately 80% to 90% of diabetic patients have type-2 diabetes. Type-2 diabetes is polygenic and multifactorial. Insulin resistance and impaired insulin secretion are central to the development of type-2 DM. Most studies support that insulin resistance precedes an insulin secretory defect but that diabetes develops when insulin secretion becomes inadequate. [1]

Diabetic ketoacidosis (DKA) and hyperglycemic hyperosmolar state (HHS) are acute complications of diabetes. Accumulation of ketone bodies, β hydroxy butyrate and acetoacetate results in high anion gap metabolic acidosis. Both DKA and HHS are associated with absolute or relative insulin deficiency, hyperosmolarity, volume depletion, acid-base and electrolyte abnormalities.[1]

At physiologic pH, ketone bodies exist as ketoacids, which are neutralized by bicarbonate resulting in depletion of bicarbonate stores.[3] As body tries to compensate for acidosis, compensatory increase or decrease in pCO_2 and bicarbonate levels is observed.[4]

Increased lactic acid production also contributes to the metabolic acidosis in diabetes.[5] Lactic acidosis, an acute complication of DM, occurs due to increased rate of anaerobic glycolysis and/or impairment of citric acid cycle.[2] Increased cellular oxidative stress due to diabetes also leads to increased cellular lactate production.[6] Adipose tissue is responsible for a large portion of the lactate produced in obesity. Among obese subjects, decreased blood flow to adipose tissue leads to local hypoxia and increased lactate production. Furthermore, adipocyte production of lactate increases as adipocyte size increases. There is also evidence that hypoxia drives adipocytokine dysregulation and decreased insulin signaling in adipocytes from obese individuals.[7]

Oxidative capacity may also be decreased in insulin-resistant skeletal muscle as evidenced with increased glycolysis in muscle,[8] decreased mitochondrial size and density, decreased oxidative gene expression, decreased oxidative phosphorylation and decreased aerobic capacity. The decrease in oxidative capacity may account for the markedly altered lactate metabolism in insulin-resistant muscle, where lactate concentration is increased and the lactate-pyruvate interconversion rates are enhanced as much as 3 to 4 fold.[9]

Conclusion:

Diabetes mellitus type 2 patients with higher degree of hyperglycemia (group 2) have shown metabolic acidosis (decreased arterial pH and bicarbonate) and hyperlactetemia.

References:

1. Powers AC. Diabetes Mellitus, in Fausi AS, Braunwald E, Kasper D, Hauser S, Longo D, Jameson J et al, editors. Harrison's principles of internal medicine. 17th ed., New York, McGraw Hill companies 2008:2275-2304.

2. Vasudevan DM, Sreekumari S, Kannan V. Regulation of blood glucose, insulin and Diabetes Mellitus; Textbook of Biochemistry for medical students, 6th ed., New Delhi, JPBMP; 2011:274-91.

3. Discussion in 'Australian Medical Council (AMC) EXAM' started by MMC. Diabetic ketoacidosis (DKA) and hyperglycemic hyperosmolars Apr 14, 2007.

4. Martinu T, Menzies D, Dial S. Re-evaluation of acid-base prediction rules in patients with chronic respiratory acidosis. Can Respir J 2003; 10(6):311-5.

5. Watkins PJ, Smith JS, Fitzgerald MG, Malins JM. Lactic Acidosis in Diabetes. Br Med J. 1969;22(1):744-47.

6. Maiese K. Diabetic stress: new triumphs and challenges to maintain vascular longevity. Expert Rev Cardiovasc Ther. 2008;6(3):281-4.

7. Goossens GH, Blaak EE. Adipose tissue dysfunction and impaired metabolic health in human obesity: A Matter of Oxygen? Front Endocrinol (Lausanne) 2015;6:55.

8. Muhammad A, Ghani A, DeFronzo RA. Pathogenesis of Insulin Resistance in Skeletal Muscle, Journal of Biomedicine and Biotechnology 2010:19.

9. Stephen OC, Ron CH, Frederick LB, Brad CA, Christie MB. Association of blood Lactate with type 2 diabetes: the atherosclerotic risk in communities, carotid MRI study [Oxford university press on behalf of International epidemiological association 2010 internet] Int J Epidemiol 2010;39(6):1647-55.