ASSESSMENT OF BLOOD LACTATE LEVELS AND ITS CORRELATION WITH STRENUOUS EXERCISE IN MALE ATHLETES WITH TYPE 2 DIABETES MELLITUS (T2DM)

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ABSTRACT

In athletes with Type 2 Diabetes Mellitus, exercise regiments are very important, as minor deviation could cause release of biochemical radicals and lactate over-production. Therefore proper exercise, viz aerobic, resistance or combined is suggested to help in control of glycemia in T2DM patients. Present study reports the assessment of blood lactate concentrations in athletes with controlled type 2 diabetes mellitus, who exercise regularly. Post-exercise 1 h level of lactate was high, 21.4 ± 12.55 ($P < 0.05$), which was gradually decreased and significantly normalized to 3.15 ± 1.10 ($P < 0.001$) mg/L within 6 h. Enzymes LDH and CK/CPK also normalized gradually within 6 h ($P < 0.05$) in addition to glucose levels which declined from 110 mg/dL (post 1h) to level of 85 mg/dL (post 6 h $P < 0.05$). It was concluded that for muscle activity and oxidative metabolism in T2DM athletic individuals, regular exercise regulates glycemic control by increasing intermittent lactate concentration and activates antioxidant enzymes, which consequently controls reduction of Reactive oxygen species (ROS) production such minimizing muscle and cellular damages.

Key Words: Hyperlactatemia, lactate, glycemic control, type 2 diabetes mellitus, T2DM

INTRODUCTION

It is a known fact that sites of lactate production and utilization are muscles (Asano et al., 2014; Miller et al., 2002; Huang et al., 2018). Several studies documented that moderate to high-intensity exercises cause overproduction of lactate by the body muscle, and the condition known as hyperlactatemia (Asano et al., 2014; Huang et al., 2018; Miller et al., 2002). Thus lactic acidosis or hyperlactatemia are clinically noted as potential marker of inadequate oxygen perfusion, mostly in patients with uncontrolled diabetes mellitus, critical care individuals or patients with pulmonary anomalies. Factually, complex etiological factors are the basis of hyperlactatemia such as tissue hypoxia, pulmonary abnormalities, Ischemic shock, low levels of hemoglobin, T2DM and generalized an-aerobic conditions (Luft et al., 2001; Mak et al., 2016; Mustafa et al., 2003; Okorie et al., 2011). In hypoxic state body continue to receive oxygen through an-aerobic glycolytic pathway, thus increasing production of lactate[6]. However in healthy individuals, overproduction of lactate is adjusted through balance between production and clearance (Jabbari et al., 2013; Khoravani et al., 2009). Moreover, in athletes with T2DM, following prescribed exercise regiments are very important, as minor deviation could cause release of biochemical radicals and lactate over-production (Heden et al., 2017; Huang et al., 2018; Miller et al., 2002). Proper exercise, viz aerobic, resistance or combined is suggested to help in control of glycemia in T2DM patients (Asano et al., 2014; Colberg et al., 2010; Hiyane et al., 2006). Present study described the assessment of blood lactate concentrations in those individuals who are athletes, patients of controlled type 2 diabetes mellitus, regularly participates in sprinter, volleyball, football, tennis games and exercise regularly.

MATERIAL AND METHODS

Selection of study group and Research Design:

It's an observational prospective study conducted at Departments of Biochemistry Laboratory services & Chemical Pathology, Liaquat National Hospital, Karachi and Department of Physical Education, Karachi, for the period Dec 2017 to Dec 2018. Demographic data of all athletes were collected and documented through review their cases, files, HIMS and LIS and categorized accordingly. Inclusion criteria was dependent on history of diabetes > 2 years and age > 25 yrs and < 36 years. Athletes with multiple surgeries, < 25 yrs and > 36 yrs, missing history of co-

morbid and who do not exercise regularly were excluded. Data of a total of 65 athletes were reviewed, out of which only 44 (n = 44), all males, were documented as per availability of all demographic data, T2DM information, follow medication of diet recommendation, exercise regularly and participate in games, including availability of complete and relevant biochemical parameters. Age-matched 20 male T2DM individuals, who don't exercise were taken as control group.

Analytical methods

Blood samples were analyzed for lactate and other biochemical parameters such as uric acid, creatinine, albumin, magnesium, calcium, phosphorus, lactate dehydrogenase, creatinine kinase and sugar according to the methods described earlier (Alam *et al*., 2012; 2014; Matinuddin *et al*., 2015). Pre-exercise and Post-exercise blood sample analyses were performed 1-6 hrs (each h) after completion of their routine- average of 30 minutes on static-bicycle and light-pushups (3 rounds of 5 each). Normal ranges for biochemical parameters are; Glucose 120-180 mg/dL; lactate 4.5-19.8 mg/dL, urea < 50 mg/dl; creatinine 0.5-1.5 mg/dL; albumin 3.4-4.8 gm/dL; magnesium 1.70-2.55 mg/dL; calcium 8.6-10.2 mg/dL; phosphorus 2.5-4.5 mg/dL; Lactate dehydrogenase (LDH) < 480 IU/L; Creatinine Kinase (CK) < 192 IU/L; sugar 80-160 mg/dl. Data is reported as mean ± SD.

Statistical analysis

Biochemical parametric data of pre-exercise and 1-6 h post-exercise was categorized, compared and analyzed by SPSS ver 20.0. ANOVA was performed and difference in means was followed by Duncan Muliple Range Test at $P < 0.05$.

RESULTS

Results are summarized in Table 1 and 2. Athletes (all Males), n = 44, average age 28.45 ± 10.25 yrs, were selected for current study with 5 individuals having previous history of co-morbid other than T2DM. Their pre-exercise Lactate level (pre-exercise) was 3.50 ± 1.50 mg/dL. Post-exercise 1 h level of lactate was 21.4 ± 12.55 ($P < 0.05$), which was gradually decreased and significantly normalized to 3.15 ± 1.10 ($P < 0.001$) mg/L within 6 h. Enzymes LDH and CK/CPK also normalized gradually within 6 h ($P < 0.05$) in addition to glucose levels which declined from 110 mg/dL (post 1h) to level of 85 mg/dL (post 6 h $P < 0.05$). Urea, albumin, magnesium, calcium and phosphorus exhibited non-significant variation except creatinine which showed mild elevation 1 hr post exercise (Table 2).

Table 1. Pre-Exercise demographic and biochemical characteristic of T2DM athletes.

Parameters	**Data, Mean ± SD**
Athletes (all Males)	*n* = 44
Age	28.45 ± 10.25
Gender	--
History of previous co-morbid other than T2DM	05
Lactate levels (pre-exercise) (mg/dl)	3.50 ± 1.50
Pre-Exercise biochemical characteristics	
Urea (mg/dl)	16.15 ± 3.5
Creatinine (mg/dl)	0.84 ± 0.03
Albumin (g/dl)	3.80 ± 0.80
Magnesium (mg/dl)	2.25 ± 0.85
Calcium (mg/dl)	8.90 ± 3.50
Phosphorus (mg/dl)	3.30 ± 1.55
LDH (IU/L)	225.55 ± 22.55
CPK/CK (IU/L)	120.40 ± 20.75
Glucose (mg/dl)Random	145.50 ± 27.60

Results are expressed in mean ± SD

Table 2**.** Post-Exercise (1-6 h) biochemical characteristic of T2DM athletes.

Parameters	**1 h**	**2 h**	**3 h**	**4 h**	**5 h**	**6 h**	**LSD $_{0.05}$**
Lactate level (Post-Exercise) mg/dl	21.4 ± 12.55a	15.25 ± 6.40b	10.70 ± 5.25c	7.35 ± 4.10d	5.85 ± 2.10d	3.15 ± 1.10e	1.78
Post-Operative biochemical characteristics							
Urea (mg/dL)	15.0 ± 10.60a	14.10 ± 6.35a	13.55 ± 5.65ab	13.10 ± 6.55a	12.45 ± 4.35bc	11.10 ± 4.05a	1.77
Creatinine (mg/dL)	1.20 ± 1.25a	1.11 ± 0..95a	0.85 ± 0.80a	0.80 ± 0.40a	0.75 ± 0.10a	0.70 ± 0.10a	0.73
Albumin (g/dL)	3.68 ± 0.85a	3.60 ± 0.90a	3.10 ± 0.95a	3.45 ± 0.85a	3.75 ± 0.75a	3.81 ± 0.60a	1.78
Magnesium (mg/dL)	2.50 ± 0.75a	2.65 ± 0.85a	2.55 ± 0.80a	2.45 ± 0.75a	2.40 ± 0.70a	2.40 ± 0.65a	1.78
Calcium (mg/dL)	8.4 ± 4.30a	8.50 ± 3.40a	8.55 ± 2.50 a	8.60 ± 3.65a	8.70 ± 3.35a	8.85 ± 3.60a	1.78
Phosphorus (mg/dL)	3.5 ± 2.35a	3.40 ± 1.35a	3.35 ± 1.40a	3.30 ± 1.55a	3.32 ± 1.45a	3.30 ± 1.65a	2.28
LDH (IU/L)	299.70 ± 68.55a	280.15 ± 60.75b	275.25 ± 55.40c	260.35 ± 54.70d	255.20 ± 50.30e	230.55 ± 55.10f	1.78
CPK/CK (IU/L)	185.55 ± 40.35a	160.10 ± 35.60b	150.10 ± 30.65c	135.55 ± 25.75d	130.30 ± 22.8e	122.45 ± 25. 45f	1.78
Glucose (mg/dL) Random	110.25 ± 57.30a	101.10 ± 45.65b	100.30 ± 35.60bc	98.75 ± 40.10c	90.80 ± 28.50d	85.10 ± 38.95e	1.78

Results are expressed in mean ± SD; Similar letters are non significant according to Duncan Multiple Range Test in each row at $P < 0.05$.

DISCUSSION

Present study described the assessment of lactic acidosis or hyperlactatemia, post-exercise, in athletes with T2DM. Lactate was determined after athletes went through exercise regiments of 30 minutes on static bicycle. Lactate levels, however, were normally determined in critical care patients or individuals abnormal glycemic control with to monitor development of lactic acidosis (Attana *et al*., 2012; Hajjar *et al*., 2013; Mak *et al*., 2016). Results showed increase in Lactate levels post-exercise (1 hr at highest peak) which was then subsided gradually to normal levels within 3 hrs to 6 hrs. Lactate levels also corresponded proportionally with glucose levels as well, same goes for LDH and CPK, enzyme for lactate and muscle activity, respectively.

Previous studies reported that moderate to intense exercise increases lactate levels that coincided with glucose levels catabolism (Asano *et al*., 2014; Heden *et al*., 2017; Huang *et al*., 2018; Miller *et al*., 2002). The conclusion supports our results as well, where lactate increase was noted 1 h post-exercise from glucose 145 mg/dL (pre-exercise) to 110 mg/dL and lactate 3.50 mg/dL (pre-exercise) to 21.40 mg/dL, respectively. Further earlier research concluded that during moderate to intense exercise, and in case of T2DM cases as well, blood lactate is in competition with blood glucose for oxidative metabolism (Asano *et al*., 2014; Huebschmann *et al*., 2012; Kemppainen *et al*., 2002; Miller *et al*., 2002). Moreover, this intermittent elevation of lactate during exercise spares blood glucose for more crucial body functions such as neuronal, functioning as a valuable oxidative substrate (Asano *et al*., 2014; Colberg I., 2010; Hiyane I., 2006; Miller *et al*., 2002).

More recent reports corroborated our findings of gradual reduction of glucose concentration proceeding to 30 minutes continuous exercise, mostly after 2-4 h with significant increase in lactate concentration just 1hr post exercise (Erickson *et al*., 2017; Huang *et al*., 2018; Revdal *et al*., 2016). The corroboration and correlation indicated

that timings and type of exercise in T2DM individuals might influence glycemic controls. Moderate and intense exercises recently gained its clinical importance, mostly in patients with T2DM (Cassidy *et al*., 2017). Several related pilot study and case control cohorts revealed and supported the importance of controlled-intense exercise for better glycemic control (Gillen *et al*., 2012; Karstoft *et al*., 2014).

It was reported that when a 30 minutes exercise was performed, glucose metabolism was facilitated, stabilizing post-feed and post-exercise glycemic fluctuations (Cassidy *et al*., 2017; Frontoni *et al*., 2013; Monnier *et al*., 2006), which in turn manages metabolic oxidations in individual with T2DM. Furthermore, acute and regular exercise, mostly by individuals with T2DM and athletic, activates antioxidant enzymes, which consequently controls reduction of Reactive oxygen species (ROS) production (Cassidy *et al*., 2017; Frontoni *et al*., 2013; Monnier *et al*., 2006).

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