International Journal of Chemical and Biochemical Sciences
(ISSN 2226-9614)

Journal Home page: www.iscientific.org/Journal.html

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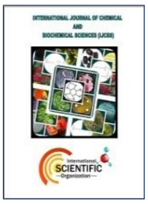

Impact of aortic clamping technique on serum lactate level and postoperative complications in coronary artery bypass graft surgeries

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Abstract

Coranry artery disease require revascularization (CABG) during which we use aortic clamping technique SCT\DCT affect serum lactate level and have several postoperative complications. The aim of the study is to assess the impact of aortic calmping technique on serum lactate in CABG and to assess the effect of hyperlactatemia on the postoperative complications in CABG patients. This prospective comparative study was conducted in Cardiothoracic Surgery Department, Zagazig University Hospitals on 60 patients who underwent elective isolated CABG. Patients were divided into two groups; 30 patients were included in the first group, single clamping technique group where we use only aortic cross-clamp only and 30 patients were included in the second group , the double clamping technique group, where we use aortic cross clamp in addition to side-biting clamp during proximal revascularization of graft. There was a statistical significance decrease in lactate level at 10 minutes after by pass, 1 h & 3 h post operative among Group II compared to Group I. Also, there was a increase in the frequency of arrythmia and stroke and pulmonary complications in group 1 with no significant statistical significance between both groups. After cardiac surgery, hyperlactatemia is common. Postoperative lactatemia monitoring is clinically helpful. A subgroup of patients at higher postoperative risk was identified by using a threshold of 3 mmol/L at time of ICU admission. CBP time and blood lactate levels following CPB in the SCT and DCT groups differed significantly. Additionally, increased postoperative stroke reported in DCT groups is a result of increased aortic manibulation.

Keywords: Aortic Clamping, Lactate, hyperlactatemia, Coronary Artery Bypass Graft.

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1. Introduction

Cerebrovascular damage following coronary artery bypass grafting (CABG) is associated with high rates of morbidity and mortality; in older and high-risk individuals who need surgical revascularization for complicated coronary artery disease. The surgical approach used for CABG, and in particular the degree of aortic manipulation, has frequently been associated with the etiology of postoperative neurological problems, despite the possibility of several contributing factors **[1]**. During CPB, proximal and distal anastomoses are often constructed using two different aortic clamping procedures. In the single clamp technique (SCT), only one aortic cross-clamp (XCL) is utilized; in the double clamp technique (DCT), one additional clamp, known as the partial side-biting clamp, is used in addition to the aortic cross-clamp. In terms of postoperative complications, these two procedures have been compared in numerous research. The majority of them discovered that SCT is better in terms of postoperative stroke. There were no appreciable variations in the rates of any postoperative problems mentioned in these investigations **[2]**. For heart surgery, cardiopulmonary bypass (CPB) is generally recommended in order to preserve systemic perfusion and oxygenation. It is commonly known that an increase in lactate levels resulting from anaerobic metabolism is linked to tissue hypoperfusion caused by circulatory failure. In order to assess shock, blood lactate levels must be monitored **[3]**. An improved predictor of shock, multiple organ failure, and survival over cardiac output, oxygen supply, and interleukin-6 (IL-6) is serial blood lactate levels. Blood lactate level has been investigated as a biochemical marker for prognosis in critical cases, shock therapy, disease severity, and hypoxia. The sensitivity of the bedside serial blood lactate level as an indication of shock severity was demonstrated. Adults with severe sepsis and septic shock have been shown to have better outcomes when their lactate levels are cleared early **[4]**. Hyperlactatemia is frequently linked to open-heart surgery, especially when cardiopulmonary bypass (CPB) is used. Multifactorial hyperlactatemia is observed in patients undergoing CPB. More significantly, a number of studies have unequivocally demonstrated that hyperlactatemia is linked to worse postoperative clinical results for various forms of cardiac surgery **[5]**. Cardiopulmonary bypass (CPB) may be the first stimulus that causes lactate generation. Hypoperfusion during CPB may be caused by a number of factors, including the length of CPB, the duration of circulatory arrest, the degree of hypothermia, the length of cooling and rewarming, the pH management strategy, the hematocrit value, and the systemic inflammatory response to CPB. Tissue oxygen extraction, in particular, may be hampered by these factors **[6]**. Peak blood lactate levels of 3 mmol/L or above at the sixth hour following ICU transfer are a reliable indicator of significant postoperative problems following heart surgery using cardiopulmonary bypass, and they are linked to an elevated risk of perioperative morbidity. When patients have heart surgery, early hyperlactatemia (<6h) increases the risk of adverse outcomes by three times **[7]**.

2. Patients and methods

2.1. Ethical statement

The institutional review board of Zagazig University approved the study (Approval number, 10881) and written informed consent was taken from all patients involved in the study. The study was conducted according to the ethical principles of the declaration of Helsinki.

2.2. Study design and population

Our study is a prospective comparative study included 60 patients .all patients underwent elective isolated CABG. The study was conducted in Cardiothoracic Surgery Department, Zagazig University Hospitals. The whole study cohort was divided into two groups. In the first group (STUDY GROUP) 30 patients, single clamping technique group (SCT, aortic cross-clamp only), patients received application of aortic cross clamp only. In the second group 30 patients (CONTROL GROUP), (double clamping technique) (DCT, aortic cross-clamp + side-biting clamp), both a side biting clamp and an aortic cross clamp were applied to each subject. The operating surgeon made the decision regarding the clamp technique to be used for creating proximal anastomoses. The following variables were compared between the study groups: the amount of bleeding (discharged blood) during the first postoperative day, the length of stay in the intensive care unit and hospital, the need for revision surgery, the need for inotropic support beyond three hours after the procedure, and the rates of cerebrovascular accident, de novo AF, surgical site infection, and mortality. Apart from examining the possible impact of the clamping technique on the level of lactate after surgery, our objective was to determine if there existed any correlation between the levels of lactate after surgery and any of the previously specified study criteria. Adult age group patients (45-65) years old complaining from coronary artery disease and need on pump Coronary Artery and Bypass Graft surgery for revascularization were included in the study. Age below than 45 years old, off-pump Coronary Artery Bypass Graft surgery, patients who need valve surgery, previous stroke, emergency Coronary Artery Bypass Graft surgery, before open heart surgery, elevated trponin levels or blood lactate levels prior to surgery, patients who had percutaneous coronary intervention on last week, hepatic dysfunction and end stage renal disease were excluded from the study. All patients were subjected to full history taking, clinical examination, routine hematological investigations including complete blood picture using (XN330, Sysmex corporation, Japan), prothrombin time and concentration, partial thromboplastin time via (CS1600, Sysmex corporation, Japan). Liver function tests, kidney function tests, fasting blood sugar and Hemoglobin A1C “for diabetic patients”, serum electrolytes, and preoperative serum lactate were operated on (Cobas 8000 c702, Roche Diagnostics, Switzerland). Arterial Blood Gases using (Cobas b221, Roche Diagnostics, Switzerland), and Troponin HS analysis on (Cobas e411, Roche Diagnostics, Switzerland).

2.3. Intraoperative Surgical technique

All patients underwent the same intraoperative anesthetic procedure, which included the insertion of a non-dominant radial artery cannula under local anesthesia. Two arterial blood samples were taken: one for baseline arterial blood gas (ABG) analysis and the other for preoperative baseline activated clotting time (ACT). Two 16G (gray) peripheral venous cannulas were inserted. Three-lead electrocardiogram (ECG) was used for monitoring, followed by fentanyl (5–10 µg/kg) and pancuronium (0.02 mg/kg) supplemented with 0.5–1 mg/kg of propofol for hypnotic effects. Fentanyl doses ranging from 100 to 200 µg were administered based on individual need. An appropriate-sized endotracheal tube was used to intubate the trachea orally once the patient's muscles had fully relaxed. Isoflurane 0.5–1.0% was inhaled to maintain anesthesia in all cases. The right internal jugular vein was perforated with a single lumen central venous catheter (Angiocath 16 gauge) in addition to a triple lumen catheter. In addition, a urethral catheter was implanted. General anesthesia was used to conduct a median sternotomy. All patients received a saphenous vein graft (SVG), and those without a contraindication received a LIMA graft. A dual-stage venous cannulation and standard aortic cannulation were carried out. An suitably sized curved aortic cannula was used to cannulate the distal ascending aorta following complete systemic heparinization. The right atrial appendage is typically used to get access to the right atrium using a two-stage venous cannula. Aortic root cardioplegia/vent placement is done. All patients received CPB and were chilled to a maximum temperature of 31 °C. For topical hypothermia, ice water was applied and the XCL was positioned. A CPB was utilized to infuse the cold blood cardioplegic solution at an average pressure of 80120 mmHg. The maintenance blood cardioplegic solution was administered every 20 minutes. In the 20-minute intervals in between, arteriotomy sites were done just distally enough to bypass the obstruction and proximal enough to offer the largest-sized coronary target. Distal anastomoses were also conducted. By observing an epicardial indentation, associated epicardial veins, or a white streak inside the myocardium, intramyocardial arteries were identified. The intended target spot was located by carefully dissecting the tissue that was on top of it. The no. 11 blade was used to execute the arteriotomy. Pott's scissors were used to expand the arteriotomy both proximally and distally. The arteriotomy was at least 1.5 times the diameter of the distal coronary and was made to match the conduit diameter. Lastly, LIMA-LAD anastomosis was done on patients who had received LIMA grafts. Those who had proximal anastomosis with a cross-clamp received a final cold blood cardioplegic solution after all distal anastomoses were finished (Within SCT group A). Aortic occlusion was used for the construction of both distal and proximal anastomoses. A single-cross clamp was used to make the proximal anastomosis, and the fatty tissue covering the intended aortotomy site was excised. A no.11 blade is used to create an arteriotomy. A circular aortotomy was created using a 4- to 5-mm aortic punch. The conduit graft size was taken into consideration when determining the punch size. The conduit's proximal aspect was notched at the heel after being beveled. For a venous graft, a running 5-0 or 6-0 polypropylene suture was utilized, and for an artery conduit, a 6-0 or 7-0 polypropylene suture. The graft's long axis was positioned with respect to the ascending aorta at the proper angle. Hemostasis was ensured by making sure the stitches were symmetrical in their spacing. Following the completion of each proximal anastomosis, patients were returned to 34.5 °C and given an additional cardioplegia.

A warm blood solution was supplied by CPB at a mean pressure of 80–120 mmHg. The cross-clamp was then taken off. Patients who achieved the desired blood pressure and arterial blood gas analysis were then weaned off of CPB once the flow rate was lowered. Patients whose blood pressure did not rise or fall while the flow rate reduced received inotropic support, while patients whose cardiac contractions were insufficient were not weaned off the machine. Proximal anastomoses were created in GROUB (B) (DCT group) when the first aortic clamp was released and a second partially occluding aortic clamp was applied. In other words, patients were warmed to 33.5 °C and given a warm solution via CPB at a mean pressure of 80–120 mmHg. The cross-clamp was then taken off. A side biting clamp was then inserted. There were proximal anastomoses made. Patients were weaned off of CPB when proximal anastomoses were completed, provided that the proper blood pressure, body temperature, and blood gas levels were achieved. In the event of blood pressure issues, inotropic assistance was started, just like in the patients undergoing cross-clamp. The radial artery cannula in both patient groups was used to obtain arterial blood gas samples prior to CPB, every 20 minutes while CPB was in effect, and during weaning from CPB. Ten minutes following the cardiopulmonary bypass weaning and five minutes prior to the aortic cross clamp being applied, serum lactate level analysis was carried out. Closure: the surgeon closes the chest incision using sutures or surgical staples. In minimally invasive approaches, smaller incisions may be closed with stitches or adhesive strips. Recovery: After that, the patient is moved to the intensive care unit (ICU) for careful observation. They will be given medications for pain management and to prevent infection. The recovery period varies, but most patients can expect to stay in the hospital for several days. Data about intraoperative aspects, including the number of proximal and distal anastomoses, cross-clamp and CPB timings, and requirement for inotropic support, were extracted from surgical and anesthetic monitoring notes.

2.4. Follow up

Postoperative follow up was done by measuring serum lactate level 6 hours and 24 hours after admission to the Intensive care unit. Follow up of early complications detected in the postsurgical ICU was done. Low cardiac output, prolonged need for mechanical ventilator>24 hours, prolonged ICU stay>48 hours, neurological deficit, re-opening for bleeding, arrhythmia, perioperative myocardial infarction, renal dysfunction, mortality were recorded. Follow up for complications detected after ward transfer was done including neurological deficit, arrhythmia, perioperative myocardial infarction, wound infection, pulmonary complications and mortality.

2.5. Statistical analysis

The acquired data was digitized and statistically analyzed using the SPSS (Statistical Package for Social Science) version 27.0 (IBM, 2020). Chi square test, independent T test, Mann Whiteny (MW) test and Paired sample T test were used.

3. Results

There were no statistical significance differences between the studied groups in age or sex distribution, frequency of hypertension, diabetes, smoking, mean EF, number of proximal anastomosis, distal anastomosis or grafts and mean blood pressure but there was a statistical significance decrease in CBP (Cardiopulmonary bypass) & AXC time among Group I compared to Group II. Regarding CPB B.G, there was no statistical significance differences between the studied groups in pre & post CPB but there was a statistical significance increase in post CBP compared to pre in both groups (Table 1). There were no statistical significance differences between the studied groups in lactate level 5 minute before clamp, and at 5h, 24h, & 48 h post operative but there was a statistical significance decrease in lactate level at 10 minutes after by pass, 1 h & 3 h post operative among Group II compared to Group I. Regarding difference at different times in each group, in Group I there was a statistical significant increase in lactate level at all times versus 5 minute before clamp while in Group II there was a statistical significant increase in lactate level at all times versus 5 minute before clamp except 48h post operative (Table 2). There were no statistical significance differences between the studied groups in length of ICU stay, duration of mechanical ventilation or drain but there was a statistical significance decrease in hospital stay among Group II compared to Group I. There was an increase in frequency of arrythmia and stroke and pulmonary complications in Group I compared to Group II but without statistical significance. No statistical significance difference was found between the studied groups in frequency of wound infection (Table 3). There was a statistical significance increase in number of proximal anastomosis, distal anastomosis, grafts, CBP time and lactate level 5 min before clamp among cases with lactate level >3 compared to cases with lactate level ≤ 3 (Table 4). There was a statistical significance increase in CBP time, hospital stay, ICU stay and duration of mechanical ventilation among cases with lactate level >3 compared to cases with lactate level ≤ 3 (Table 5).

4. Discussion

Prolonging CPB and cross-clamp periods may have more negative impacts on the myocardium and all other organs. The purpose of this study was to look at the CPB and cross-clamp timings of various clamping procedures and how they affect blood lactate levels. In our study, we used LIMA in all cases, so there were no statistically significant differences between the studied groups in the number of proximal anastomosis, distal anastomosis or grafts, or mean blood pressure, but there was a statistically significant decrease in CBP and AXC time between Group I and Group II. A previous study revealed that the SCT group's cross-clamp time was significantly longer than that of the DCT group (80.4±65435إإ25.6 vs. 63.7±21.1 min). However, there was no difference between the groups' CPB times (108.4±34.0 min in the SCT group, 110.4±33.7 min in the DCT group, P=0.768) (against us). This may be explained by that the proximal anastomoses were carried out with XCL in the SCT group. The DCT group utilized LIMA more frequently than the SCT group (P=0.044). The SCT group used SVG the most frequently (P=0.049). When the records were randomly evaluated, it was discovered that LIMA-LAD anastomosis was lower in the SCT group. It had been shown that LAD distal anastomosis was conducted with SVG in disorders connected with LIMA (atherosclerosis, narrower LIMA diameter, insuffcent blood flow). These observations prevented them from using LIMA, unlike DCT groups **[8]. Sinatra et al. [9]** demonstrated that patients in the SCT group had a longer cross-clamp period (74.2 ± 13 min) than those in the DCT group (46.7 ± 15 min). Additionally, the SCT group's cardiopulmonary bypass time was considerably greater (95.5 ± 32 vs. 71 ± 15 min; p = NS). Patients undergoing heart transplants, CPB, valve surgery, and other types of heart surgery frequently experience hyperlactatemia. Our study shows that in table 5 Between the studied groups, there were no statistically significant differences in lactate level 5 minute before clamp, and at 5h, 24h, & 48 h post operative but there was a statistical significance decrease in lactate level at 10 minutes after by pass, 1 h & 3 h post operative among Group II compared to Group I. When it comes to variations in each group's lactate levels at different times, Group I showed a statistically significant increase in lactate levels at all times compared to five minutes before clamp, while Group II showed a statistically significant increase in lactate levels at all times compared to five minutes before clamp, with the exception of 48 hours after surgery. However, **Özmen et al. [8]** study results were similar prior to cross-clamp in terms of blood lactate levels. Blood lactate levels were measured 10 minutes after CPB weaning and found no significant differences between the groups. Additionally, they discovered that the amount of proximal saphenous grafts and distal anastomoses, cross-clamp time, and CPB time all significantly positively correlated with the lactate level following CPB in the entire group. this agrees with table 10 of our analysis. Only cross-clamp times and CPB were found to be independent predictors of hyperlactatemia in multivariable regression analysis, after CPB.

Since hyperlactatemia was present in both groups at similar rates, it appears that there was no increased risk of hyperlactatemia development as a result of the clamping approach. 32% of the cohort as a whole experienced hyperlactatemia following CPB. According to earlier research, this incidence ranged from 5.7% **[10]** to 71% **[11].** Both groups' mean postoperative lactate levels and the proportion of patients with hyperlactatemia were similar. They reasoned that the CPB times of the SCT and DCT groups might be comparable, explaining the absence of difference. It's interesting to note that SCT patients had longer cross-clamp times than DCT patients. Nevertheless, there was no variation in the groups' lactate levels. Our study concluded that CPB time and the clamping technique associated with hyperlactatemia. In our study there was a statistical significance increase in number of proximal anastomosis, distal anastomosis, grafts, CBP time and lactate level 5 min before clamp among cases with lactate level >3 compared to cases with lactate level ≤ 3. Providing sufficient protection of the myocardial tissue with the cardioplegic solutions through the severely stenosed coronary arteries during the aortic cross-clamping period is one of the most crucial factors for a successful CABG procedure. The degree of myocardial injury that might happen after CABG procedures depends on how much cardioplegia is maldistributed **[12]. Buckberg et al. [13]** suggested in 1979 that the distal and proximal anastomose be built successively during a single aortic clamping time in order to achieve homogenous delivery of cardioplegia and cooling of all myocardial regions for sufficient myocardial protection. During ischemia, cold blood cardioplegia infusion from newly created grafts as well as native coronary arteries reduces metabolic demand and allows for continual lactic acid cleaning. The removal of the cross-clamp causes a maximal reactive hyperemia and an abrupt maximal reperfusion of the coronary arteries, which completely washes away any lactic acid buildup and speeds up the regeneration of the substrates required for aerobic metabolism **[14].** While some researchers theorized that sequential partial occluding aortic side biting technique, which involves building the proximal veno-aortic anastomoses one by one, reduces ischemic time, it also improves myocardial protection in patients undergoing CABG **[14].** Serum levels of CPK-MB and troponin I were significantly lower in the study group 24 hours after the operation compared with the single-clamp group, according to a study by **Jelodar et al. [15]** that compared sequential partial occluding aortic side biting technique with single clamp technique. **Eris et al. [16]** discovered that, in the postoperative period, the single-clamp group's troponin and CK-MB readings were much lower than those of the sideclamp group. This indicates that the SCT has a less ischemic effect on the myocardial.and our research, which also considered blood lactate level as an indication, supports this result. They found that the myocardium is better protected during on-pump CABG procedures when the single-clamp technique is used. Our research revealed a non-statistically significant increase in the frequency of arrhythmia and stroke in Group I relative to Group II. **Anyanwu et al. [17]** Research indicates that between 50% and 75% of strokes following CABG are embolic, and that they are detected within 24 hours following the procedure.

In patients receiving CABG, postoperative stroke is an uncommon but significant source of morbidity and mortality. Perioperative cerebrovascular accident (CVA) rates in on-pump CABG range from 1.5% to 5.2% in prospective studies and from 0.8% to 3.2% in retrospective studies **[18]. Daniel III et al. [19]** revealed that emboli are created during aortic cannulation and clamping, as demonstrated by transcranial Doppler ultrasonography. Therefore, by reducing the creation of emboli, minimizing aortic manipulation by doing away with cannulation and clamping may lower the incidence of postoperative stroke. **Hannan et al. [20]** discovered that the 30-day mortality and surgical stroke incidence were considerably reduced in the OPCAB patients. Nevertheless, the mechanisms underlying the noted decline in postoperative stroke were not identified. Nevertheless, two recent meta-analyses found no evidence of a decrease in postoperative stroke in individuals at low risk. **[21,22].** Proximal anastomoses to in situ arterial grafts, the use of proximal anastomotic connectors, or the use of facilitating devices like the Heartstring proximal anastomosis system can all be done without the need for a partial aortic clamp, thereby avoiding partial clamping during the construction of proximal anastomoses in OPCAB cases. All reported strokes happened in patients who had an aortic clamp in a randomized clinical trial comparing the PASPort proximal anastomotic connector (Cardica, Redwood City, Calif.) versus making hand-sewn proximal anastomoses with partial clamping **[23]. Hammon et al. [24]** found that patients undergoing single cross clamp had a lower incidence of postoperative cognitive impairments than patients undergoing double-clamp ONCABG (ON PUMP CABG) or patients undergoing OPCABG (OFF PUMP CABG) with partial clamping. **Özmen et al. [8]** found that the OPCAB patients had significantly lower 30-day mortality and surgical stroke incidence. However, the mechanisms responsible for the observed decrease in stroke following surgery remained unknown. However, two recent meta-analyses did not discover any proof that people at low risk would get fewer postoperative strokes. **Sinatra et al. [9]** discovered that there were no variations in the number of cerebrovascular incidents between the groups. One patient in group 1 (0.6%) and one patient in group 2 (0.7%) both experienced a stroke. Therefore, there is no difference in the neurologic outcome between individuals who have CABG who are subjected to DCT and those who are submitted to SCT. Compared to hemorrhagic stroke, ischemic stroke typically occurs three times more frequently **[25].** Aortic SCT is linked to a reduced risk of postoperative stroke than DCT, according to several studies **[19].** Other postoperative consequences, including as mortality and the rate of AF, did not differ between the groups in the **Özmen et al. Study [8].**

Eriset al. [16] the study discovered that although the requirement for defibrillation was marginally higher in the single-clamp group (39% versus 30%; P =.18) following the removal of the cross clamp, it was not statistically significant. They postulated that the singleclamp group experienced more fibrillation following cross-clamping because they received significantly more potassium-rich cardioplegic solutions after each proximal and distal anastomosis than the other group, which only received cardioplegia after distal anastomoses. 10% of the single-clamp group and 15% of the side-clamp group experienced postoperative atrial fibrillation; there was no statistically significant difference (P =.28) between the groups, which is consistent with our findings.

Results of our study proved that instances with a lactate level greater than three had a statistically significant longer hospital stay, stay in the intensive care unit, and duration of mechanical breathing than cases with a level less than three. A number of comorbidities or perioperative variables could provide the ideal conditions for hyperlactatemia during CPB. Risk factors for hyperlactatemia included age, female gender, congestive heart failure, low left ventricular ejection fraction, hypertension, atherosclerosis, diabetes, the number of blood units received, the average amount of time transfused blood was stored, preoperative hemoglobin value, pump duration, prolonged aorta cross-clamp duration, repeat or complex surgery, and emergency procedures **[26].** In addition, systemic inflammation, cardiac injury, myocardial shocking, hemodynamic instability, tissue edema, bleeding diathesis, and ultimately multiorgan dysfunction are brought on by cardioplegic cardiac arrest and extracorporeal circulation (ECC). Anaerobic myocardial metabolism is induced by cardioplegic arrest, resulting in a net generation of lactate from glycolysis. A delayed return to normal aerobic metabolism is suggested by persistent lactate release following reperfusion, which could result in impaired cardiac function **[26]**. Oxidative phosphorylation cannot occur in anaerobic conditions; instead, pyruvate is converted to lactate to create ATP. Thus, in anaerobic conditions, the typical lactate/pyruvate ratio (10:1) is altered and is superior to 10:1. When systemic oxygen delivery and tissue oxygen use are out of balance, anaerobic glycolysis occurs, leading to type A lactic acidosis. Lactate is a reasonable indicator of the degree of tissue oxygen deficiency and anaerobic metabolism in this case. Numerous investigations have demonstrated a robust affirmative association between blood lactate concentrations and the likelihood of morbidity and death in clinical scenarios including circulatory shock and extracorporeal support **[27]. Siegel et al. [28]** revealed that a PPV of 100% was linked to an initial postoperative lactate level of 4.2 mmol/L, whereas **Sajjanhar et al. [29]** found that a level of 4.5 mmol/L had a PPV of only 16.7%. The results indicated that the best predictive value for mortality, as determined by receiver operating characteristics, was only 32% for even the first postoperative lactate level of 6 mmol/L. The fact that hyperlactatemia might be due to causes other than tissue hypoxia, such as enhanced glycolysis or the presence of exogenous lactate seen in red cell prime during CPB, may account for these discrepancies in the results **[30]. Mishra and Singhal [26]** discovered that the mean lactate levels of NYHA 4 patients increased after termination, rewarming, and the recovery period. **Algarni et al. [31]** discovered that during the perioperative phase, there is a correlation between elevated mean lactate levels and lactate clearance and an increase in NYHA class. ILonger periods of mechanical breathing and inotropic support were linked to higher mean lactate levels and lactate clearance. In later NYHA classes, higher perioperative lactate levels also resulted in longer hospital and intensive care stays. **Özmen et al. [8]** revealed that the only factor that was independently linked to hyperlactatemia was CPB time.

Table 1: Demographic and intra-operative data of the studied groups

Variable		Group I (DCT) (n=30)		Group II (SCT) (n=30)		t	P
Age: (years)	Mean ± Sd Range	54.07±5.38 43-65		53.7±4.78 44-65		0.28	0.78 NS
Variable		No	%	No	%	χ^2	P
Sex:	Female Male	4 26	13.3 86.7	9 21	30 70	2.46	0.12 NS
Hypertension:	No Yes	13 17	43.3 56.7	15 15	50 50	0.27	0.60 NS
DM:	No Yes	11 19	36.7 63.3	11 19	36.7 63.3	0	1 NS
Smoking:	No Yes	13 17	43.3 56.7	16 14	53.3 46.7	0.60	0.44 NS
EF%	Mean ± Sd Range	45.73±4.53 38-55		46.9±3.09 40-55		1.17	0.25 NS
No of proximal anastomosis:	Mean ± Sd Range	1.87±0.78 1-3		1.63±0.62 1-3		1.30	0.20 NS
No of distal anastomosis:	Mean ± Sd Range	2.87±0.78 2-4		2.63±0.62 2-4		1.29	0.20 NS
Number of grafts:	Mean ± Sd Range	2.87±0.78 2-4		2.63±0.62 2-4		1.29	0.20 NS
Mean bl pressure: (mmHg)	Mean ± Sd Range	71.67±5.55 60-80		71.5±5.24 65-80		0.12	0.91 NS
CBP time: (min)	Mean ± Sd Range	88±21.40 50-150		99.83±10.54 80-130		2.72	0.009*
AXC time: (min)	Mean ± Sd Range	61.33±18.14 25-110		78.33±8.94 65-110		4.60	<0.001 **
pre CPB B.G:	Mean ± Sd Range	136.33±17.76 100-160		136.83±19.29 110-160		0.10	0.92 NS
post CPB B.G:	Mean ± Sd Range	163.4±17.68 130-190		164.63±18.65 135-195		0.26	0.79 NS
P^		<0.001**		<0.001**			

SD: Standard deviation, t: Independent t test, χ^2:Chi square test, ^: Paired t test, NS: Non significant (P>0.05)

Table 2: Lactate level at different times among the studied groups

Lactate level		Group I (DCT) (n=30)	Group II (SCT) (n=30)	t	P
5 min. before clamp:	Mean ± Sd Range	1.61±0.46 0.6-2.5	1.61±0.47 0.7-2.4	0.06	0.96 NS
10 min. after by pass:	Mean ± Sd Range	3 .64±0.90 2.5-6	3.15±0.67 1.8-4.3	2.40	0.02*
1st h postoperative:	Mean ± Sd Range	3.43±0.68 2.5-5.5	2.95±0.61 1.6-4	2.86	0.006 *
3rd h postoperative:	Mean ± Sd Range	3.09±0.68 2.2-5	2.65±0.65 1.3-3.7	2.52	0.02*
5th h postoperative:	Mean ± Sd Range	2.64±0.87 1.8-6	2.38±0.47 1.8-4.1	1.46	0.15 NS
24 h postoperative:	Mean ± Sd Range	2.35±0.82 1.1-5.1	2.08±0.65 1-4.5	1.38	0.17 NS
48 h postoperative:	Mean ± Sd Range	1.95±0.84 0.9-4.5	1.78±0.63 0.7-4.2	0.89	0.38 NS
P^		<0.001**^{1} <0.001**^{2} <0.001**^{3} <0.001**^{4} <0.001**^{5} 0.04*^{6}	<0.001**^{1} <0.001**^{2} <0.001**^{3} <0.001**^{4} <0.001**^{5} 0.16NS^{6}		

SD: Standard deviation, t: Independent t test, ^: Paired t test versus 5 min. before clamp, NS: Non significant (P>0.05), *: Significant (p<0.05), **: Highly Significant (p<0.001), P1: 10 min after by pass, P2: 1h postoperative, P3: 3h post-operative, P4: 5h post-operative, P5: 24h post-operative, P6: 48h post-operative.

Table 3: Post-Operative data and complications among the studied groups

Variable		Group I (DCT) (n=30)		Group II (SCT) (n=30)		Test	P
Length of ICU stay: (day)	Mean ± Sd Range	2.3±0.91 1-5		2.07±0.58 0.5-4		t 1.19	0.24 NS
Duration of mechanical ventilation: (hours)	Mean ± Sd Median Range	12.13±12.25 6 6-48		7.87±3.79 6 6-24		MW 0.45	0.65 NS
Hospital stay: (day)	Mean ± Sd Range	8.03±1.22 5-10		7.1±0.99 4-8		t 3.25	0.002*
Drain: (cc)	Mean ± Sd Median Range	320±150.06 300 200-1000		300±62.97 300 200-400		MW 0.02	0.98 NS
Arrythmia:	No Yes	21 9	70 30	25 5	83.3 16.7	1.49	0.22 NS
Wound infection:	No Yes	28 2	93.3 6.7	27 3	90 10	0.22	0.64 NS
Stroke:	No Yes	27 3	90 10	30 0	100 0	3.16	0.08 NS
Pulmonary complications:	No Yes	20 10	66.7 33.3	25 5	83.3 16.7	2.22	0.14 NS
Survival:	Live Dead	28 2	93.3 6.7	29 1	96.7 3.3	0.35	0.55 NS

SD: Standard deviation t: Independent t test MW: Mann Whitney test, χ^2:Chi square test, NS: Non significant (P>0.05) *:Significant (<0.05)

Table 4: Comparison between cases in different parameters according to lactate level at 10 minutes after by pass

Variable		Lactate ≤3 (n=23)		Lactate >3 (n=37)		t	P
Age: (years)	Mean ± Sd	54.52±4.85		53.49±5.19		0.77	0.44 NS
Variable		No	%	No	%	χ^2	P
Sex:	Female Male	6 17	46.2 36.2	7 30	53.8 63.8	0.43	.051 NS
Hypertension:	No Yes	11 12	39.3 37.5	17 20	60.7 62.5	0.02	0.89 NS
DM:	No Yes	9 14	40.9 36.8	13 24	59.1 63.2	0.10	0.76 NS
Smoking:	No Yes	10 13	34.5 41.9	19 18	65.5 58.1	0.35	0.55 NS
EF%	Mean ± Sd	46.78±3.19		46.03±4.29		t=0.73	0.47 NS
No of proximal anastomosis:	Mean ± Sd	1.48±0.59		1.92±0.72		t=2.57	0.01*
No of distal anastomosis:	Mean ± Sd	2.48±0.59		2.92±0.72		t=2.46	0.02*
Number of grafts:	Mean ± Sd	2.48±0.59		2.92±0.72		t=2.46	0.02*
Mean bl pressure: (mmHg)	Mean ± Sd	70.91±5.36		72±5.38		t=0.76	0.45 NS
CBP time: (min)	Mean ± Sd	86.74±14.89		98.38±18.11		t=2.59	0.01*
AXC time: (min)	Mean ± Sd	64.78±16.13		72.97±16.26		t=1.9	0.06 NS
pre CPB B.G:	Mean ± Sd	137.04±18.84		136.3±18.36		t=0.15	0.88 NS
post CPB B.G:	Mean ± Sd	163.43±17.74		164.38±18.44		t=0.20	0.85 NS
Lactate 5 min. before clamp:	Mean ± Sd	1.29±0.36		1.81±0.40		t=5.12	<0.001**
Length of ICU stay: (day)	Mean ± Sd	2±0.80		2.30±0.73		t=1.48	0.14 NS
Duration of MV (day)	Median(Range)	6 (6-48)		6 (6-48)		MW=0.61	0.54 NS
Hospital stay: (day)	Mean ± Sd	7.61±1.20		7.54±1.22		t=0.21	0.83 NS
Drain: (cc)	Median(Range)	300(200-450)		300(200-100 0)		MW=0.25	0.80 NS
Arrythmia:	No Yes	18 5	39.1 35.7	28 9	60.9 64.3	χ^2 0.05	0.82 NS
Wound infection:	No Yes	23 0	41.8 0	32 5	58.2 100	3.39	0.07 NS
Stroke:	No Yes	23 0	40.4 0	34 3	59.6 100	1.96	0.16 NS
Pulmonary complications:	No Yes	16 7	35.6 46.7	29 8	64.4 53.3	0.59	0.44 NS
Mortality:	Live Dead	22 1	38.6 33.3	35 2	61.4 66.7	0.03	0.86 NS

SD: Standard deviation t: Independent t test MW: Mann Whitney test χ^2:Chi square test NS: Non significant (P>0.05) *:Significant (<0.05) **: Highly significant (P<0.001)

Table 5: Comparison between cases in different parameters according to lactate level at 24h post operative

Variable		Lactate ≤3 (n=53)		Lactate >3 (n=7)		t	P
Age: (years)	Mean ± Sd	53.89±4.98		53.86±5.93		0.01	0.99 NS
Variable		No	%	No	%	χ^2	P
Sex:	Female	12	92.3	1	7.7	0.25	0.61
	Male	41	87.2	6	12.8		NS
Hypertension:	No	26	92.9	2	7.1	1.04	0.31
	Yes	27	84.4	5	15.6		NS
DM:	No	19	86.4	3	13.6	0.13	0.72
	Yes	34	89.5	4	10.5		NS
Smoking:	No	25	86.2	4	13.8	0.25	0.62
	Yes	28	90.3	3	9.7		NS
EF%	Mean ± Sd	46.42±3.26		45.57±7.5		t=0.54	0.59 NS
No of proximal anastomosis:	Mean ± Sd	1.7±0.64		2.14±1.07		t=1.59	0.12 NS
No of distal anastomosis:	Mean ± Sd	2.7±0.64		3.14±1.07		t=1.60	0.12 NS
Number of grafts:	Mean ± Sd	2.7±0.64		3.14±1.07		t=1.6	0.12 NS
Mean bl pressure: (mmHg)	Mean ± Sd	71.45±5.12		72.57±7.28		t=0.52	0.61 NS
CBP time: (min)	Mean ± Sd	91.98±16.88		108.57±18.65		t=2.42	0.02*
AXC time: (min)	Mean ± Sd	70.09±14.53		67.86±29.42		t=0.33	0.74 NS
pre CPB B.G:	Mean ± Sd	136.66±18.82		136±16.01		t=0.09	0.66 NS
post CPB B.G:	Mean ± Sd	163.79±18.11		165.71±18.71		t=0.26	0.79 NS
Lactate 5 min. before clamp:	Mean ± Sd	1.6±0.43		1.66±0.68		t=0.29	0.78 NS
Length of ICU stay: (day)	Mean ± Sd	2.02±0.49		3.43±1.27		t=5.67	<0.001**
Drain: (cc)	Median(Range)	300(200-450)		400(200-1000)		MW=1.78	0.08 NS
Hospital stay: (day)	Mean ± Sd	7.68±1.02		6.71±2.06		t=2.06	0.04*
Duration of MV (day)	Median(Range)	6(6-48)		24(6-48)		MW=2.67	0.008*
Arrythmia:	No	39	84.8	7	15.2	$\chi2$	
	Yes	14	100	0	0	2.41	0.12 NS
Wound infection:	No	49	89.1	6	10.9	0.37	0.54
	Yes	4	80	1	20		NS
Stroke:	No	50	87.7	7	12.3	0.42	0.52
	Yes	3	100	0	0		NS
Pulmonary complications:	No	41	91.1	4	8.9	2.13	0.14
	Yes	12	80	3	20		NS
Mortality:	Live	53	93	4	7	23.91	<0.001**
	Dead	0	0	3	100		

SD: Standard deviation t: Independent t test MW: Mann Whitney test χ^2:Chi square test NS: Non significant (P>0.05) *:Significant (<0.05) **: Highly significant (P<0.001)

Acute renal injury, preoperative ejection fraction, and elevated glucose levels have also been identified in certain studies as independent predictors of postoperative hyperlactatemia. **Puspanjono et al. [4]** revealed that the lactate level peaked during CPB and dropped after the patient was admitted to the intensive care unit. Lactate levels were higher in patients with problems at all times.It is likely that the change in blood lactate during CPB is a better determinant of patient outcome because the serial blood lactate level or range has not been determined to correspond accurately with postoperative outcomes in the intensive care unit. Type A hyperlactatemia, a syndrome characterized by inadequate oxygen delivery, appears to be the primary cause of hyperlactatemia during cardiopulmonary bypass. The duration of cardiopulmonary bypass seems to be associated with the development of lactic acidosis, particularly with regard to the incidence of hypotension at the beginning of the bypass period **[32].**

5. Conclusion

After cardiac surgery, hyperlactatemia is common. Our analysis suggests that postoperative lactatemia monitoring is clinically helpful. A subgroup of patients at higher postoperative risk was identified by using a threshold of 3 mmol/L at the time of ICU admission. The CBP time and blood lactate levels following CPB in the SCT and DCT groups differed significantly. Additionally, we believe that the increased postoperative stroke reported in DCT groups is a result of increased aortic manibulation. In contrast, stroke incidence is lower in SCT, but sct has longer AXL and CPB times, which may be linked to elevated lactate levels. potentially enhance the prognosis by managing or preventing this metabolic imbalance. Since there was no discernible difference in the postoperative problems between the two groups, we assume that more research is necessary to fully understand how the clamping technique affects blood lactate levels.

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