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Research Article

# The effect of cross clamp time on Troponin I levels in patients undergoing coronary artery bypass grafting

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**Abstract:** **Background:** In this study, we investigated the change in aortic cross clamp time and Troponin I levels in 132 patients undergoing elective coronary bypass surgery. **Methods:** 65 of our patients were male and 67 were female. Blood samples were taken for Troponin I 3 times from each patient. (before cross-clamp, after per-operative cross-clamp placement and postoperative 1st day). **Results:** Mean age was 57,2 ± 4,4 years. Euro score value was 3,1 ± 1,5. Mean values were 198,1 ± 50,1 minutes for operation time, 58,2 ± 21,7 minutes for cross clamp time, 129,5 ± 17,4 minutes for cardiopulmonary bypass time and 572,5 ± 42,2 minutes for intubation time. Internal mammarian artery and saphenous vein grafts were used for coronary anastomosis in all patients. Overall intensive care unit stays were 3,4 ± 1,9 days and hospitalizations were 8,8 ± 4,7 days. Troponin I measurements were significantly higher with longer cross clamping time. **Conclusions:** There was a direct relationship between aortic cross clamp time and postoperative Troponin I levels in patients with coronary artery bypass graft surgery without any other cardiac pathology. We also think that the 50-minute cross clamp time is a safe and protective safety limit for these operations.
**Keywords:** Coronary artery bypass graft, cross clamp time, troponin I levels.

## INTRODUCTION

In cardiac surgery such as coronary artery bypass (CABG) or heart valve surgery, cardiopulmonary bypass (CPB) procedure is mostly used, resulting in different degrees of myocardial cell and tissue damage. In these patients using cross-clamp CPB, despite cardiac perfusion, cooling of patients and improvements in cardioplegic solutions, intraoperative myocardial damage may still occur. Cross-clamp duration, the amount of myocardial tissue volume affected, and the degree of ischemia have a direct relationship, and these factors play an important role in early postoperative success and survival of patients (Chaikhouni, A., & Al-Zaim, H. 2007; Sadony, V *et al.*, 1998).

In this study, we investigated the correlation between aortic clamp time (CCT) and Troponin I levels for elective coronary artery bypass graft operations in 132 patients.

## MATERIAL AND METHOD

A total of 132 patients were included in the study. Men and women were 49.2% and 50.8%, respectively. In this study, the effect of aortic cross clamp duration on Troponin I levels was investigated. Troponin I levels were measured with blood samples. These levels were measured 3 times for each patient. Troponin I levels were measured in blood samples before cross clamp operation, after cross clamp and postoperative first day. Biochemical analysis was performed in Troponin I measurements. The Troponin I ELISA kits (Boehringer Mannheim) was used in the ES 300 immunoassay. Normal values for Troponin I were evaluated in the range 0-0.06 ng / mL. Values above 0.2 ng / mL, which are indicative of cardiac injury, were considered significant. Surgery was performed by the same resident's team consisted of 2 cardiac surgeons.

Data that could directly affect Troponin I levels such as age, gender, Euroscore, co-morbidity (diabetes, hypertension), smoking history, lung disease, echocardiographic parameters, number and type of coronary artery bypass grafts, operative time, and postoperative conditions were recorded for evaluation. In addition, the parameters of the intensive care unit were also recorded as intubation time, daily bleeding volumes and blood and blood product use. As a final

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data, this prospective study also presented the patients' intensive care unit and total hospitalization time.

Propofol, fentanyl citrate and pancuronium bromide were preferred for surgical premedication. After endotracheal intubation, propofol and fentanyl citrate were used as the maintenance of anesthesia. Inhaled anesthesia obtained by sevoflurane. Procedures were performed for each patient for surgical procedures. Median sternotomy was performed in all patients. Left internal mammarian artery and large saphenous vein were used in each patient. Patients were given heparin at a dose of 350U / kg to establish CPB. Thus, the activated clotting time reached at least 400 seconds. After pericardiectomy, aortic caval cannulation was performed. Patients were usually cooled to 32 degrees after initialization of CPB. After the aortic cross-clamp was inserted, pleisol solution was used as a cardioplegic agent for myocardial protection (10 cc / kg). Blood cardioplegia was performed for every 20 min. All patients were given hot blood before the cross clamp was removed. Cross-clamp was removed after all coronary anastomoses were performed. Aortic proximal anastomoses were performed during the patient warming period. CPB was removed and after control of bleeding mediastinal and thoracic cavity drains were placed. The operations were terminated by closing sternum. The patients were then transferred to our intensive care unit for follow-up and extubation.

The exclusion criteria were as follows: patient age lower than 50 and higher than 75, existence of preoperative medically treated renal disease or chronic obstructive pulmonary disease, existence of preoperative hematological dysfunction, preoperative warfarin and/or fibrinolytic agent treatment, acute myocardial infarction with emergent surgery, re-operations for CABG, concomitant valve and/or vascular surgery, existence of preoperative atrial fibrillation, intraoperative or early postoperative deaths, intra-aortic balloon pump implantations, off-pump CABG operations, left ventricle ejection fraction equal or worse than 35 %, postoperative severe neurologic and/or other systemic complications, reoperations for early massive bleeding after surgery.

## RESULTS

We tried to examine the change in Troponin I levels due to cross clamp use. Blood samples taken in 3 periods and Troponin I values were recorded and the effect of cross clamp time was investigated. In the postoperative period, it was decided to remove the patient in the event of an important systemic complication or death and these patients were excluded from the study. Our preoperative and operative data are summarized in Table 1.

**Table-1. Preoperative and operative variables**

| Parameters | Mean | Number | % |
|---|---|---|---|
| Age (years) | 57,2 ± 4,4 | | |
| Male/Female | | 65/67 | 49.2/50.8 |
| Hypertension | | 102 | 77,2 |
| Hyperlipidemia | | 87 | 65,9 |
| Diabetes Mellitus | | 79 | 59,8 |
| LVEF | | | |
| 35-40 | | 14 | 10,6 |
| 40-50 | | 48 | 36,4 |
| > 50 | | 70 | 53 |
| Smoking history | | 124 | 93,9 |
| Euroscore | 3,1 ± 1,5 | | |
| Coronary artery bypass counts | | | |
| Less than 3 vessels | | 24 | 18,2 |
| 3-vessels | | 71 | 53,8 |
| 4-vessels | | 21 | 15,9 |
| More than 4 vessels | | 16 | 12,1 |
| LIMA usage | | 130 | 98,5 |
| Saphenous vein usage | | 132 | 100 |
| Endarterectomy | | 111 | 84,1 |
| Aortic CC time (min) | 58,2 ± 21,7 | | |
| CPB time (min) | 129,5 ± 17,4 | | |
| Operation time (min) | 198,1 ± 50,1 | | |
| Intubation time (min) | 572,5 ± 42,2 | | |
| ICU stay (day) | 3,4 ± 1,9 | | |
| Hospitalization (day) | 8,8 ± 4,7 | | |
| Reoperation for bleeding | 9 | | 6,8 |

LVEF: Left ventricle ejection fraction, CABG: Coronary Artery bypass graft, CC: Cross clamp, CPB: Cardiopulmonary bypass, ICU: Intensive care unit, LIMA: Left internal mammarian artery.

Saphenous vein was used for coronary bypass grafting and LIMA was used in most patients. Postoperative bleeding levels gradually decreased after the second day, and 9 patients required revision for bleeding.

Postoperative data and complications were presented in Table 2. Neurological dysfunction was observed in 5 patients. Neurological conditions such as transient ischemic attack, agitation and orientation problems did not cause any morbidity or mortality in the postoperative period. In 11 patients, sternum problems and mediastinal region-related infections were observed. Only 3 patients underwent sternal revision. In the other 5 patients, the infection improved with vacuum assisted closure systems. The other 3 patients disappeared with superficial infections antibiotic treatment and dressing.

**Table-2. Postoperative complications and data**

| Parameters | Number | % |
|---|---|---|
| Inotropic support (single) | 34 | 25,7 |
| Inotropic support (double) | 31 | 23,5 |
| Atrial fibrillation | 18 | 13,6 |
| Pulmonary dysfunction failure without intubation | 11 | 8,3 |
| Defibrillation for ventricular fibrillation | 5 | 3,8 |
| Postoperative IABP application | 7 | 5,3 |
| Re-intubation | 4 | 3 |
| Diuretic need | 55 | 41,6 |
| Neurologic dysfunction | 5 | 3,8 |
| Death | 2 | 1,5 |
| Infections associated with sternotomy and mediastinal region | 11 | 8,3 |
| GI dysfunction | 4 | 3 |
| Renal dysfunction | 12 | 9,1 |

IABP: Intra-aortic balloon pump; GI: Gastrointestinal

Two patients died postoperatively. The EF of these two patients was 35%, and these patients had multi-vessel disease. Despite IABP and bilateral inotropic support, all 2 patients died in the first postoperative week in the ICU. Gastrointestinal hemorrhage occurred in 3 patients and paralytic ileus in 1 patient. Clinical manifestations were improved in 4 patients with nasogastric tube insertion, oral feeding and blood transfusion. Twelve patients had different degrees of renal dysfunction. In 9 of these patients, creatinine values increased to 2,1-2,5 mg/dL. Renal function improved with fluid replacement without dialysis. In 3 patient, anuria appeared creatinine levels increased to 3,5-4 mg/dL levels. Dialysis was performed 2 times a week for 1 month postoperatively. After 1 month, renal dysfunction regressed and the patient was discharged.

Troponin I levels taken 3 times were evaluated postoperatively. Table 3 shows the mean results of troponin I for samples taken in all 3 periods. As shown in Table 3, the mean troponin I levels of the patients were within the normal range before the cross-clamp was inserted. After entering the CPB and inserting the cross clamp (during operation), it is observed that the average of troponin I levels increased. On the first postoperative day, the mean results of the troponin I levels were similar to those obtained during operation (cross-clamped). In addition, we compared the levels of troponin I in the operative and postoperative periods with cross-clamp times.

**Table 3: Mean Troponin I for all 3 periods**

| Blood samples taken 3 period / Troponin I levels | Mean troponin I levels (ng/mL) |
|---|---|
| Before cross clamping | 0,03 ± 0,4 |
| After cross clamping (during operation) | 2,5 ± 1,5 |
| Postoperative first day | 2,7 ± 1,4 |

Table 4 shows the comparison of cross-clamp times with troponin I levels during operation (CPB + cross-clamp) and postoperative first day. The highest cross-clamp time was 92 minutes, the lowest was 31 minutes. The mean cross-clamp time was 58,2 ± 21,7. There was no difference in the levels of troponin I during the operation and postoperative first day. The mean values were similar. However, troponin I levels were also increased as cross clamp times increased. The mean of the troponin I levels in both the operation and the postoperative first day were higher in the prolonged cross clamp periods (Table 4). These results also showed that the increase in troponin levels was seen more in cross-clamp times of more than 50 minutes (Fig.1).

**Table 4: Comparison of prolonged cross clamp times and troponin I levels**

| Cross clamping time / Troponin I levels | during operation troponin I levels (CPB+CC) | postoperative first day troponin I levels |
|---|---|---|
| < 40 (min) | 2,2 ± 1,2 | 2,0 ± 0,9 |
| 40-50 (min) | 2,3± 1,3 | 2,1 ± 1,5 |
| 50-60 (min) | 5, 9 ± 1,2 | 5,5 ± 1,4 |
| 60-70 (min) | 7,2 ± 2,2 | 7,8 ± 1,6 |
| > 70 (min) | 7,5 ± 2,3 | 7,6 ± 2,0 |

CPB: Cardiopulmonary bypass; CC: Cross clamping

## DISCUSSION

There are some parameters indicating myocardial injury in various clinical conditions such as acute myocardial infarction (AMI), myocarditis, polymyositis, low exercise capacity, sepsis, multiorgan failure, severe pulmonary embolism and / or tachycardia, cadogenic shock, heart failure or cardiomyopathy (Vermes, E. *et al.*, 2000; Galvani, M. *et al.*, 1997; Carrier, M. *et al.*, 2000). Some serum markers such as troponins, creatinine kinase and its isoenzyme types, sedimantation levels, lactate dehydrogenase, aspartate transaminase, ischemia-modified albumin, natriuretic peptide, and glycogen phosphorylase isoenzyme bb and myoglobin were determined by this evaluation with blood serum samples.

Troponin has different subunits as Troponin C, Troponin T and Troponin I. Troponin is a product of actin and myosin filament degradation. In physiological point of view, Troponin consists of three different proteins and is a segment of both skeletal and cardiac muscle. It plays a key role on muscle contraction stimulated by action potential, sarcoplasmic reticulum and calcium through actin and tropomyosin. Troponin I specifically interacts with actin to hold this tropomyosin complex by muscle activity. Troponin I and Troponin T are called as "cardiac troponins". Because, they provide valuable evidence for heart muscle damage. Troponin I has been shown to be the most sensitive and most specific assessment method in many articles in terms of cardiac muscle functions. Troponin I is a clear indicator of myocardial cell damage and myocardial cellular ischemia released through cytosolic structures of myocytes (Adams 3rd, J. E. *et al.*, 1993; Etievent, J. P. *et al.*, 1995).

Chaikhouni, A., & Al-Zaim, H. (2007) conducted studies to determine the relationship between coronary bypass surgery and troponin levels. This study argues that changes in troponin levels are an independent predictor of morbidity and mortality in the short and long term. In their study group of 333 patients, 77 patients had a Troponin value over 10 mg/ml (Group II). Group II reported to have more cardiac (13 %) and non-cardiac (12 %) complications, postoperatively. These postoperative complications were stroke, bleeding, arrhythmia, infarction, pleural effusion, renal insufficiency, wound infection, confusion and gastrointestinal conditions. Chaikhouni also showed a higher mortality rate in this Group II in 6.5 % when compared to the other group with lower postoperative Troponin levels in 0.4 %. Our results also showed that cross-clamp had negative effects on troponin levels such as other studies (Galvani, M. *et al.*, 1997; Adams 3rd, J. E. *et al.*, 1993; Etievent, J. P. *et al.*, 1995). In addition, it was determined that long cross clamp times increased at troponin levels compared to other short cross clamping times. In addition, it was determined that long cross clamp times increased at Troponin levels compared to other short cross clamping times. It has been shown that cardiac cell damage, heart failure findings and adverse cardiac conditions may be higher in these cases.

A similar study was conducted by Sadony *et al.* (1998) In this study, it was determined that patients with coronary artery bypass grafting and cross-clamping had more or less varying degrees of myocardial damage. He reported that the prognostic effects of Troponin I on various types of myocardial injury, including transmural infarction, were 100 % sensitivity and 97 % specific. In this study, it has been reported that all patients undergoing coronary artery bypass surgery have a myocardial damage.

Despite many studies, the variation between cross-clamp time and Troponin levels remains unclear. The aim in our study was to prove this relationship and to determine cross-clamp times that resulted in higher levels of Troponin. In other words, we tried to find safe cross-clamp times in patients who would undergo coronary bypass surgery using cross-clamp. According to the results of our study, we have determined that surgical procedure will be performed safely in patients with cross-clamp time shorter than 50 minutes. In these cases, while troponin levels were found to be increased at reasonable levels, troponin levels were found to be significantly higher in cross-clamp periods that lasted more than 50 minutes. This causes significant increases in myocardial tissue damage. When the patients who died in the postoperative period were examined, we determined that these patients had a lot of vessel disease and therefore cross clamp times were more than 50 minutes. These high levels of troponin have been shown as an indicator of cardiac failure and our patients have been lost due to heart failure. In other words, high cross-clamp durations cause significant increases in morbidity and mortality.

Cardioplegia application plays an important role in reducing myocardial injury during the operation. Cardioplegia solutions protect both myocardial cells and stop the heart and are effective in making easy and effective surgery. In the hearts with proximal coronary artery disease, retrograde cardioplegia should be administered continuously in addition to antegrade cardioplegia to protect the heart muscle. In patients with particularly significant proximal coronary lesions, a surgical procedure involving successful and low myocardial cell damage can be achieved with retrograde cardioplegia and short cross-clamp time (Adams 3rd, J. E *et al.*, 1993; Chaikhouni, A., & Al-Zaim, H. 2007). However, since we have created a working principle that provides the same characteristics for all patients, we have generated similar patient data by performing the same preoperative and operative applications for all patients. To evaluate the relationship between cross clamp time and troponin, we had to choose the same surgical principles as the patients with the same characteristics. We also tried to prevent such additional pathological conditions that could cause myocardial cell damage such as rhythm problems, bleeding, low oxygen values, blood pressure, and electrolyte changes during and after surgery as soon as possible. Further studies are needed, even though short cross clamp times are important for reducing the levels of troponin (ie, reducing cell damage), which is indicative of myocardial cell damage, according to the results of other studies and our study. Because myocardial cell damage can be affected by many factors. The patient's age, additional diseases, preoperative status, severity and localization of coronary lesions, and the degree of myocardial cell damage in the case of other heart diseases may be different (Caputo, M. *et al.*, 1997; Eigel, P. *et al.*, 2001). As we mentioned above, we chose as much similar patients as possible in creating this study and tried to apply the same surgery and methods in the operation.

## CONCLUSION

It is a known fact that high levels of Troponin are always associated with more damaged myocardial cell damage. There is a direct relationship between aortic cross clamp time and postoperative Troponin I levels in patients with coronary bypass surgery. A cross clamp duration of more than 50 minutes leads to an increase in Troponin levels, the most important finding indicating high myocardial cell damage.

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