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Hyperlactatemia after Cardiac Surgery as a Prognostic Risk Factor

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Abstract: ***Background: Elevated blood lactate level after cardiac surgery is an indicator of systemic hypoperfusion and tissue hypoxia. Our aim of the study was to evaluate the relationship between postoperative blood lactate levels and outcome in patients undergoing open heart surgery and to verify the clinical impact of hyperlactatemia (HL) and low lactemia (LL) after coronary artery bypass grafting in terms of postoperative morbidity and mortality rate. Methods: Postoperative blood lactate level was measured in 96 patients. Low and high lactate level was defined as level less than or equal to 4 mmol/L in 69 (Group A) and more than 4 mmol/L in 27 patients (Group B) respectively. Preoperative, perioperative and postoperative details were retrieved from patient records. Results: Demographic characteristics, postoperative data were similar in both groups. Increased cross-clamp and cardiopulmonary bypass times in patients who underwent on pump were associated with a significant rise in postoperative lactate levels. Increased length of ICU stay (Group A 78.49 ± 41.96 vs. Group B 91.81 ± 59.44), mechanical ventilation time (Group A 9.47 ± 6.17 vs. Group B 15.07 ± 14.15) and higher mortality rates (Group A no=01 vs. Group B no=4) were also found in high lactate group. Conclusion: Longer duration of CPB and cross clamp time are associated with a significant increase in lactate levels during perioperative period and that increased lactate levels are directly associated with the increased duration of mechanical ventilation, postoperative ICU stay and mortality.***

Keywords: Cardio pulmonary bypass, Hyperlactatemia, Coronary artery bypass grafting

1. Introduction

Identification of predictors of morbidity and mortality is an important issue for the management of cardiac surgical patients. Morbidity and mortality are directly related to the preoperative status of the patient, as well as to specific anesthetic, surgical, and postoperative factors. Surrogate markers of tissue perfusion such as central venous oxygen saturation and blood lactate may therefore, represent important tools for the management of these patients. [1] After coronary artery bypass grafting (CABG) surgery, hyperlactatemia (HL) is frequently seen in 10-20% ratio and it is related with increased postoperative mortality and morbidity [2]. A prolonged duration of poor tissue oxygen delivery triggers the anaerobic energy production, leading to increased levels of blood lactates [3]. Hyperlactatemia during cardiopulmonary bypass (CPB) is associated with a low oxygen delivery [4] and with bad outcomes in adult [5] and pediatric patients [6]. HL immediately following heart surgery is a marker of an impaired hemodynamic condition and is associated with an increased morbidity and mortality [7, 8, 9]. Although higher lactate levels cannot be explained exactly, the likely mechanism suggested is tissue hypoxia in CPB [10, 11]. Hemodilution, inappropriate peripheral oxygen distribution and hemodynamic instability could lead to tissue hypoxia. It is reported that hyperlactatemia after CPB tends to occur commonly in procedures requiring more prolonged CPB times. Its presence should prompt a thorough search for potential causes of tissue hypoxia and rectification of the causative factors may improve patient outcome. In contrast, late-onset Hyperlactatemia, a less well recognized complication, occurs 4 to 24 hours after completion of surgery and is typically associated with preserved cardiac output and oxygen delivery. Risk factors for late-onset Hyperlactatemia include hyperglycemia, long CPB time and is associated with longer duration of ventilation and intensive care unit length of stay than those with normolactataemia.

The purpose of our study was to determine the risk factors concerned with hyperlactatemia after elective cardiac surgeries and to analyze the mortality and morbidity.

2. Material Method

Study was performed during the period of April 2015 to May 2015 at U.N. Mehta institute of cardiology and research center, Ahmedabad. This was observational study and designed to assess whether the postoperative high lactate level affect the mortality and morbidity in patients undergoing cardiac surgery. This prospective study enrolled 96 consecutive patients who underwent on pump or off pump cardiac surgery. We excluded patients requiring surgery in an emergency situation, ascending or descending thoracic aortic procedures, left ventricular aneurysm resection, inability to receive blood products, pregnancy, cancer, congenital heart defect, hepatic dysfunction, end-stage renal disease, and the refusal to consent. Allocation concealment to patients, anesthesiologists, cardiac surgeons, intensive care specialists, bedside nurses, and investigators was ensured. Treatment allocation was only revealed after the study had been completed, the database locked, and statistical analysis completed.

Arterial and mixed venous blood gas analyses and arterial lactate concentrations were performed using a commercial blood gas analyzer (Cobas b 221). We assessed the values of blood lactate measurements as predictors of postoperative complications in all the patients. Postoperative blood lactate levels were determined at different time point. On the basis of these patients were divided into two groups according to their lactate levels; blood lactate levels less than 4 mmol/l, group A having 67 patients, and blood lactate levels greater than 4 mmol/l group B having 29 patients.

All the relevant details such as age, sex, height, weight, types of surgery and history of patient for example diabetes, smoking were recorded. We noted the following intraoperative variables: such as CPB time and aortic cross-clamp duration in which patients were operated on pump; mean arterial pressure, heart rate, central venous pressure, saturation and urine output were also measured at different time point. Blood investigations were done on the day before and after surgery.

Statistical analysis: All data were analyzed by using SPSS version 20.0 (SPSS Inc., USA). Descriptive statistical methods evaluated included mean and standard deviation, the Student t-test in comparisons of quantitative data with normal distribution, and Mann Whitney U-test in the comparison of groups without normal distribution. Chi-square and tests were used for qualitative data analysis. The results were evaluated at 95% confidential interval (CI) and significance ($p<0.05$) level.

3. Result

In the low and high lactate groups, Demographic data showed age mean (49.79 ± 14.35 versus 46.37 ± 13.17 years), sex (Male=41 write %, Female=28 versus Male=12, Female=15) and weight (55.21±11.48 versus 50.23 ± 11.05 kg) (Table 1).

Table 1: Demographic data

Variables	Group A Blood lactate ≤4 mmol/l	Group B Blood lactate >4 mmol/l	P value
Age (years)	49.79 ± 14.35	46.37 ± 13.17	0.285
Sex	M=41, F=28	M=12, F=15	-----
Weight (kg)	55.21 ± 11.48	50.23 ± 11.05	0.060
DM	17	8	0.8084
HTN	22	12	0.3578

DM: Diabetes Mellitus, HTN: Hypertension

Table 2: Postoperative findings

Variables	Group A Blood lactate ≤4 mmol/l	Group B Blood lactate >4 mmol/l	P value
Heart Rate			
Postop 6 hrs	95.01 ± 18.26	100.962 ± 19.31	0.164
Postop 12 hrs	91.54 ± 15.31	97.70 ± 18.20	0.099
Post op 24 hrs	97.66 ± 15.74	94.22 ± 16.35	0.346
Mean arterial pressure			
Postop 6 hrs	87.27 ± 14.34	80.40 ± 12.42	0.032
Postop 12 hrs	85.01 ± 12.63	80.48 ± 15.59	0.146
Post op 24 hrs	85.92 ± 11.19	81.96 ± 12.18	0.135
Urine Output			
Postop 6 hrs	104.39 ± 62.21	83.14 ± 46.14	0.113
Postop 12 hrs	93.40 ± 53.025	82.03 ± 39.22	0.317
Post op 24 hrs	79.77 ± 40.69	82.40 ± 44.55	0.783
Central venous pressure			
Postop 6 hrs	8.96 ± 6.25	8.88 ± 6.98	0.957
Postop 12 hrs	8.89 ± 6.36	8.66 ± 6.27	0.876
Post op 24 hrs	9.32 ± 4.88	9.55 ± 5.23	0.839

The postoperative details at different time points were statistically non-significant in both the group, including heart rate, mean arterial pressure, central venous pressure, and urine output. Same blood indices were also found statistically non-significant in both the group (Table 2, 3).

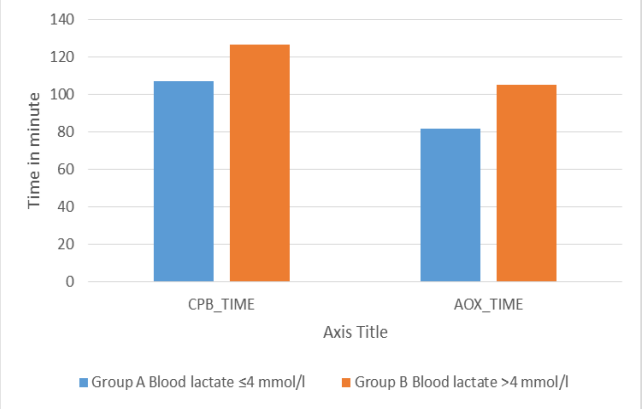

Figure 1: Patients underwent on pump cardiac surgery

Postoperative finding

In our study we have enrolled total 96 patients, among them 64 patients underwent on pump cardiac surgery. Postop high lactate group had increased cross-clamp time (105.13 ± 48.88 versus 82 ± 39.7) and CPB times (126.73 ± 51.36 versus 107.32 ± 43.58) as compared to low lactate group. (Figure 1)

Table 3: Postoperative findings

Variables	Group A Blood lactate ≤4 mmol/l	Group B Blood lactate >4 mmol/l	P value
Haemoglobin			
Preop	12.24 ± 1.55	11.94 ± 1.67	0.401
Postop day 1	11.60 ± 1.29	11.22 ± 1.22	0.200
Postop day 2	10.52 ± 1.18	10.28 ± 1.26	0.393
Postop day 3	11.73 ± 11.82	10.17 ± 1.44	0.515
Total count			
Preop	8971.91 ± 2714.02	8995.18 ± 2392.09	0.969
Postop day 1	16441.19 ± 4870.29	17281.11 ± 4652.90	0.446
Postop day 2	16231.87 ± 5853.67	18007.2 ± 6466.41	0.215
Postop day 3	14077.28 ± 5398.35	14326.81 ± 5043.18	0.851
Serum creatinine			
Preop	0.89 ± 0.24	0.82 ± 0.24	0.198
Postop day 1	0.95 ± 0.29	1.015 ± 0.36	0.445
Postop day 2	0.92 ± 0.42	0.90 ± 0.40	0.846
Postop day 3	0.88 ± 0.42	0.922 ± 0.43	0.744
Serum Bilirubin			
Preop	0.906 ± 0.598	0.82 ± 0.573	0.570

Postop day 1	1.45 ± 0.94	1.43 ± 0.97	0.923
Postop day 2	1.55 ± 1.01	1.53 ± 1.35	0.939
Postop day 3	1.38 ± 0.71	1.58 ± 1.320	0.472
Prothombin time			
Preop	1.22 ± 0.33	1.174 ± 0.16	0.472
Postop day 1	1.47 ± 1.14	1.36 ± 0.35	0.640
Postop day 2	1.69 ± 1.25	1.58 ± 0.36	0.696
Postop day 3	1.82 ± 0.86	2.52 ± 1.09	0.007

The ICU mortality rate differed significantly among two groups: (Group A n= 1 (1.4%) and Group B n=4 (14.8%) p= 0.032). Duration of mechanical ventilation was also significantly low in group B patients (9.47 ± 6.17 versus 15.07 ± 14.15). Postoperative ICU stay was also high in Group B compare to Group A (78.49 ± 41.96 versus 91.81 ± 59.44) (Table 4).

Table 4: Postoperative findings

Variables	Group A Blood lactate ≤4 mmol/l	Group B Blood lactate >4 mmol/l	P value
Mechanical ventilation hrs	9.47 ± 6.17	15.07 ± 14.15	0.008
ICU stay in hrs	78.49 ± 41.96	91.81 ± 59.44	0.219
Mortality	1	4	0.032

ICU: Intensive care unit

4. Discussion

Hyperlactatemia after major surgeries is one of the independent early predictor of morbidity, mortality and increased ICU stay. Cohen and Woods have classified lactic acidosis in two categories: Type A lactic acidosis with clinical evidence of poor tissue perfusion caused by oxygen deficits Type B lactic acidosis with no evidence of poor tissue perfusion. [12] Anerobic metabolism during reduced tissue perfusion results in hyperlactatemia.

On the other hand, increased intracellular concentrations of free fatty acids after cardiac surgery inhibit conversion of pyruvate to acetyl coenzyme A, results in increased production of lactic acid. Interventions like, administration of exogenous beta adrenergic agonists and dialysis using lactate containing fluids also results in hyperlactatemia. Hyperlactatemia was also associated with hyperglycemia, probably due to the release of stress hormones and cytokines leads to insulin resistance producing hyperglycemia and the extra amount of glucose is degraded to lactate by the glycolytic pathway [13, 14].

Demers and coworkers were found increased incidence of hyperlactatemia in patients with preoperative factors or comorbidities like age, female gender, congestive heart failure, low ventricular ejection fraction, hypertension, atherosclerosis, diabetes, preoperative low hemoglobin value, redo or complex surgery and emergency procedures.[15]

Studies performed in patients with shock and other critically ill patients have demonstrated that a circulating blood lactate level of 4 mmol/l or more predisposes to a striking increase in morbidity and mortality rate. [16] In our study also, we found that group B (lactate > 4mmol/l) have higher mortality in comparison to group A (lactate < 4 mmol/l). A high mortality in patients with lactate levels of > 4 mmol/l have been shown by Munoz et al. [17]. Increased risk of postoperative morbidity and mortality in patients with blood lactate concentration of 4 mmol/l or higher during CPB has been identified by Demers et al. [15].

A study in 82 patients undergoing valvular heart surgery has shown that, elevations in lactate levels of more than 4 mmol/l had the longest duration of mechanical ventilation and inotropic support while those with lactate levels less than 2 mmol/l had least duration of post-operative mechanical ventilation and inotropic requirement.[18].

In one study by Toraman F et al. demonstrated that increased cross-clamp and CPB times and highly positive fluid balance at the end of the operation are associated with an early rise in postoperative lactate levels, which is associated with increases in need for IABP support, length of ICU stay, need for red blood cell transfusion, length of hospital stay and mortality rates. [19]. We also found rise in lactate in patients with increased CPB time as compare to patients with low CPB time. Our study also shows increase in ICU stay, ventilatory hours and mortality in patients with hyperlactatemia.

In our study, we did not include other markers of low cardiac output states like mixed venous oxygen saturation and base excess to correlate it with hyperlactatemia.

Conclusion

We conclude that a longer duration of CPB and cross clamp time are associated with a significant increase in lactate levels during perioperative period and that increased lactate levels are directly associated with the increased duration of mechanical ventilation, postoperative ICU stay and mortality.

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Author Profile

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