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Correlation between Prolonged Aortic Cross Clamp and New Onset Cardiac Arrhythmia after Cardiac Surgery

Mohammad H. Khassawneh(MD)[1*], Sakher M. Maayah(MD)[1], Mohammad A. Abu Taleb(MD)[1], Malek A. Alrihani(MD)[1], Waed K. Alhourani(MD)[1]

[1]Department of Cardiac Surgery, Queen Alia Heart Institute, Jordan

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***Corresponding author:** Dr. Mohammad H. Khassawneh (MD)
Department of Cardiac Surgery, Queen Alia Heart Institute, Jordan

Abstract **Original Research Article**

***Objectives*:** Cardiac arrhythmia involves a wide range of abnormalities associated with heart rhythm and rate disorders. It mainly refers to an irregular rhythm of the heart. It has been demonstrated through various clinical studies that aortic cross-clamp time during cardiac surgeries are independent predictors of the morbidity and mortality, and prolonged cross-clamp (XCL) time have been linked to the low cardiac output. Present study was aimed to examine the correlation between the prolonged aortic cross clamp time (XCL) in low-risk patients and the incidence of cardiac arrhythmia during cardiac surgery within 48 hours postoperatively. ***Methods*:** A retrospective study was carried out from March 2020 to February 2021 including 100 patients who underwent elective cardiac surgery as low-risk patients. The duration of XCL and new-onset cardiac arrhythmia was monitored within the first 48 hours postoperatively. ***Result*:** This study revealed a significant relationship between new onset Arrhythmia and prolonged cross clamp time (more than 90 min). It also revealed a weak correlation ($r = 0.26$) between the aortic cross clamp time and new onset of cardiac arrhythmia after cardiac surgery (average XCL time 60 min). Therefore, this study suggested XCL time one of important predictors of cardiac arrhythmia postoperatively. ***Conclusion*:** Prolonged aortic cross-clamp time was found to minimally affect the incidence of arrhythmia in cardiac surgery within 48-hour post-operatively in low-risk cardiac patients. Patients with cross clamp time of over 90min were observed to be the most affected by the Arrhythmia with a high prevalence rate, which further buttress on the fact that extended/prolonged XCL affect cardiac arrhythmia after cardiac surgery.

Keywords: Arrhythmias, cross-clamp time, Cardiac surgery.

INTRODUCTION

The term "cardiac arrhythmia" generally refers to the set of conditions of irregular heartbeat which may be either faster or slower than the normal heartbeat [1]. Currently, the main types of cardiac arrhythmia include supraventricular tachycardia, conduction block, bradyarrhythmia, premature beats, and ventricular arrhythmia [2]. Premature beats primarily encompass the ventricular premature beat (VPB) and atrial premature beats [1, 2]. Supraventricular tachycardias encompass paroxysmal supraventricular tachycardia (PSVT), atrial flutter (AF), and atrial fibrillation (Af) [3-6]. Ventricular arrhythmias encompass ventricular tachycardia and ventricular fibrillation [1, 7].

Cardiac arrhythmia involves a wide range of abnormalities of heart rhythm and rate disorders. Typical normal rhythm of the heart is a "normal sinus rhythm", where an impulse is produced in the sinoatrial (SA) node [8]. Thereafter, this is carried across and stalled while going across the atrioventricular node (AVN); then the impulse is carried through the bundle of His to the branches of the right and left bundle, and finally into the Purkinje fibers [8]. Any alteration in this conduction pathway leads to cardiac arrhythmia which may be categorized based on a variety of conditions [8]. The most widespread approach to classify them is based on the rate of conduction with tachyarrhythmia having a heart rate exceeding one hundred beats per minute (bpm) and bradyarrhythmia with a heart rate of less than sixty beat per minutes (bpm) [9].

Cardiac arrhythmia has been further grouped based on their source, mode of transmission, as well as the syndromes linked to it [8]. Cardiac arrhythmia patients may manifest a wide range of clinical presentations ranging from being completely asymptomatic to unexpected cardiac arrest. Cardiac arrhythmias may be paroxysmal, making it extremely difficult to estimate the actual prevalence [8].

Arrhythmias are among the very frequent complications that occur after cardiac surgery, and they embody a major source of morbidity as well as mortality [10]. The most common postoperative heart rhythm disorders are Atrial tachyarrhythmia [11]. Bradyarrhythmias and ventricular arrhythmias are less common [11].

The application of cardiopulmonary bypass differentiates the cardiac surgery from all other kind of surgeries [12]. It also initiates a distinctive group of potential postoperative complications, including vasospasm, a sweeping inflammatory response because of blood touching the synthetic surfaces of the bypass equipment, and distorted platelet- endothelial cell interactions [13]. This results to low flow in the microcirculation of the brain, heart, as well as other organs, which might lead to organ dysfunction [13, 14].

It has been demonstrated by various clinical studies that aortic cross-clam time during cardiac surgeries are independent predictors of morbidity and mortality [15-17]. Also, prolonged XCL time has been linked to low cardiac output, renal compromise, and prolonged ventilation after surgery [15-19]. Following the different adverse effects associated with the prolonged cross-clam time, mid-term survival after intricate surgeries has witnessed inadequate prognosis as evident by previous studies [20]. Al-Sarraf *et al.*, (2011) demonstrated in a study that "in-hospital mortality was significantly higher for the patients with XCL times greater than 90 min than for the patients with XCL times >60≤90 min. Furthermore, the in-hospital mortality in the latter group was significantly higher than among patients with XCL times≤60 min" [15].

Although there have been numerous studies investigating cardiac arrhythmia as well as XCL time, there is extremely limited literature correlating both. The present study was therefore designed with an aim to investigate the correlation between the prolonged aortic cross clamp time (XCL) in low-risk patients and the incidence of cardiac arrhythmia during cardiac surgery.

METHOD

Patients

This was a retrospective study conducted from March 2020 to February 2021, patient demography mentioned in table (6). A total of one hundred (100) low-risk patients undergoing elective cardiac surgery - Coronary artery bypass graft (CABG), Aortic valve replacement (AVR), Mitral Valve replacement (MVR), Bentall procedure, or Subaortic membrane (SAM) Morrow carried out at the Queen Alia Heart Institute, Jordan, were included in the study. Low risk patients for arrhythmias are those with no previous record of coronary artery disease, connective tissue disease, scaring from previous heart attack (or heart failure), high blood pressure, a normal or near-normal electrocardiogram and negative initial cardiac injury markers, which correlate with low likelihood of arrhythmias. The low likelihood of arrhythmias entail absence of high and intermediate likelihood features [21]. However, patients with low likelihood have normal or unchanged ECG during an episode of chest discomfort; normal troponin I (cardiac marker); and normal immune system [22]. The cardiac surgical operations utilized for this study were carried out by four surgeons. All the data was collected by one or more of the following sources viz. perfusion data, ICU sheet, electrocardiogram (ECG) paper, anesthesia note, or intra op arrhythmias seen in the patients on the monitor. The duration of cross clamp time and new-onset cardiac arrhythmia within the first 48 hours post operatively were monitored.

The data was obtained from the departmental records with the help of a record manager. The variables recorded were register number, co-morbidities (diabetes mellitus), cardiac surgery procedure, cross clamp time, reference, and arrhythmia (American Diabetes Association, 2018) [23]. Patients were moved to the ICU after the surgery.

Exclusion Criteria

Twenty-five (25) patients were excluded from this study due to renal failure, connective tissue disease, systemic lupus erythematosus (SLE) malignancy, immunocompromised patients or heart failure. These and others such as previous record of coronary artery disease, scaring from previous heart attack, high blood pressure, excessive intake of alcohol, caffeine or nicotine, use of certain medication – drug abuse, smoking make up the high or intermediate likelihood features in a patient.

Data Analysis

IBM SPSS Statistics version 20 was utilized for analyzing the data. Microsoft excel 2007 was used for the data entry purpose, after which it was moved to SPSS data sheet. Categorical data was analyzed by simple descriptive statistics presented in the tables or charts where necessary. The mean and standard deviation of continuous data was determined. 95% confidence interval (p-*value* ≤ 0.05) was used as our significant level. In a bid to fulfill the objective of this study i.e., "to evaluate the relation of aortic cross clamp time duration (XCL) in low-risk patients and the incidence of cardiac arrhythmia during cardiac surgery within 48 hours post operatively", directional measure (Eta and Eta – squared), univariate analysis of variance, correlation and point biserial correlation were measured.

RESULTS

Total 100 patients who underwent elective cardiac surgery were included in this study. The prevalence of Arrhythmia in the study was found to be 29.0% (see Table 1).

Table 1

Table 1 shows the relationship between Arrhythmia and prolonged cross clamp time in a total sample size of 100. There is a weak positive correlation (r = 0.260) between Patients' cross clamp time and Arrhythmias. There is a slight positive association between cross clamp time and arrhythmias which statistically significant at 0.05 significant level (p = 0.009).

Table 1: Relationship between Arrhythmia and Cross Clamp Time (XCL)

Correlations			
		Arrhythmias	**Cross Clamp Time**
Arrhythmias	Pearson Correlation	1	.260**
	Sig. (2-tailed)		.009
	N	100	100
Cross Clamp Time	Pearson Correlation	.260**	1
	Sig. (2-tailed)	.009	
	N	100	100
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 2a

Presented in Table 2 is a point biserial correlation which gives a weak positive correlation (r = 0.26) between the aortic cross clamp and time and new onset of cardiac arrhythmia after cardiac surgery, with p-value < 0.05 (*P* = 0.009). This indicated that the coefficient of correlation was statistically significant.

Table 2a: Correlation between prolonged aortic cross clamp and new onset cardiac arrhythmia after cardiac surgery (*Point Biserial Correlation*)

Correlations			
		Cross Clamp Time	**Arrhythmias**
Cross Clamp Time	Pearson Correlation	1	.260**
	Sig. (2-tailed)		.009
	N	100	100
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 2b

Table 2b presents the Eta value of our variable. The eta value of cross clamp time (XCL) was calculated to be 0.26 signifying a weak association. The eta value for Arrhythmias was 0.773. The Eta square of the dependent variable – Arrhythmias was 0.597 indicating a large effect size.

Table 2b (i): Correlation between prolonged aortic cross clamp and new onset cardiac arrhythmia after cardiac surgery (*Directional Measure*)

Directional Measures			
			Value
Nominal by Interval	Eta	Cross Clamp Time Dependent	0.260
		Arrhythmias Dependent	0.773

Table 2b (ii): Tests of Between-Subjects Effects

Tests of Between-Subjects Effects						
Dependent Variable: Arrhythmias						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	12.290[a]	59	.208	1.004	.502	.597
Intercept	5.653	1	5.653	27.242	.000	.405
XCL	12.290	59	.208	1.004	.502	.597
Error	8.300	40	.208			
Total	29.000	100				
Corrected Total	20.590	99				
a. R Squared = .597 (Adjusted R Squared = .002)						

Table 3

Presented in Table 3 are the cardiac surgery procedures and the aortic cross clamp time after 48 hours of the cardiac surgery. The most utilized cardiac surgery procedure was CABG undergone by 82.0% of the patients who were on elective admission for cardiac surgery. This was followed by MVR and AVR each carried out on the 5% patients. A very few number (2%) of the patient had both CABG and AVR cardiac surgery procedure; the MVR and AVR cardiac surgery was also undertaken by 2% of the patients. Cardiac surgical procedures such as Bentall, SAM Morrow, Redo AVR and MVR, and Redo CABG were the least represented as each of them were undergone by 1% patients. In total, 56 patients had cross clamp time (XCL) not greater than 60mins (XCL ≤ 60mins) and 28 patients had XCL greater than 60mins but no more than 90mins (60 < XCL ≤ 90mins). 16 patients had XCL greater than 90mins (XCL > 90mins).

Table 3: Relationship between cardiac surgery procedure and aortic cross clamp time (XCL)

Cardiac surgery procedure * XCL Cross tabulation					
Count					
		XCL			**Total**
		XCL ≤ 60mins	60 < XCL ≤ 90mins	XCL > 90mins	
Cardiac surgery procedure	CABG	49 (87.5%)	25 (89.3%)	8 (50.0%)	82
	SAM MORROW	1 (1.8%)	0 (0.0)	0 (0.0)	1
	AVR	2 (3.6%)	1 (3.6%)	2 (12.5%)	5
	MVR	3 (5.4%)	1 (3.6%)	1 (6.3%)	5
	Redo CABG	1 (1.8%)	0 (0.0)	0 (0.0)	1
	MVR + AVR	0 (0.0)	0 (0.0)	2 (12.5%)	2
	Redo AVR + MVR	0 (0.0)	0 (0.0)	1 (6.3%)	1
	CABG + AVR	0 (0.0)	1 (3.6%)	1 (6.3%)	2
	BENTALL	0 (0.0)	0 (0.0)	1 (6.3%)	1
Total		56 (100.0)	28 (100.0)	16 (100.0)	100

CABG: "Coronary artery bypass graft", AVR: "Aortic valve replacement", MVR: "Mitral Valve replacement", SAM: "Subaortic membrane"

Table 4

The relationship between Diabetes mellitus and Arrhythmias was evaluated in Table 4. It was observed that there was a weak negative correlation (-0.060) between Diabetes mellitus (co-morbidity) and Arrhythmias. Since the p- value is greater than 0.05, we fail to reject the null hypothesis and thus conclude that the correlation is not statistically significant. In other words, there is not a significant linear correlation between co-morbidity and arrhythmias.

Out of 53 Diabetes mellitus (DM) patients tested, 14(26.4%) when compared to 15 (31.9%) positive tests from a sample size of 47 patients were negative for DM. 73.6% (39) and 68. 1% (32) recorded negative in DM and non- Diabetes mellitus respectively.

Table 4: Relationship between Co-morbidity (Diabetes mellitus) and Arrhythmias [Multiple Logistic Regression]

Table 4a

		Co_mobidities
Arrhythmias	Pearson Correlation	-.060
	Sig. (2-tailed)	.550
	N	100

Model Fit: Model fit is seen with the help of Hosmer and Lemeshow Test. In testing the hypothesis, the null hypothesis states, "the model adequately fits the data"; if the significant value is less than 0.05 (p<0.05), we reject it, but if p>0.05 we accept the null hypothesis. Since the significant value of the two models – step 1 (0.684) and step 2 (0.215) is more than 0.05, we accept the null hypothesis and conclude that the models adequately fits the data.

Table 4b

Hosmer and Lemeshow Test			
Step	Chi-square	df	Sig.
1	5.669	8	.684
2	10.769	8	.215

Model Summary

Model 2 shows more variation in the dependent variable than model 1.

Table 4c

Model Summary			
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	113.955[a]	.063	.090
2	97.713[b]	.203	.290
a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.			
b. Estimation terminated at iteration number 20 because maximum iterations has been reached. Final solution cannot be found.			

Selecting the right Model

The third table is selecting the right data. How much percentage is correctly explained in each model (Steps 1 or 2). Step 2 (80.0) has more percentage of correctly explaining the data than step 1 (72.0)

Table 4d (i)

Classification Table[a]					
	Observed		Predicted		
			Arrhythmias		Percentage Correct
			Negative	Positive	
Step 1	Arrhythmias	Negative	69	2	97.2
		Positive	26	3	10.3
	Overall Percentage				72.0
Step 2	Arrhythmias	Negative	70	1	98.6
		Positive	19	10	34.5
	Overall Percentage				80.0
a. The cut value is .500					

4d (ii)

Variables not in the Equation					
			Score	**Df**	**Sig.**
Step 1	Variables	Co_mobidities(1)	.171	1	.679
		Cardiac_procedure	17.510	8	.025
		Cardiac_procedure(1)	3.517	1	.061
		Cardiac_procedure(2)	5.892	1	.015
		Cardiac_procedure(3)	.681	1	.409
		Cardiac_procedure(4)	6.571	1	.010
		Cardiac_procedure(5)	.164	1	.685
		Cardiac_procedure(6)	1.856	1	.173
		Cardiac_procedure(7)	.312	1	.577
		Cardiac_procedure(8)	.064	1	.801
		AGE	.307	1	.580
	Overall Statistics		18.429	10	.048
Step 2	Variables	Co_mobidities(1)	.119	1	.730
		AGE	1.278	1	.258
	Overall Statistics		1.296	2	.523

In step 1, XCL is first added; in step 2, with XCL, the system added cardiac procedure. From the first model (Step 1), XCL (p = 0.015) has adequate impact on Arrhythmias whereas, the cardiac procedure, age and co-morbidity (diabetes) does not have adequate impact on Arrhythmias. In the second model (step 2), cardiac procedure and XCL seems to have impact on Arrhythmia, however, it is not significant, as the p-value are more than 0.05. Also, age and co- mordity had no impact on Arrhythmias.

Table 4e

Variables in the Equation									
		B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**	**95% C.I. for EXP(B)**	
								Lower	Upper
Step 1[a]	XCL	.020	.008	5.914	1	.015	1.021	1.004	1.037
	Constant	-2.238	.609	13.520	1	.000	.107		
Step 2[b]	Cardiac_procedure			5.261	8	.729			
	Cardiac_procedure(1)	22.032	40192.888	.000	1	1.000	3700788146.981	.000	.
	Cardiac_procedure(2)	45.296	56841.386	.000	1	.999	46953866176645 380000.000	.000	.
	Cardiac_procedure(3)	21.280	40192.888	.000	1	1.000	1745398004.392	.000	.
	Cardiac_procedure(4)	24.527	40192.888	.000	1	1.000	44862864384.75 9	.000	.
	Cardiac_procedure(5)	2.982	56841.385	.000	1	1.000	19.735	.000	.
	Cardiac_procedure(6)	43.083	48954.345	.000	1	.999	51381197615992 25900.000	.000	.
	Cardiac_procedure(7)	41.805	56841.386	.000	1	.999	14306881691483 76320.000	.000	.
	Cardiac_procedure(8)	22.498	40192.888	.000	1	1.000	5896192916.036	.000	.
	XCL	.023	.012	3.745	1	.053	1.023	1.000	1.048
	Constant	-24.648	40192.888	.000	1	1.000	.000		
a. Variable(s) entered on step 1: XCL.									
b. Variable(s) entered on step 2: Cardiac_procedure.									

Table 4f

Risk Estimate			
	Value	**95% Confidence Interval**	
		Lower	Upper
Odds Ratio for Co_mobidities (NiL / Diabeties Milletus)	.766	.322	1.820
For cohort Arrhythmias = Negative	.925	.718	1.192
For cohort Arrhythmias = Positive	1.208	.654	2.231
N of Valid Cases	100		

The result implies that there is a 0.766 times greater likelihood of being diagnosed with arrhythmia if a patient had Diabetes Miletus co-morbidity versus if a patient had no co-morbidity

Table 5

Table 5 illustrates the number of cardiac patients who had arrhythmia 48hours postoperatively after the cardiac surgery procedure they underwent. The fisher exact test statistics was also utilized (17.020, p = 0.004). Since the p-value (0.004) is less than the nominal level for statistical significance (0.05), we conclude that there is evidence for statistically significant difference between cardiac surgery procedures and arrhythmias.

Table 5a: Relationship between cardiac surgery procedure and Arrhythmia

Cardiac_procedure * Arrhythmias Crosstabulation					
			Arrhythmias		**Total**
			Negative	**Positive**	
Cardiac_procedure	CABG	Count	63	19	82
		Expected Count	58.2	23.8	82.0
	SAM MORROW	Count	0	1	1
		Expected Count	.7	.3	1.0
	AVR	Count	4	1	5
		Expected Count	3.6	1.5	5.0
	MVR	Count	1	4	5
		Expected Count	3.6	1.5	5.0
	Redo CABG	Count	1	0	1
		Expected Count	.7	.3	1.0
	MVR + AVR	Count	0	2	2
		Expected Count	1.4	.6	2.0

Cardiac_procedure * Arrhythmias Crosstabulation					
			Arrhythmias		**Total**
			Negative	**Positive**	
	Redo AVR + MVR	Count	0	1	1
		Expected Count	.7	.3	1.0
	CABG + AVR	Count	1	1	2
		Expected Count	1.4	.6	2.0
	BENTAL	Count	1	0	1
		Expected Count	.7	.3	1.0
Total		Count	71	29	100
		Expected Count	71.0	29.0	100.0

Table 5b: Chi-Square Tests

Chi-Square Tests			
	Value	**df**	**Asymp. Sig. (2-sided)**
Pearson Chi-Square	18.905[a]	8	.015
Likelihood Ratio	18.871	8	.016
Linear-by-Linear Association	5.662	1	.017
N of Valid Cases	100		
a. 16 cells (88.9%) have expected count less than 5. The minimum expected count is .29.			

Table 6

Presented in table 6 are the baseline characteristics of patients in this study. The mean age of the patients was 57.6±11.1. 52.3% of the patients showed co-morbidity (*Diabetes mellitus*). The patients were all low risk patients undergoing elective cardiac surgery.

Table 6: Baseline Characteristics of Patients

Characteristics	
Variables	**N = 100**
Study period	03/2020 – 02/2021
Gender	Not stated
Age	
Mean Age (range) in years	57.6±11.1 (67.0)
Less than 35 yrs	2.9 (3)
35 – 44 yrs	7.8 (8)
45 – 54 yrs	22.5 (23)
55 – 64 yrs	40.2 (41)
65 – 74 yrs	21.6 (22)
75 yrs and above	4.9 (5)
Co-morbidity: *Diabetes mellitus*	52.0% (53)
Low risk patients	100%
no previous record of coronary artery disease	
No history of connective tissue disease	
normal or near-normal electrocardiogram	
high blood pressure	
scaring from previous heart attack (or heart failure),	
negative initial cardiac injury markers	

Figure 1

Figure 1 illustrates the distribution of aortic cross clamp time (XCL) over arrhythmia. For cross clamp time that is below 100mins, patients showed negative arrhythmia post operatively. Patients with prolonged aortic cross clamp (XCL greater than 100mins) presented new onset cardiac arrhythmia after cardiac surgery.

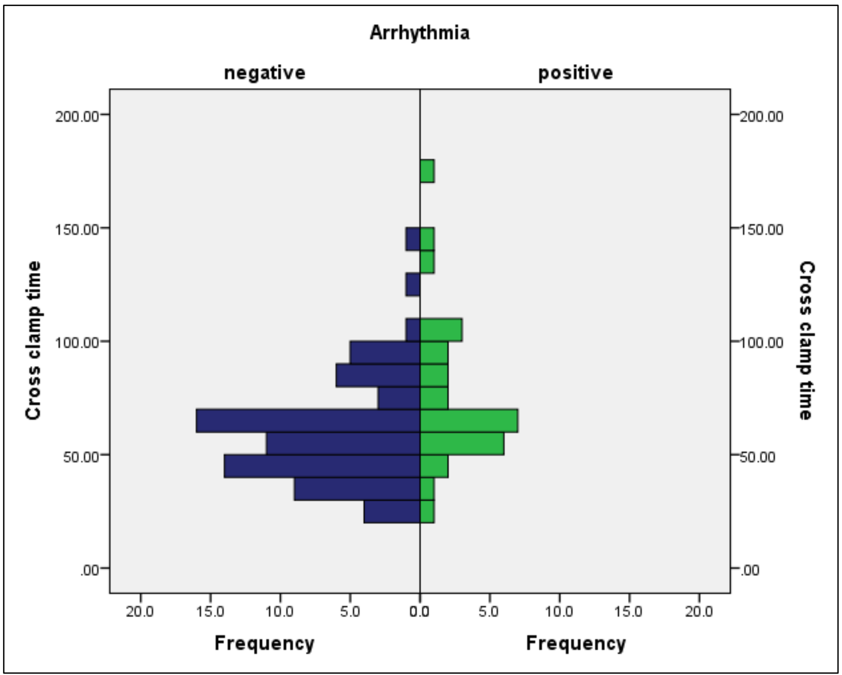

Figure 1: Distribution of Cross Clamp Time (XCL) over Arrhythmia

Figure 2

Presented in figure 2 is the relationship between Co-morbidity and Arrhythmia. In terms of the relationship between Arrhythmia and co-morbidity of patient, there was no likely relationship between co-morbidity and arrhythmia. Patients without co-morbidity were observed to develop arrhythmia more than patients having co-morbidity (*Diabetes mellitus*).

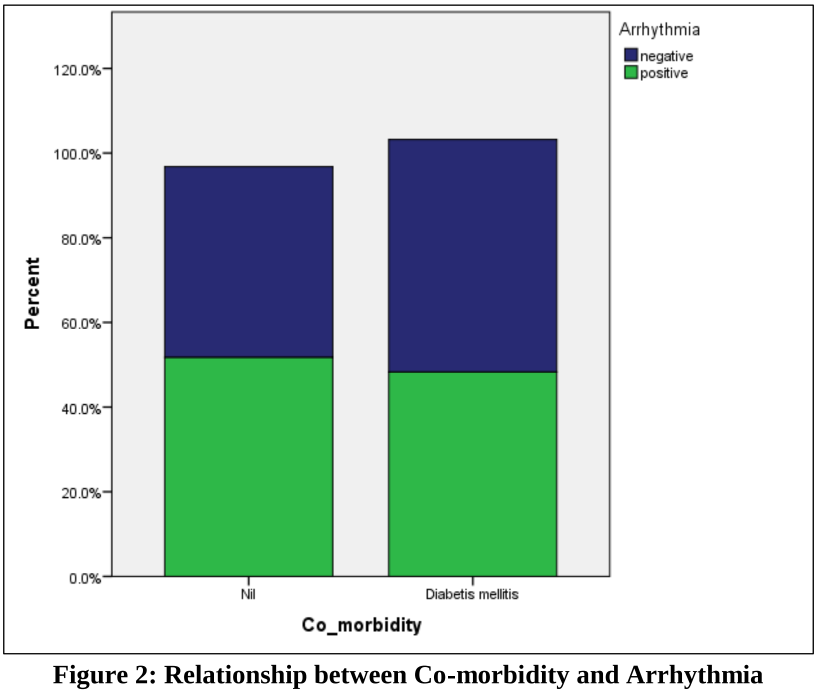

Figure 2: Relationship between Co-morbidity and Arrhythmia

DISCUSSION

This study evaluated both preoperative and postoperative variables of 100 patients who were on elective admission for cardiac surgery. These variables were studied to explore the postoperative relationship between the aortic cross clamp time (XCL) in low-risk patients and the incidence of cardiac arrhythmia within 48 hours of cardiac surgery. Several previous studies have evaluated cardiac arrhythmia after aortic cross clamp postoperatively [9, 24-29]; many studies have established this relationship.

Preceding studies have pointed out a surge in risk of morbidity and/or mortality because of prolonged aortic cross-clamp time [15, 17, 30, 31]. However, there is a lack of sufficient and robust data on the effect of aortic cross clamp time on the cardiac arrhythmia after cardiac surgery. This study could provide a better comprehension of the clinical importance of XCL and with this knowledge clinical outcomes in the aspect of cardiac surgery could be better understood.

Although the study revealed a relationship between the prolonged aortic cross clamp time (more than 90 min), it also revealed a weak correlation (r = 0.26) between the aortic cross clamp time duration and new onset of cardiac arrhythmia after cardiac surgery(60min), implying a minimal relationship between XCL and new onset of arrhythmia. Data therefore suggested that XCL is an important predictor of cardiac arrhythmia postoperatively. This is so as several risk factors can synergically determine arrhythmia and other complication after a cardiac surgery. These factors may range from age, XCL, emergency surgery, perivascular vascular disease, a redo CABG, heart failure, etc. [17]. After cardiac surgery, arrhythmias which may be mild in a younger patient could be severe or a major cause of morbidity and mortality for patient with congenital heart disease [32, 33]. Kirklin (1990) reported that “A long aortic cross-clamp time is a significant risk factor for predictors of postoperative morbidity and mortality” [34]. Further, Al-Sarraf *et al.*, (2011) in their study found that “prolonged aortic XCL time significantly correlated with the worse clinical outcomes in both low-risk and high-risk cardiac surgery patients”. However, they reported no association between the prolonged XCL and arrhythmias and other complications postoperatively [15]. According to Al-Sarraf *et al.*, (2011), “Arrhythmias are the result of hyper adrenergic stimulation that occurs following the stress of cardiac surgery and the use of inotropic medications post-surgery rather than ischemic time” [15]. Prior studies which examined post-operative arrhythmias predictors also revealed a short of association between XCL and arrhythmias [35, 36].

Few previous studies reported an increase in the catecholamine during aorta cross clamp time [37-39]. The effect of this could be greater than before because of extended aortic cross clamp time, thereby resulting in obvious sympathetic activation [15]. Notwithstanding, Bezon *et al.*, (2006) reported that “Continuous retrograde intermediate warm blood cardioplegia associated with systemic normothermia allows prolonged aortic clamping time for complex intervention without increase in operative mortality and morbidity” [40].

This study reported 29% prevalence of Arrhythmia. This was higher than that (6.0%) reported by Liu, Dzankic and Leung (2002) as one of the postoperative cardiac complications in the geriatric surgical patients.

Limitations

There are few limitations in our study. To begin with, regardless of the fact that all data were retrieved prospectively, our study remains a retrospective study; thus only association (and not causality) can be reported. Furthermore, some preoperative characteristics among the independent variables could have contributed to the observed outcome. Nevertheless, within these acceptable limitations, we trust our study will give more insight on the subject and possibly inspire more research on this subject matter.

CONCLUSION

Prolonged aortic cross-clamp time minimally affected the incidences of arrhythmia postoperatively after the cardiac surgery within 48 hours in low-risk cardiac patients. Patients with cross clamp time of over 90min were observed to be the most affected by Arrhythmia with a high prevalence rate. Thus, this further buttress the fact that extended/prolonged XCL affect cardiac arrhythmia after cardiac surgery.

Being updated on the effect of prolonged cross-clamp time could facilitate prevention of arrhythmia and other form of complications postoperatively. Thereby, there is the need for more research on this aspect to clarify the means by which these postoperative adverse outcomes occur.

REFERENCES

1. Liu, J., Li, S. N., Liu, L., Zhou, K., Li, Y., Cui, X. Y., Wan, J., Lu, J. J., Huang, Y. C., Wang, X. S., & Lin, Q. (2018). Conventional Acupuncture for Cardiac Arrhythmia: A Systematic Review of Randomized Controlled Trials. *Chinese Journal of Integrative Medicine*, 24(3), 218–226. https://doi.org/10.1007/s11655-017-2753-9
2. Types of Arrhythmia. Available at: http://www.nhlbi.nih.gov. Retrieved 8 October 2021.
3. Hafeez, Y., Quintanilla Rodriguez, B. S., Ahmed, I., & Grossman, S. A. (2021). StatPearls Publishing; Treasure Island (FL), Paroxysmal Supraventricular Tachycardia.
4. Martin, C. A., Matthews, G. D., & Huang, C. L. (2012). Sudden cardiac death and inherited channelopathy: the basic electrophysiology of the myocyte and myocardium in ion channel disease. *Heart*, *98*(7), 536-543.
5. Hindricks, G., Potpara, T., Dagres, N., Arbelo, E., Bax, J. J., & Blomstrom-Lundqvist, C. (2020). ESC Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association of Cardio-Thoracic Surgery (EACTS). *Eur Heart J*, *42*, 373–498.
6. Deliargyris, E. N., Raymond, R. J., Guzzo, J. A., Dehmer, G. J., Smith, S. C., Weiner, M. S., & Roberts, C. S. (2000). Preoperative factors predisposing to early postoperative atrial

fibrillation after isolated coronary artery bypass grafting. *American Journal of Cardiology*, *85*(6), 763-764.
7. Osranek, M., Fatema, K., Qaddoura, F., Al-Saileek, A., Barnes, M. E., Bailey, K. R., ... & Seward, J. B. (2006). Left atrial volume predicts the risk of atrial fibrillation after cardiac surgery: a prospective study. *Journal of the American College of Cardiology*, *48*(4), 779-786.
8. Desai, D. S., & Hajouli, S. (2021). Arrhythmias. [Updated 2021 Jun 18]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan-.
9. Spodick D. H. (1992). Normal sinus heart rate: sinus tachycardia and sinus bradycardia redefined. *American heart journal*, *124*(4), 1119–1121. https://doi.org/10.1016/0002-8703(92)91012-p
10. Peretto, G., Durante, A., Limite, L. R., & Cianflone, D. (2014). Postoperative Arrhythmias after Cardiac Surgery: Incidence, Risk Factors, and Therapeutic Management. *Cardiology Research and Practice, 2014,* 1–15. doi:10.1155/2014/615987
11. Herzog, L. & Lynch, C. “Arrhythmias accompanying cardiac surgery,” in Clinical Cardiac Electrophysiology, C. Lynch, Ed., p. 231,JB Lippincott, Philadelphia, Pa, USA, 3rd edition,1994.
12. Machin, D., & Allsager, C. (2006). Principles of cardiopulmonary bypass. *Continuing Education in Anaesthesia Critical Care & Pain, 6(*5), 176–181. doi:10.1093/bjaceaccp/mkl043
13. Lakshminarayan, K., Anderson, D. C., Herzog, C. A., & Qureshi, A. I. (2008). Clinical epidemiology of atrial fibrillation and related cerebrovascular events in the United States. *Neur, 14*(3), 143-150.
14. Kaplan, J., & Lala, V. (2020). StatPearls. StatPearls Publishing; Treasure Island (FL): Paroxysmal Atrial Tachycardia.
15. Al-Sarraf, N., Thalib, L., Hughes, A., Houlihan, M., Tolan, M., Young, V., & McGovern, E. (2011). Cross-clamp time is an independent predictor of mortality and morbidity in low-and high-risk cardiac patients. *International Journal of Surgery*, *9*(1), 104-109.
16. Nissinen, J., Biancari, F., Wistbacka, J. O., Peltola, T., Loponen, P., Tarkiainen, P., ... & Tarkka, M. (2009). Safe time limits of aortic cross-clamping and cardiopulmonary bypass in adult cardiac surgery. *Perfusion*, *24*(5), 297-305.
17. Doenst, T., Borger, M. A., Weisel, R. D., Yau, T. M., Maganti, M., & Rao, V. (2008). Relation between aortic cross-clamp time and mortality—not as straightforward as expected. *European journal of cardio-thoracic surgery*, *33*(4), 660-665.
18. Yves, D. D., Mohamed, Y., & Bruno, M. (2008). Pediatric Warm Open Heart Surgery and Prolonged Cross-Clamp Time. *Ann. Thorac. Surg., 86*(6), 1941-1947.
19. Safi, H. J., Winnerkvist, A., Miller III, C. C., Iliopoulos, D. C., Reardon, M. J., Espada, R., & Baldwin, J. C. (1998). Effect of extended cross-clamp time during thoracoabdominal aortic aneurysm repair. *The Annals of thoracic surgery*, *66*(4), 1204-1208.
20. Shultz, B., Timek, T., Davis, A. T., Heiser, J., Murphy, E., Willekes, C., & Hooker, R. (2016). Outcomes in patients undergoing complex cardiac repairs with cross clamp times over 300 minutes. *Journal of Cardiothoracic Surgery, 11*(1). doi:10.1186/s13019-016-0501-4
21. Amsterdam, E. A., Kirk, J. D., Bluemke, D. A., Diercks, D., Farkouh, M. E., Garvey, J. L., Kontos, M. C., McCord, J., Miller, T. D., Morise, A., Newby, L. K., Ruberg, F. L., Scordo, K. A., Thompson, P. D., & American Heart Association Exercise, Cardiac Rehabilitation, and Prevention Committee of the Council on Clinical Cardiology, Council on Cardiovascular Nursing, and Interdisciplinary Council on Quality of Care and Outcomes Research (2010). Testing of low-risk patients presenting to the emergency department with chest pain: a scientific statement from the American Heart Association. *Circulation, 122*(17), 1756–1776. https://doi.org/10.1161/CIR.0b013e3181ec61df
22. Raman, G. P., & Zellweger, R. (2004). Cardiac Troponin I as a Predictor of Arrhythmia and Ventricular Dysfunction in Trauma Patients with Myocardial Contusion. *The Journal of Trauma: Injury, Infection, and Critical Care,* 57(4), 801–808. doi:10.1097/01.ta.0000135157.93649.72
23. American Diabetes Association. (2018). Diabetes Care in the Hospital: Standards of Medical Care in Diabetes-2018. *Diabetes Care*, *41*(1), S144–S151.
24. Amatya, A., Sharma, A., Pokharel, J. N., Amatya, A., & Shrestha, S. M. (2015). Ventricular Tachyarrhythmia after Aortic Cross Clamp Release in Cardiac Surgeries. *J Nepal Health Res Counc, 13*(31), 201-204.
25. Kron, I. L., DiMarco, J. P., Harman, P. K., Crosby, I. K., Mentzer Jr, R. M., Nolan, S. P., & Wellons Jr, H. A. (1984). Unanticipated postoperative ventricular tachyarrhythmias. *The Annals of thoracic surgery*, *38*(4), 317-322.
26. Gray, R. J., & Sethna, D. H. (2011). Medical management of the patient undergoing cardiac surgery, cardiovascular convalescence. Braunwald’s Textbook of Cardiovascular Medicine, 9th edition, 1793–1808.
27. Topol, E. J., Lerman, B. B., Baughman, K. L., Platia, E. V., & Griffith, L. S. (1986). De novo refractory ventricular tachyarrhythmias after coronary revascularization. *The American journal of cardiology*, *57*(1), 57-59.

28. Clayton, R. H., Murray, A., & Campbell, R. W. (1995). Evidence for electrical organization during ventricular fibrillation in the human heart. *Journal of Cardiovascular Electrophysiology*, *6*(8), 616-624.
29. Sun-Ae, H. H., Simon, G., & Todd, H. (1992). Angiotensin and Adrenoceptors in the Hemodynamic Response to Aortic Cross-clamping. *Arch, Surg.*, 127(4), 438-441.
30. Schwartz, J. P., Bakhos, M., Patel, A., Botkin, S., & Neragi-Miandoab, S. (2008). Repair of aortic arch and the impact of cross-clamping time, New York Heart Association stage, circulatory arrest time, and age on operative outcome. *Interactive CardioVascular and Thoracic Surgery*, *7*(3), 425-429.
31. K Chandler, H., & Kirsch, R. (2016). Management of the low cardiac output syndrome following surgery for congenital heart disease. *Current cardiology reviews*, *12*(2), 107-111.
32. Peretto, G., Durante, A., Limite, L. R., & Cianflone, D. (2014). Postoperative arrhythmias after cardiac surgery: incidence, risk factors, and therapeutic management. *Cardiology research and practice*, *2014*, 15. Article ID 615987, http://dx.doi.org/10.1155/2014/615987
33. Mathew, J. P., Fontes, M. L., Tudor, I. C., Ramsay, J., Duke, P., Mazer, C. D., ... & Mangano, D. T. (2004). A multicenter risk index for atrial fibrillation after cardiac surgery. *Jama*, *291*(14), 1720-1729.
34. Kirklin, J. W. (1990). The science of cardiac surgery. *Eur J Cardiothorac Surg.*, *4*, 53–71.
35. Almassi, G. H., Schowalter, T., Nicolosi, A. C., Aggarwal, A., Moritz, T. E., Henderson, W. G., ... & Hammermeister, K. E. (1997). Atrial fibrillation after cardiac surgery: a major morbid event?. *Annals of surgery*, *226*(4), 501-511.
36. Mahoney, E. M., Thompson, T. D., Veledar, E., Williams, J., & Weintraub, W. S. (2002). Cost-effectiveness of targeting patients undergoing cardiac surgery for therapy with intravenous amiodarone to prevent atrial fibrillation. *Journal of the American College of Cardiology*, *40*(4), 737-745.
37. Normann, N. A., Taylor, A. A., Crawford, E. S., DeBakey, M. E., & Saleh, S. A. (1983). Catecholamine release during and after cross clamping of descending thoracic aorta. *Journal of Surgical Research*, *34*(2), 97-103.
38. Strømholm, T., Aadahl, P., Saether, O. D., Myking, O. D., & Myhre, H. O. (1999). Excessive increase in circulating catecholamines during cross-clamping of the descending thoracic aorta in pigs. *International Journal of Angiology*, *8*(02), 91-94.
39. Symbas, P. N., Pfaender, L. M., Drucker, M. H., Lester, J. L., Gravanis, M. B., & Zacharopoulos, L. (1983). Cross-clamping of the descending aorta: hemodynamic and neurohumoral effects. *The Journal of Thoracic and Cardiovascular Surgery*, *85*(2), 300-305.
40. Bezon, E., Choplain, J. N., Aziz Khalifa, A. A., Numa, H., Salley, N., & Barra, J. A. (2006). Continuous retrograde blood cardioplegia ensures prolonged aortic cross-clamping time without increasing the operative risk. *Interactive cardiovascular and thoracic surgery*, *5*(4), 403-407.