Original Article

The Effect of the Cross Clamp Time on the Post Operative Ventilation in Post Cabg Patients

Ahmed Sultan Mohamed, Mohamed Ezzeldin Azzam*, Ahmed Hamdy Lamlom, Waleed Gamal Abo Senna, Mohamed Ibrahim Sewielam, Tarek Mohamed Kandeel

Cardiothoracic surgery Department, Kasr Ainy Medical School, Cairo University, Egypt

Correspondence: Mohamed Ezzeldin Azzam, Cardiothoracic surgery Department, Kasr Ainy Medical School, Cairo University, Egypt, E.Mail: dr.mohamed.ezzazzam@gmail.com

ABSTRACT

Background: Coronary artery bypass grafting using cardio pulmonary bypass is a successful procedure in modern medicine; however, prolonged aortic cross clamp time is linked to adverse outcome following cardiac surgery. During aortic cross clamping, a period of global myocardial ischemia is followed by reperfusion injury that manifests as myocardial stunning, arrhythmia and changes in cardiac performance that needs inotropic support in early post-operative period, also associated with acute lung injury that needs mechanical ventilation of different duration. Objectives: To assess the effect of the aortic cross clamp time on the mechanical ventilation post-operatively. Patient and methods: Thirty elective patients of isolated ischemic heart disease undergoing on pump CABG, were collected from Cardio Thoracic Surgery department Elkasr Alainy Hospital. We assessed the post-operative ventilation time and inotropic support of those patients post-operatively. Results: Statistical analysis showed, when the mean time of the cross clamp was (±73minutes), the mechanical ventilation time was only up to one day in twenty-five patients (83.33%), but with increased time of the cross clamp, when the mean time was (±135 minutes), the post-operative ventilation was up to three days in four patients about (16%). Conclusion: Prolonged aortic cross clamp time correlates with post-operative morbidity and mortality studies to decrease this morbid effect are warranted.

Keywords: Coronary artery bypass grafting, cross clamp time, mechanical ventilation

Introduction

(CABG) is one of the most important surgical procedures in the history of medicine. Arguably, no other operation has prolonged more lives, provided more symptom relief, and been more thoroughly studied[1]. The predictions have not materialized, and most institutions have reduced their use of off-pump CABG to only 5% to 15% of cases, Despite the belief that the need for CPB would be significantly diminished because of the surge in interest in off-pump coronary artery bypass grafting (CABG),[2]. Moreover, the ability of the heart to assume normal electromechanical function adequate to support the systemic circulation must rapidly follow the ischemic interval. The need for inotropic support or mechanical support devices (e.g., ventricular assist device, intra-aortic balloon assist device) to wean the patient from cardiopulmonary bypass when support was not required preoperatively represents a failure of myocardial protection[3]. The contribution of systemic inflammatory response to CPB and surgical trauma may worsen cardio circulatory disturbances. The usage of certain drugs (e.g., calcium-channel antagonists, angiotensin-converting enzyme inhibitors, and heparin) for long period of time, patients' co-morbidities (e.g., diabetes mellitus, heart failure,) and procedure-related factors (e.g., residual hypothermia, prolonged CPB), have been identified as contributors of norepinephrine-resistant vasoplegia being associated with mortality rates as high as 25% when vasoplegia prolonged for more than 36 h[4].

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AIM OF WORK

The overall aim of this paper is to find out the correlation between prolonged cardiopulmonary bypass and cross clamping time, on one hand, and the post-operative mechanical ventilation time on the other hand, in low risk ischemic heart patients undergoing on pump coronary artery bypass grafting.

Patients and Methods

I. Patient population:

This prospective non-randomized study included 30 ischemic patients who were candidates for isolated on-pump CABG surgery in Kaser alainy hospital after obtaining the approval of the local ethical committee.

III. Preoperative assessment:

In the study, all patients were assessed in the preoperative period along the following lines:

1) History: A full history was taken from each patient including her/his age, history of Diabetes Mellitus (DM), hypertension (HTN), and functional status is assessed according to the New York Heart Association (NYHA) criteria (for heart failure symptoms) and the Canadian Cardiovascular Society (CCS) classification (for angina pectoris). Also history of smoking and symptoms suggestive of COPD (expectoration and chronic cough) were kept in mind.

2) Clinical Examination: full physical examination and a local cardiological examination

3) Investigations: Routine panel of preoperative studies, including:

- **Laboratory Investigations:**

i. Complete blood picture (CBC)
ii. Renal and liver function tests (urea, creatinine, creatinine clearance, ALT, AST, total and direct bilirubin, Prothrombin time and concentration, albumin.
iii. Electrolytes (Na, K, Ca, Ph)
iv. Lipid profile (TGs, HDL, LDL, cholesterol) Fasting and 2 hours' postprandial blood glucose level was included.

- **Imaging:**

-**Electrocardiogram (ECG):** 12 lead ECG was done to assess any present ischemia or previous myocardial infarction.

-Radiological Examination: Plain chest x-ray (PA and lateral views) was done in the erect position after full inspiration to assess the cardiothoracic ratio and detect any lung or chest wall abnormalities.

-Trans thoracic Echocardiography (Echo): Two dimension, M Mode, and Doppler echocardiography were done for each patient. The different dimensions of the cardiac chambers were measured as well as the LV Function, regional wall motion abnormalities and valves evaluation.

-Coronary Angiography: Coronary angiography was used to determine the different sites and extents of coronary arteries blockage and the culprit lesions.

4) Preoperative Counseling: A brief explanation of the steps of the surgery and postoperative ICU course with possible complications early and late postoperative were explained to the patients in the preoperative visit prior to surgery.

5) Preoperative Preparation: A broad spectrum antibiotic (usually first generation cephalosporin) and an H2 receptor blocker were given on the night of the surgery and in the early morning. A 10 mg intramuscular injection of morphine sulphate was given before the patient left the ward for surgery. All the patients have their chests, forearms and legs up to the level of the thighs shaved on the night if the surgery. Cleaning the body areas was carried out after shaving by Bovidin iodine.

IV. Intraoperative management:

- **Cardiopulmonary Bypass (CBP):**

Membrane oxygenators were used in all cases. The hematocrit of the patients was aimed at around 28%. Intermittent antegrade warm blood cardioplegia which was instilled in the ascending aorta to achieve a good myocardial protection by starting with an initial dose of 300 ml/min for 3 minutes and containing 15 mEq of potassium chloride. Additional doses of cardioplegia were given every 20 minutes at a rate of 200 ml/min for 2 minutes containing 5 mEq of potassium chloride.

Operative data and Parameters:

- Total bypass time: This is the time from initiating the cardiopulmonary bypass until weaning from the cardiopulmonary bypass.
- Total cross clamp time: This is the time recorded from applying the aortic clamp until removal of the clamp.
- Urine output and aspect on bypass: The amount of urine collected in cc starting upon initiation of the bypass till its weaning and its aspect
- Use of intra-aortic balloon.
- Blood transfusion: The number of blood units transfused to each patient during the procedure whole or packed (on bypass and post weaning)
- Use of grafts: The number and type of grafts used for patients, arterial and venous
- ABGs (pH and BE): ABG results (pH and BE) was obtained at the beginning before starting the procedure (baseline) and after completion of the procedure, before weaning off cardiopulmonary bypass.

V. Postoperative Assessment:

All patients were assessed thoroughly during their ICU stay till their transfer to the ward and their discharge from the hospital.

*Duration of Mechanical Ventilation (MV):

The average number of hours from the time the patient was transferred to the ICU to the time of his/her extubation.

Extubation criteria included the following:

- Full recovery
- Adequate ventilation
- Satisfactory ABG including electrolyte readings
- CPAP with pressure support of 5 cm H2O
- Fractional inspired oxygen concentration (FiO2) of 40% or less

- Hemodynamic stability with minimal or without inotropic support
- Minimal drainage from chest tubes

The prolonged mechanical ventilation (PMV) was defined as cumulative duration of 24 hours or more of post-operative endotracheal intubation starting from transfer of the patient to cardiac intensive care unit after completion of the desired operation. This implies that it included patients who were not extubated within 24 hours as well as those who had one or more unsuccessful extubation attempts resulting in an accumulated duration of at least 24 hours of endotracheal intubation.

*Incidence of major complications:

- Postoperative ischemia: It is defined by new ECG evidence of ischemia as evidenced by ST segment depression or T-wave inversion. A 12-lead ECG was done immediately upon admission to the ICU, 12 hours later and 24 hours postoperatively.
- Postoperative myocardial infarction: It is defined by new ECG evidence of MI as evidenced by new Q-wave, ST segment changes with elevated cardiac enzymes (CK-MB >100 IU/L or >10% of total CK level).
- Re-exploration: It regards bleeding and the need for blood transfusion.
- Neurologic dysfunction: It is defined as a central neurologic deficit, persisting for more than 24 hours and severely affecting amputation and day-to-day function.
- Renal impairment: It is defined as a serum creatinine level above 2 mg% whether or not requiring postoperative dialysis.
- Chest infection and respiratory failure.

4) Length of ICU stay (LOS): It is defined as number of days from patient's arrival to the ICU to patient's transfer to ward.

5) In hospital length of stay (LOS): It is defined as the total number of days from operation to patient's discharge from the hospital.

6) Early mortality: It is defined as death after the procedure before patient's discharge regardless of the duration of hospitalization, or equal to 0.05 was considered significant and less than 0.01 was considered highly significant.

Results

- Patient demographics: The study was conducted on 30 patients with isolated ischemic heart disease, who met the inclusion criteria admitted in Cardiothoracic Unit, Cairo University.

Vascular revascularization was done to all those patients (on pump coronary artery bypass grafting).

Table 1: Preoperative patients' characteristics

Number of patients		Thirty(30)
Clinical characteristics:		
I.	Age (years).	51.6 ± 8.8
II.	SEX.	21 Males (70%), 9 Females (30%)
III.	BMI(Body mass index).	27.3 ± 3.5

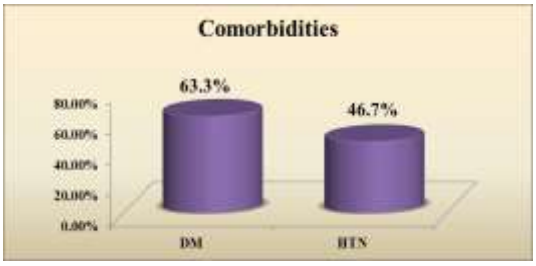

Figure1: DM and HTN Distribution

Table 2: Preoperative clinical and echocardiographic data

a. Smoking.	
	16 Patients were smoker.
	14 Patients were non-smoker.
b. NYHA:	
Class I	4 Patients (13.3 %)
Class II	13 Patients (43.3 %)
Class III	13 Patients (43.3 %)
c. BMI:	
• More than 30: (obese).	8 Patients (26.7 %)
• From 25 to 30: (overweight)	19 Patients (63.3 %)
• From20 to less than 25: (average)	2 Patients (6.7 %)
• Less than 20: (underweight).	1 Patient (3.3 %)
d. EF %	50.8±10.8

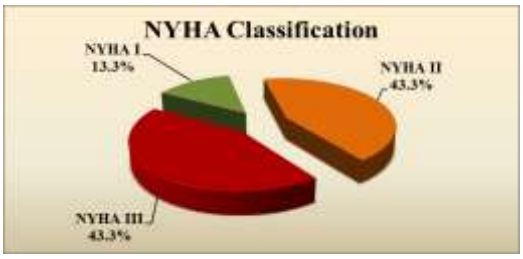

Figure2: Pie chart to show the classification of patients according to NYHA

Operative results:

Table 3: Intra-operative data

	Range	Mean ± SD
Total CBP time (min).	30-175	108.8 ± 29.1
Cross clamp time (min).	20-150	79.8 ± 26.8
No. of distal anastomosis.	1-5	3.1 ± 1.2
Intra-operative inotropic support	Needed in 3 patients (10 %).	
Intra operative IABP insertion.	Not needed for any patients in this study group.	

The left internal mammary artery (LIMA) was exclusively used to bypass the left anterior descending artery (LAD) in the entire study group. A total of 1-5 distal coronary anastomoses were

constructed in the study group with a mean of 3.1 ± 1.2 anastomoses per patient.

The mean duration of aortic clamping time and cardiopulmonary bypass were 79.8±26.8 min and 108.8±29.1 min, respectively. There was no need for intra-aortic balloon counter pulsation in any patient.

- **Post-operative results:**

❖ Post-operative mortality:

Table 4: Post-operative morbidity and mortality

Post-operative mortality	One patient (3.33%)
Post –operative ICU stay (days)	2.3± 1.0
Post- operative hospital stay (days)	8 ±1.8
Post-operative MV (hours)	9.8 ± 8.4
Post-operative inotropic support	3 patients (10%)
Post-operative pulmonary complications	Post-operative pulmonary complications

The overall post-operative mortality in our study was one patient, constituting a 3.3 % mortality rate. This was a 63 years old male patient who was diabetic, hypertensive, chronic heavy smoker with BMI of 28, his echo showed EF 40%, he underwent CABG x 3 with LIMA to LAD with endarterectomy, SVG to RCA and SVG to OM.

Intraoperatively, the Bypass time was 172 minutes and the cross clamp time was 123 minutes, inotropic support in the form of (0.15 µg/Kg/min adrenaline) was needed for weaning from the cardiopulmonary bypass.

Postoperatively, patient could not be weaned from inotropic or mechanical ventilation. Brief bed side transthoracic echocardiography was done and showed deterioration of EF to 25% with a kinetic anterior wall.

Patient started to develop low cardiac output manifestations in the form of decreased urine output and hemodynamic instability. Frequent arrhythmias in the form of ventricular extra systoles were noticed in the

Patient's ECG for which amiodarone loading dose was started, but intractable ventricular fibrillation developed not responding to multiple DC shocks and CPR and the patient passed away eight hours from the transfer.

❖ Post-operative ICU stay:

The mean period of ICU stay was 2.3± 1.0 days; while the mean hospital stay time was 8 ± 1.8 days. Four patients required prolonged ICU stay > 5 days, due to either high inotropic support which required longer time for weaning or due to pulmonary dysfunction the required time for weaning from mechanical ventilator.

❖ Post-operative mechanical ventilation:

The post-operative mechanical ventilation time ranged from 5 to 48 hours with mean of 9.8 ± 8.4 hours.

Most of the patients were extubated within the first 24 hours post-operative, except for four patients who required mechanical ventilation beyond 24 hours.

❖ Post-operative Inotropic support:

The post-operative duration of inotropic support ranged from one to three days with mean of 2±1 day. Three patients were in need for post-operative inotropic support (10%).

❖ Bleeding and Re-exploration:

Two patients had postoperative bleeding, requiring blood and blood products transfusion; however, no one of them required re-exploration.

❖ Pulmonary Complications:

Three patients had pulmonary complications, two of them had profuse chest secretions with poor oxygenation, and one was complicated with left lower lobar collapse with viscid secretions that required frequent suction.

Table 5: Comparison of different parameters as regarding sex

	Sex		
Different parameters	**Male (n=21)**	**Female (n=9)**	**P value**
MV time	10.7±10.0	7.8 ±0.8	0.4 NS
ICU LOS	1.8±1.1	1.6±0.5	0.6 NS
Hospital LOS	6.8±2.2	7.6 ±0.5	0.3 NS

Table 6: Comparison of different parameters as regarding presence of hypertension

	Hypertension		
Different parameters	**Present (n=14)**	**Absent (n=16)**	**P value**
MV time	8.6±4.7	10.9 ±10.8	0.5 NS
ICU LOS	1.5±0.5	1.9±1.2	0.2 NS
Hospital LOS	6.6±1.9	7.4 ±1.9	0.2 NS

Table 7: Comparison of different parameters as regarding presence of Diabetes Mellitus

	Diabetes Mellitus		
Different parameters	**Present (n=19)**	**Absent (n=11)**	**P value**
MV time	9.2±5.3	10.9 ±12.4	0.6 NS
ICU LOS	1.7±0.8	1.7±1.2	1.0 NS
Hospital LOS	7.2±1.8	6.8 ±2.2	0.6 NS

Table 8: Correlation of Age, BMI, EF and Smoking

index and NYHA with other parameters						
		Age	BMI	Smoking index	NYHA	EF
MV time	r	0.520	0.199	0.640	0.311	-0.021
	P	0.003	0.292	0.008	0.094	0.912
Inotropic time	r	0.655	-0.655	0.500	0.0	0.951
	P	0.546	0.546	0.667	1.0	0.201
ICU LOS	r	0.405	0.242	0.665	0.410	0.181
	P	0.026	0.198	0.005	0.024	0.338
Hospital LOS	r	0.378	0.271	0.673	0.145	0.197
	P	0.040	0.147	0.004	0.444	0.296

Table 9: Correlations between cross clamp time & other parameters

		Bypass time	Cross clamp time	No grafts	MV time	Inotropic time	ICU LOS
Cross clamp time	r	0.982					
	P	<0.001					
No grafts	r	0.687	0.678				
	P	<0.001	<0.001				
MV time	r	0.644	0.687	0.306			
	P	<0.001	<0.001	0.100			
Inotropic time	r	0.397	0.500	0.500	0.866		
	P	0.00 7	0.0 07	0.667	0.333		
ICU LOS	r	0.581	0.582	0.574	0.749	0.961	
	P	0.001	0.001	0.001	<0.001	0.179	
Hospital LOS	r	0.259	0.216	0.413	0.380	0.939	0.761
	P	0.166	0.251	0.023	0.038	0.224	<0.001

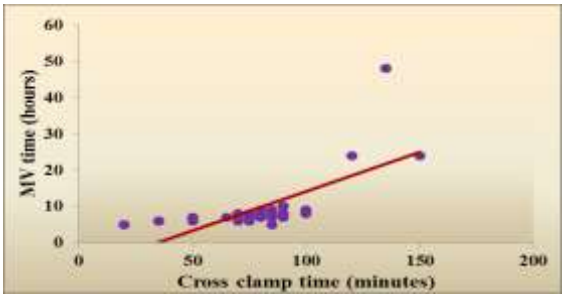

Figure3: Scatter plot showing the positive correlation between intra-operative cross clamp time and post-operative mechanical ventilation time

Discussion

Our study in the Coronary artery bypass graft (CABG) surgery that is one of the most common operations in cardiac surgical field, can be done either with usage of cardiopulmonary bypass on pump or off pump, it's the procedure for cardiac revisualization to relief chest pain and associated dyspnea and exercise intolerance. When the patients have a good target vessel vascular anastomosis is simple and done in short time compared to another poor target vessel where the procedure becomes lengthy and carries the risk of early graft occlusion or graft failure. Unlike closed cardiac procedures on pump CABG procedures, there is relative myocardial hypoxia due to interruption of the coronary circulation. As we found in this study, there is a direct relation between the cardiopulmonary bypass time, and the cross clamp time on one side and the clinical outcome of the patients. Where with cardiopulmonary bypass duration of around (135) minutes and cross clamp time around (73) minutes in 25 patients (83.33%) of the sample size there was no need of post-operative inotropic usage and there was early extubation within the first day post-operative, and also there was early transfer from ICU to the ward. In general, the post-operative outcome was significantly different from the other patients, when the bypass time was (around 163) minutes and the cross clamp time was (around 102) minutes. There was one post-operative mortality patient (3.33%), mandatory usage of inotropes during weaning from the cardio pulmonary bypass in three patients (10%) and the extubation was beyond the first two days post-operative in four patients (13.33%). With increased cross clamp (XCL) time the reduction in the cardiac output, prolonged ventilation time, renal dysfunction; prolonged hospital stay in a study on patients underwent on pump CABG about four thousands patients**,** Cross Clamp time >60 min was an independent risk factor for low cardiac output, prolonged mechanical ventilation time, renal dysfunction, blood transfusion, mortality and prolonged hospital stay, one minute interval in XCL time was associated with a 2% increase in mortality[5]. A study included patients with isolated ischemic heart disease patients for on pump CABG where the mean cardio pulmonary bypass time (97.8 ±15.3) minutes and mean cross clamp time of (52.6 ± 12.0) minutes, the results was early patients extubation in about 30% of the total patients' number; while, with mean cardio pulmonary bypass of (118.2 ± 23.0) minutes and cross clamp time of (68.8 ± 48.8) minutes, there was late extubation. The extubation within first eight hours' post-operative is considered as early extubation and more than eight minutes is considered as late extubation. The recommendation is the refinement of surgical techniques, decrease in cardiopulmonary bypass time, and performance of off-pump CABG can lead to early extubation [6]**.** A major risk factor for late extubation was prolonged cardiopulmonary bypass after CABG. It is associated with a systemic inflammatory response; this has harmful effect on important organs, such as the heart, lung, kidney, and brain, prolonged cardiopulmonary bypass was expected to negatively influence cardiopulmonary and renal functions, and thus requirement of longer ventilation support with high settings for long period of time. In addition, prolonged cardiopulmonary bypass and cross clamp time associated with poor myocardial protection may have led to longer ventilation support [7].

In 2012, a study on ventilator-associated pneumonia (VAP) following cardiac procedure in which they reported a direct relationship between CPB time and aortic cross clamping time

and the risk of development of ventilator associated pneumonia which is a major risk of mortality after cardiac surgery [8].

In a prospective observational study, they used the levels of cardiac markers (e.g. troponin, IL-6, CK-MB), as markers of myocardial injury in response to CPB and aortic cross clamping time. They reported that CPB time and aortic cross clamping time had a direct relation to the increase and the peak of troponin level on 30 adults undergoing elective on pump CABG surgery [9].

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