Original Research Article

The relationship between serum lactate and VO_2/VCO_2 in patients undergoing coronary artery bypass grafting in Ardabil city hospital, 2017

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ABSTRACT

Background: VO_2/VCO_2 ratio and blood lactate are different indices of adequacy of oxygen delivery to oxygen needs. The aim of this study was to investigate the relationship between serum lactate and VO_2/VCO_2 in patients undergoing CABG in Ardabil city.
Methods: This descriptive-analytical study was performed on 30 patients who underwent CABG at Ardabil city hospital during 2017. Demographic data of patients including age and sex were collected. Standard monitoring included electrocardiogram, invasive arterial pressure, pulse oximetry, end tidal carbon dioxide, temperature and urine output was done. The CAB was carried out through a CPB pump at the time of grafting. Blood lactate and VO_2/VCO_2 were measured in 3 groups of patients based on number of grafts, EF and serum Creatinine. Collected data analyzed by statistical methods in SPSS version 19.
Results: Most of patients were male (86.7%). The mean age of patients was 58.1 years. The blood lactate and VO_2/VCO_2 values increased after surgery. There was no statistically significant difference in two groups based on number of grafts and serum Cr but it was statistically significant based on E/F. There was a significant correlation between Blood lactate and VO_2/VCO_2 ratio in patients.
Conclusions: The results showed that blood lactate as an indicator for patients status during CABG surgery can be replaced with VO_2/VCO_2.

Keywords: VO_2/VCO_2, Blood lactate, Coronary artery bypass graft

INTRODUCTION

Cardiovascular disease is a major public health problem in the world and in developing countries and the highest mortality rate in the world is due to heart disease.[1] According to the Iran ministry health statistics, cardiovascular diseases with more than 35% are known as the most important factor for mortality. Also increased serum lactate during cardio-pulmonary bypass is associated with high mortality and cardiac complications up to 20%.[2] CABG is known as one of the most effective methods for treating coronary artery disease.[3] Today,

CVD accounts for about 30% of all deaths worldwide which is close to 40% in high income and 28% in low income countries.[4] Today, many of the ischemic problems can be improved by angiography and PCI but there are still indications for CABG. In many studies, it has been shown that CABG surgery increases the survival of life in the long-term and it is the standard treatment for Unprotected Left Main Coronary.[5,6] In recent studies, measure VO_2/VCO_2 and its comparison with blood lactate levels have been considered as a safe factor for gravit performance index. As you know, hypoperfusion is caused by a defect in the circulatory cycle and in a

direction by the lack of oxygen supply to tissues and the collapse of the supply and demand for tissue. Studies have shown that by increasing the collapse of the balance, the progress towards organ defects and death is more.[7]

Central venous oxygen saturation and lactate rate have been used as indicators for circulatory failure and it can be repeatedly checked by physicians as a guide to the treatment route.[8-10] In recent studies, the change in these data was a satisfactory indicator of the occurrence of a problem especially the problem of CABG in high risk patients.[11-13]

The degree of hemodynamic compatibility during cardiac surgery, is a reflection of the complications that can occur after surgery and it can be estimated by measuring Vo2, Vco2 and its ratio. It has been shown that the amount of oxygen saturation of the intravenous influences the short and long term results in patients with heart diseases in entering ICU after surgery. Therefore considering the higher statistics of high risk patients and the higher rate of CABG in high risk patients in Iran and the role of these measurements in order to find out the problem and the limitation of this study done, the aim of this study was to investigate the relationship between serum lactate and VO_2/VCO_2 in patients with CABG.

METHODS

This descriptive analytical study was performed on 30 patients who underwent CABG in Ardabil city hospital. The inclusion criteria was measuring EF at least one time within 6 weeks before surgery and the exclusion criteria was age <18 years, heart arrest during surgery , bulky bleeding during surgery, having a ventricular, arrest or heart attack, platelet count below 100,000 cells/mm^3 immediately before surgery.

All patients underwent general anesthesia with endotracheal intubation and controlled ventilation. Demographic data of patients including age and sex were collected. Standard monitoring included electrocardiogram, invasive arterial pressure, pulse oximetry, end tidal carbon dioxide, temperature and urine output were done. The coronary artery bypass was carried out through CPB pump at the time of the graft. Left inner mammary arteries were taken for grafting the left anterior descending arteries and other vessels using plain vein stents. Arterial blood lactate levels and oxygen levels and CO_2 expulsion were measured. Blood lactate and VO_2/VCO_2 were compared in three groups of patients depending on EF ≥45% or EF >45%, the counts of grafts (≤3 or> 3) and creatinine <1.5 mg/dl or >1.5 mg/dl. The effect of blood lactate and the ratio of VO_2/VCO_2 was studied on ICU hospitalized time. Data were analyzed by SPSS version 19 using descriptive and analytical statistical methods. Pearson correlation was used to determine the relationship between serum lactate level and VO_2/VCO_2 ration in patients.

RESULTS

The average age of patients was 58.1 years in range of 43-79 years. 26 (86.7%) of patients were male and 4 (13.3%) were female. Of all patients, 24(80%) had normal serum lactate and 6 (20%) had high blood lactate. The average serum lactate of patients was 0.8 m mol/l. Of all patients, 50% had normal ratio of VO_2/VCO_2 and 50% had disturbed VO_2/VCO_2. The average scores for the patient's VO_2/VCO_2 were 0.95. Of all patients, 36.7% had EF≤45% and 63.3% had EF >45%. The average EF scores of patients were 47%. Of all patients, 83.3% had CR≤1.5 and 16.7% had CR >1.5. The average CR scores of patients were 1.27. The duration of hospitalization in 53.3% of the patients was 3 days and in 46.7% was 4 days. The average length of hospitalization was 3.46 days. 46.7% of the patients in the case group had graft count ≤3 and 53.3% had >3 and the average number of graft in patients was 3.06. There was a positive and direct relationship between serum lactate levels and VO_2/VCO_2 ratio (r=0.63, p=0.001). It can be said that with increasing serum lactate levels, the ratio of VO_2/VCO_2 also increases and vice versa (Figure 1). 15 people (50%) had normal blood lactate and VO_2/VCO_2 (Table 1). Of patients with normal blood lactate, 11 patients (45.8%) had the graft count ≤3 (Table 2). The relationship between serum lactate and number of grafts and also the relationship between VO_2/VCO_2 and the number of graft in patients with CABG was not statistically significant. 9 patients had normal blood lactate and EF≤45 and 15 patients had normal blood lactate and EF>45 (Table 3). There was a positive correlation between serum lactate and EF (r=0.435) which can be said by increase the EF levels the serum lactate levels was increased and vice versa (Figure 2). There was a positive and significant correlation between VO_2/VCO_2 and EF (r=0.733). It can be stated that by increasing the Vo2/Vco2 in patients we will see an increase in the EF and vice versa (Figure 3). The relationship between serum lactate and VO_2/VCO_2 with serum CR in CABG patients was not statistically significant.
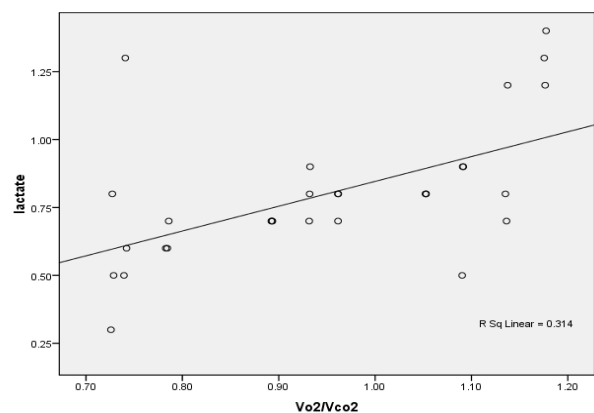

Figure 1: Correlation between VO_2/VCO_2 scores and serum lactate.

Table 1: Relation between serum lactate levels and VO$_2$/VCO$_2$.

Variables		Vo2/Vco2		Total	
		Normal	Non-normal	n	%
Serum lactate	Normal	15	9	24	80
	Non-normal	0	6	6	20
Total	n	15	15	30	100
	%	50	50		

Table 2: Relation between serum lactate levels and VO$_2$/VCO$_2$ by number of grafts.

Variables		Number of grafts		Total	
		≤3	>3	n	%
Serum lactate	Normal	11	13	24	80
	Non-normal	3	3	6	20
Total	n	14	16	30	100
	%	46.7	53.3		
Vo2/Vco2	Normal	9	6	15	50
	Non-normal	5	10	15	50
Total	n	14	16	30	100
	%	46.7	53.3		

Table 3: Relation between serum lactate levels and VO$_2$/VCO$_2$ by EF.

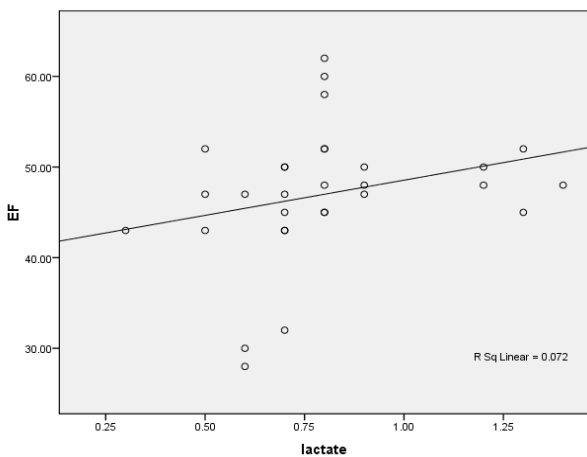| Variables		EF		Total	
		EF≤45%	EF>45%	n	%
Serum lactate	normal	9	15	24	80
	Non-normal	2	4	6	20
Total	n	11	19	30	100
	%	36.7	63.3		
Vo2/Vco2	normal	4	11	15	50
	Non-normal	7	8	15	50
Total	n	11	19	30	100
	%	36.7	63.3		

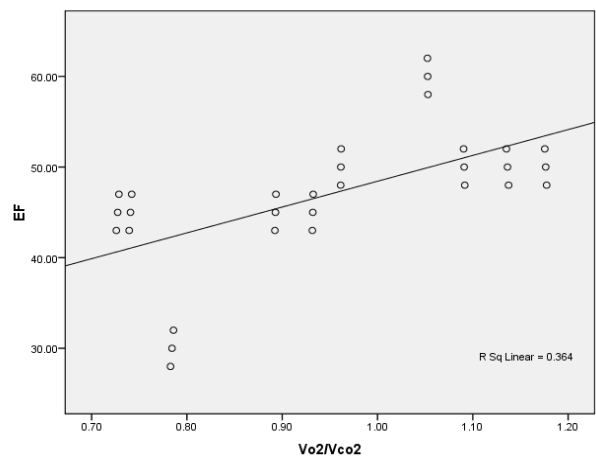**Figure 2: Correlation between EF scores and serum lactate.**

Figure 3: Correlation between EF scores and V VO$_2$/VCO$_2$.

DISCUSSION

In this study most of patients were male (86.7%). The average age was 58.1 in range 43 and 79 years. In the study of Laine et al, the average age of patients was 68 years and most of them were male (79.5%).[14] In the study of Heinz et al, 18 of patients were male and the average age was 69 years.[15]

36.7% of patients had EF≤45% and the average EF scores of patients were 47%. In a similar study, Kamalakkannan showed that the number of patients with EF>45% were 60%.[7] In this study the value of blood lactate after surgery was increased compared to baseline. Blood lactate levels in patients with EF>45% were slightly higher than those with a EF≤45%. The amount of mixed Vo_2 in postoperative patients was reduced. However the amount of mixed VO_2 was higher in patients with EF>45%. There was no significant difference between the two groups in terms of blood lactate and VO_2.

83.3% of patients had CR≤1.5 and CR average of patients was 1.27. In the study of Kamalakkannan, the number of patients with Cr≤1.5 mg/dl was 90% which was in line with our study results. The levels of lactate measured in both groups were high 2.588 mmol/l vs 2.266 mmol/l).The amount of mixed Vo2 was reduced in both groups after surgery. There was a statistically significant difference between the two groups in terms of blood lactate level after grafting. No significant difference was found between two groups in the levels of VO_2.[7]

The duration of hospitalization in 53.3% of patients was 3 days and the mean hospital stay was 3.46 days .In the study of Kamalakkannan, the results of hospitalization in ICU were measured. The number of patients with blood lactate levels ≤3 was 80%. In both groups, the duration of hospitalization and ventilation wasn't different. The number of grafts in 46.7% of the patients was ≤3 and in 53.5% was >3. In the study of Kamalakkannan, the number of patients with graft number more than 3 were 37.7%. Blood lactate increased in both groups after surgery. The levels of mixed VO_2 decreased in both groups after surgery but there was no significant difference in blood lactate and VO_2 in both groups.[7] A study by Holm et al, results showed that the best cut off point for mortality during 30 day due to heart failure and venous oxygen saturation was less than 60.1%, with a sensitivity of 59.3% and a specificity of 82.4%. The negative predictive value was reported about 99.5%. Mortality and complications after surgery were also significantly higher in patients with oxygen saturation of the venous mixture <60% and includes myocardial infarction, renal failure, stroke, re operation or bleeding, duration of stay in the ICU and the duration of ventilation.[16]

In a study by Marco Ranucci, in infants undergoing CABG, the results showed that central venous oxygen measurement alone has a high prognosis value for disease not for mortality.[17]

The combination of blood lactate measurement with central venous oxygen saturation has a high sensitivity and specificity for mortality and morbidity forecast.[15] Ozgoz and et al in a study showed that the high serum lactate levels were associated with the worse postoperative outcomes following on-pump CABG which wasn't in line with our study results.[18]

In the study of Kamalakkannan et al, the amount of oxygen saturation of the venous mixture decreased in all groups of patients from baseline to after surgery. This can lead to increased oxygen demand and extraction. In this study, the duration of ventilation and hospitalization in ICU depended to other factors such as age, pre operative cardiac function, concomitant illness and severity of disease . In a similar study, Engoren et al reviewed 20 patients under the cardiopulmonary bypass, the levels of lactic acid, oxygenated (VO2) and produced carbon dioxide (VCO_2) were measured.[19] According to the results of this study, the levels of lactate were not correlated with the levels of oxygen and carbon dioxide measured . This is a different result of our study, perhaps the reason for this difference due to sample size, type of surgery and the time of measurement of variables. However the study Engoren showed that VO_2 and VCO_2 did not change during the pulmonary artery bypass. Also, there was no relationship between VO_2 and lactic acid levels. In a similar study by Heinz et al, there was no correlation between arterial VCO_2 pressure SVO_2 arterial lactate.[15] In a study by Laine et al, the subsequences were compared in several patterns and it was shown that there was no significant difference in postoperative complications and hospitalization time in the ICU.[14] However patients with lactate ≥4 mmol/l and ScVo2≥70% had a significantly longer duration of hospitalization in ICU and hospital, duration of ventilation and higher prevalence of complications. In this study, it has been shown that increased levels of lactate higher than 4 mmol/l can be used as an independent predictor for major complications. One of the significant differences between our study with previous studies is the lactate cut- off point ,in many studies the cut-off point of 2 or 3 mmol/l was considered to determine the relationship between lactate and tissue perfusion and postoperative complications and also the number of measured times and their time were varied.

CONCLUSION

The results showed that blood lactate as an indicator for patients status during CABG surgery can be replaced with VO_2/VCO_2. In any case, early detection of abnormal amounts and suitable management, can improve the patients subsequences which can be effective on complications and mortality after surgery. It is suggested that future studies be carried out on a wider scale with a

larger sample size on a wider range of patients and in different surgeries.

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