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Evaluation of Post Cardiopulmonary Bypass Complications Related to Aortic Cross Clamp Time in Cardiac Patients from Selected Hospitals of Lahore-Pakistan

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Abstract

In this study the frequency and mortality of pulmonary complications have been investigated after cardiopulmonary bypass related to aortic cross clamp time. High rate of pulmonary complication (58%) has been reported by international journal of surgery. This was a cross-sectional study included 120 patients, which were between 16 to 78 years, with predominant male participants. The research was conducted at Punjab Institute of Cardiology and Gulab Devi Hospital, Lahore. The results revealed that about 51(42%) patients had post-operative pulmonary complication due to prolonged aortic cross clamp time (more than 90 minutes), while 37(30%) patients had pleural effusion, 22(18%) patients had prolonged mechanical ventilation, 3(2.5%) patients suffered from pneumonia and 1(0.83%) patient were suffered from pulmonary edema. It was concluded that prolonged aortic cross clamp time (> 90 minutes) is the most predominant post-operative pulmonary complication as compared to pleural effusion and prolonged mechanical ventilation.

Keywords: *Pulmonary Complications, Cardiopulmonary Bypass, Post-operative Pulmonary Complication*

Introduction

Pulmonary complications in a patient after cardiopulmonary bypass remain a foremost cause of mortality and morbidity. About, 58% of patients suffered with pulmonary complication after cardiopulmonary bypass (CPB) as reported by international journal of surgery (Gilbey et al., 2022). Moreover, CPB is a well-established procedure that briefly disables the heart and lungs ability to pump blood and oxygen throughout the body during heart surgery which aids to maintain the circulation of blood and oxygen content of the body. The pathogenesis of pulmonary complication after CPB is related with irregularities in gases exchange and alterations in lung mechanics or both (Koehler et al., 2022).

Abnormality in gaseous exchange is verified by a widening of the alveolar-arterial oxygen gradient which results in increased microvascular permeability in the lungs. Many risk factors are involved which cause pulmonary complication after CPB

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like hypertension, obesity, diabetes, Age above 65, preoperative pulmonary complication, prolonged aortic cross clamp time, prolonged CPB time, respiratory distress mainly due to non-reversal anesthesia and ventilation perfusion mismatch (Gerstein et al., 2022). Common pulmonary complication after cardiopulmonary bypass included pleural effusion, atelectasis, prolonged mechanical ventilation, pneumonia, pneumothorax and pulmonary embolism (Mali & Haghaninejad, 2019).

Pleural effusion is one of the commonest pulmonary complications after CPB. The incidence of pleural effusion after CPB has been estimated in 27-95% patients, with pleural changes after operative period would have resulted in a marked decrease in pulmonary function test (PFTs) (Tanner & Colvin, 2020). The prolonged mechanical ventilation is also a major complication after cardiopulmonary bypass. Whereas, PMV patients had high medical cost and longer stay in hospital (Sevuk et al., 2022). In this study, we examined the frequency of pulmonary complication after cardiopulmonary bypass which cause high morbidity and mortality, particularly in those patients who have extended aortic cross clamp time (Iino et al., 2017).

Materials and Methods

The present study is a cross sectional descriptive study including patients with pulmonary complications after Cardiopulmonary Bypass (CPB) presented at ICU of Punjab Institute of Cardiology and Gulab Devi Hospital Lahore. The research was completed in 6 months from January to June 2022. In this study a non-probability sampling technique was applied.

Patients aged 16 to 78 years of both genders, and patients who had undergone Coronary Artery Bypass Grafting (CABG), valve replacement and repair, congenital repair and aortic root replacement and repair were involved in this study. For all patients the same standard surgical technique was employed to collect samples. A central skin incision was used throughout the entire surgery. All patients received standard CPB equipment, including arterial line filters and membrane oxygenators.

Venus cannulation was performed as appropriate through the right atrium using bi-caval, atrio-caval, or two-stage single venous cannula methods. Using an aortic cannula with an angle or straight tip, the arterial cannulation was performed. The CPB circuit was primed with lactate ringer. Temperature was reduced to 30–28 ºC after CPB was initiated in order to maintain moderate hypothermia during surgery. After applying an aortic cross-clamp, cold blood cardioplegia was employed to induce cardiac arrest and provide protection.

After completion surgery, patients were transfer to intensive care unit (ICU). The patients who expired during surgery, with incomplete medical record and pediatric patients were excluded from this study. Duration of mechanical ventilation greater than 24 hours or need of re-intubation in patients was considered as Prolong mechanical

ventilation. Pneumonia infection was done by the appearance of fever, cough with sputum and further confirmed on chest X-ray and lab reports. Pleural effusion was labeled by the presence of pleural findings on chest X-ray scan.

The SPSS version 21.0 was used to analyze experimental data. Qualitative data were presented in the form of charts and tables along with its percentage and quantitative data were presented in the form of frequency distribution, mean, range and standard deviation by simple descriptive analysis. Chi-square test was used to rule out association between pulmonary complications after cardiopulmonary bypass and prolonged aortic cross clamp time. The results were concluded based on P-value, where 0.05 were taken as significant one.

Results

Demographic Characteristics

A total of 120 patients who underwent cardiopulmonary bypass (CPB) were included in this study. The gender distribution revealed a predominance of male patients (71.67%), with females constituting 28.33% of the study population. The mean age of the patients was 47.48 ± 15.09 years (Table 1).

Table 1: *Gender and Age Wise Demographic Profile of Studied Cardiac Patients*

Total number of patients		**120**
Gender wise (%)	Male	86(71.67%)
	Female	34(28.33%)
Age in years **(**mean± standard deviation)		47.48± 15.09

Associated Preoperative Comorbidities and Intraoperative Factors

Among the 120 patients, 49% were hypertensive and 39% were diabetic. Additionally, 28% exhibited preoperative pulmonary complications, while a significant number, 54% (65 patients), experienced a prolonged aortic cross-clamp time exceeding 60 minutes (Table 2).

Table 2: *List of other Complications in Studied Cardiac Patients*

Complications	**Yes**	**No**	**Total**
Hypertensions	0.49 (59)	0.51 (61)	100% (120)
Diabetes	0.39 (47)	0.61 (73)	100% (120)
Pre-operative Pulmonary Complication	0.28 (34)	0.72 (86)	100% (120)
Prolonged aortic cross clamp (> 60 minutes)	0.54 (65)	0.46 (55)	100% (120)

Postoperative Pulmonary Complications

Post-CPB, various pulmonary complications were observed. Pleural effusion was the most frequently encountered complication, affecting 31% (37 patients). This was followed by prolonged mechanical ventilation in 18% (22 patients). Less frequently reported were pneumonia in 2.5% (3 patients) and pulmonary edema in 0.83% (1 patient) (Table 3).

Table 3: *Frequency of Pulmonary Complications after Cardiopulmonary Bypass (CPB)*

Pulmonary complications	Frequency (120)	Percentage (100%)
Pleural effusion	37	31%
Prolonged mechanical Ventilation	22	18%
Pneumonia	3	2.50%
Pulmonary edema	1	0.83%

Association of Pulmonary Complications with Cross-Clamp Duration

A significant association was observed between prolonged aortic cross-clamp time and the incidence of pulmonary complications. Among the 11 patients who had aortic cross-clamp time exceeding 90 minutes, 72.7% (8 patients) developed pulmonary complications, whereas only 27.2% (3 patients) did not. In contrast, of the remaining 109 patients with cross-clamp time above 60 minutes, 43 (39.4%) developed pulmonary complications while 66 (60.6%) did not (Table 4). This suggests that prolonged cross-clamp time, particularly beyond 90 minutes, may significantly increase the risk of pulmonary complications following CPB.

Table 4: *Frequency of Pulmonary Complications after CPB related to Prolonged Aortic Cross Clamp Time*

Prolonged Aortic Cross clamp time	CABG Cases	Pulmonary complication (Yes)	Pulmonary complication (No)
>90 minutes	11	8	3
>60 minutes	109	43	66

Discussion

Post-operative pulmonary complications are the most predominant contributor of morbidity and mortality (Chaudhary et al., 2020). Pulmonary complication after cardiopulmonary bypass was 58% according to International

Journal of Surgery (Gilbey et al., 2022). In another study, the reported incidence of post-operative pulmonary problems after CABG and after valvular heart surgery ranges from 3% to 16% and 5% to 7%, respectively (Arif et al., 2022). In our study pulmonary complications after CPB occur approximately in 42% cases out of total 120 patients. These generally occur within the first week of cardiac surgery. Many factors involved which can cause pulmonary complication after CPB are Age (> 60 years), hypertension, diabetes, obesity, smoking, prolonged CPB time, pre-operative-pulmonary complication, redo-surgery, emergency surgery and prolong aortic cross clamp time (Lin et al., 2021). Aortic XCL time >60 min is called prolonged aortic cross clamp time and it is an independent risk factor for the low cardiac output, extended ventilation, pulmonary complication, mortality and extended stay in the hospital. The aortic cross clamp time divided into 3 categories aortic cross clamp time<60 min and aortic cross clamp time 60 to 90 min (Balkan & Magin, 2021).

In previous study, out of 1108 patients 618 patients had aortic cross clamp time <60mints in which 93(15%) patients had pulmonary complication, 362 patients had aortic cross clamp time 60 to 90 mints in which 61(17%) patients had pulmonary complication and 128 patients had aortic cross clamp time >90 min in which 28(22%) patients had pulmonary complication and their p-value=0.160 (Kreibich et al., 2019). Obtained data revealed that, among 120 patients 55 patients had cross clamp time <60 min in which 16(29%) patients had pulmonary complication, 54 patients had cross clamp time 60 to 90 mints in which 27(50%) patients had pulmonary complication and 11 patients had cross clamp time>90min in which 8(72%) patients had pulmonary complication, and their p-value <0.05. Common pulmonary complications after cardiac surgery were pleural effusion, atelectasis, pneumonia, ARDS, pneumothorax, pulmonary embolism and prolonged mechanical ventilation. Frequencies of pulmonary complication were following according to previous research.

The results revealed that there is also a marked incidence of pleural changes (pleural effusion or pleural thickening) followed by CABG (Touma et al., 2022). According to previous researches (Allou et al., 2014), pleural effusion occur in 27-95% cases which can cause pleural effusion after CPB in patient above 60 age, pre-operative pulmonary complication, prime volume, CPB time and aortic cross clamp time (Tanner & Colvin, 2020). In this study, out of 120 patients, 37 (30%) patients had pleural effusion. Main predictor of pleural effusion according to my study is prolonged aortic cross clamp time. In previous studies prolonged mechanical ventilation occur 6-58% patients (Patel et al., 2022).

According to definition of prolonged mechanical ventilation, ventilation time >24 hours. Out of 1108 patients 618 patients had cross clamp time <60 min in which 27(4%) patients had prolonged mechanical ventilation, 362 patients had cross clamp

time 60 to 90 min in which 23(6%) patients had prolonged mechanical ventilation and 128 patients had >90 min aortic cross clamp time (Tsubura et al., 2022). In which 19(15%) patients had prolonged mechanical ventilation. (p-value e<0.001). According to this study there is relation between prolonged cross clamp time and prolonged mechanical ventilation (Shehabi et al., 2018). In present study out of 120 patients 22(18%) patients had prolonged mechanical ventilation, 8 patients who had prolonged aortic cross clamp time >90min, 3(37%) patients revealed poor mechanical ventilation with p-value=0.06. It means there is no significant association between prolonged mechanical ventilation and aortic cross clamp time. Moreover, some other factors like age (>65 years), role of anesthesia and prolonged CPB time can cause prolonged mechanical ventilation. Previously, pneumonia occur in 4-20% of patients (Szylińska et al., 2020). In present study there were only 3 patients who had diagnosed with pneumonia after CPB. In present study there was no occurrence of other pulmonary complication.

Conclusion

It is concluded that pulmonary complication was the common complication after cardiopulmonary bypass and prolonged aortic cross clamp time>90 minutes had a high risk of pulmonary complications after CPB.

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