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Pleural Effusion After Open Cardiac Surgery

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ABSTRACT

Background: Pulmonary complications after cardiac surgery are a major source of morbidity and mortality, as well as increased lengths of hospital stay and resource utilization. Pleural effusion following coronary artery bypass graft surgery (CABG) has been reported in 65% to 89% of cases. The present study was designed to determine the prevalence of pleural effusion after open-heart surgery.

Methods: This study evaluated 600 patients who underwent open-heart surgery. The study population was divided into 3 groups: group A consisted of 200 patients who underwent CABG, group B comprised 200 patients who underwent aortic valve replacement (AVR) and mitral valve replacement (MVR), and group C encompassed 200 patients who underwent valve surgery and CABG. Chest radiography was performed before surgery and afterward on the first, third, and seventh postoperative days.

Results: The study population was comprised of 330 (55%) men and 270 (45%) women. The size of the pleural effusion was small in a large proportion of the patients (45%, n = 270). Additionally, 90 (15%) patients had moderate effusion, occupying between 20% and 40% of the hemithorax, and 84 (14%) patients had large effusion.

Conclusions: Pleural effusion was detected in 37% of the patients after CABG, 25% after valve surgery (MVR+AVR), and 20% after CABG and valve surgery. Most of the cases of effusion after cardiac surgery were left-sided. ***(Iranian Heart Journal 2020; 21(3): 48-54)***

KEYWORDS: Pleural effusion, Open cardiac surgery, Complication, Cardiopulmonary bypass

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Pulmonary complications after coronary artery bypass graft surgery (CABG) surgery are a major source of morbidity and mortality, as well as increased lengths of hospital stay and resource utilization, [1-3] Cardiac diseases are common nowadays, and surgical procedures such as CABG are performed routinely. Practicing cardiovascular surgeons have observed that respiratory problems are one of the major factors affecting morbidity and mortality rates among patients undergoing CABG. Anesthesia, poor preoperative pulmonary function, cardiopulmonary bypass, and poor surgical techniques are the most widely known reasons for respiratory complications after CABG. Pleural effusion is a common consequence following heart surgery. Pleural effusion after CABG has been reported in 42% to 89% of cases. [4-9] At least 40% of the patients who undergo CABG develop pleural effusion in the immediate postoperative period. [10-12] Most of the cases of effusion are small and left-sided. Open cardiac surgery requires the use of cardiopulmonary bypass pumps, which takes over the function of the heart, lung, and circulatory system. Most cases of effusion develop as a consequence of the surgical procedure itself (nonspecific pleural effusion) and follow a generally benign course. Postoperative pleural effusion may also occur with postpericardiotomy syndrome (a postoperative pulmonary complication, also known as the post-cardiac injury syndrome or Dressler syndrome), or as the initial manifestation of a potentially serious complicating event such as heart failure or pulmonary embolism. The extent of the evaluation required for postoperative pleural effusion depends upon the presence of associated cardiovascular symptoms and their volume, the timing of onset, progression, and the persistence of the pleural effusion. [13,22] The incidence of post-CABG pleural effusion is higher in patients who receive internal mammary artery grafts than in those who receive saphenous vein grafts. The etiology of these persistent effusion cases is still unknown. [23-26] This retrospective study was undertaken to determine the incidence of pleural effusion after open cardiac surgery.

METHODS

This prospective, descriptive study was conducted on 600 patients between December 2016 and November 2017 in Rajaie Cardiovascular, Medical and Research Center, Tehran. Six hundred adult patients for open-heart surgery were divided into 3 groups: group A was comprised of 200 patients who underwent CABG, group B consisted of 200 patients who underwent aortic valve replacement (AVR) and mitral valve replacement (MVR), and group C comprised 200 patients who underwent valve surgery and CABG.

The inclusion criteria consisted of having undergone CABG, having discharged from the intensive care unit (ICU) up to 3 days after surgery, and having no underlying pleural disease before surgery.

The exclusion criteria consisted of being reluctant to participate in the study, having a hemodynamic disorder following an infection, experiencing failure to wean from the ventilator, and undergoing emergency surgeries. Patients were also excluded if they had redo CABG surgery, valve surgery, preoperative renal failure (documented serum creatinine level > 2.0 mg/dL or being on dialysis), and preoperative congestive heart failure. Preoperative and postoperative data were obtained from the center's database. Information on postoperative events after hospital discharge was obtained from outpatient clinic records during the first month. The size of pleural effusion was estimated according to the criteria based on the semi-quantitation method used by Light et al [18,27] by visually estimating the percentage of the area of the hemithorax occupied by the pleural fluid on the lateral

chest radiograph (Table 1). Chest radiography was performed before the operation and subsequently on the first, third, and seventh postoperative days. In this study, the patients' chest X-rays were observed by the patients' physicians on the first, third, and seventh postoperative days and, if necessary, before hospital discharge. Pleural effusion was assessed in posteroanterior images as acute-angle pleura or the presence of silicosis symptoms.

Statistical Analysis

The data were expressed as the mean ± the standard deviation (SD) if they had normal distributions and the median with the 25th and 75th percentiles if they did not have normal distributions. The frequency of pleural effusion was compared between the 3 groups using the χ^2 test. The characteristics of the patients with no effusion, small effusion, and large effusion were compared using the one-way analysis of variance. The statistical analyses were performed using the SPSS software, version 21.0 for Windows (SPSS Inc, Chicago, IL, USA). A *P* value of less than 0.05 was considered statistically significant.

Table 1: Semi-quantitation of the size of pleural effusion

Grade of Effusion	Characteristic of Chest Radiograph
0	No pleural fluid present
1	Blunting of the costophrenic angle
2	Blunting of the costophrenic angle, but less than 25% of the hemithorax is occupied by the pleural fluid
3	Pleural fluid occupying 25–50% of the hemithorax
4	Pleural fluid occupying 51–75% of the hemithorax
5	Pleural fluid occupying more than 75% of the hemithorax

RESULTS

The mean age of the study participants was 58.17 ± 8.93 years. The study population was comprised of 250 (41.6%) men and 350 (58.4%) women. Males and females were in similar proportions in the 3 groups. These subjects were at an age range of 25 to 86 years. Most of the patients (n = 220, 36.3%) received only saphenous vein grafts, while 380 (63.7%) patients received left internal mammary artery grafts in addition to saphenous vein grafts. In general, there was no significant relationship between the occurrence of pleural effusion and sex, age, operative time, diabetes, hypertension, pump type, and the number of grafts received. The prevalence of pleural effusion in the 600 patients, who underwent open cardiac surgery, was 395 (65.8%) patients. Overall, 54% of the total cases of pleural effusion occurred in the first 24 postoperative hours. The size of pleural effusion was estimated from the lateral chest radiograph based on our criteria (Table 1).

The incidence rate of symptomatic large pleural effusion was 14.16% (65 of 600). In 38 patients, pleural effusion occurred during the first day of hospitalization, while in 14 patients, the complication occurred after hospital discharge. The symptoms comprised chest pain in 29%, cough in 65%, and shortness of breath in 63% of the patients. Most of the cases of effusion were left-sided (Table 2).

According to Table 2, in all 3 groups of patients, the largest amount of fluid accumulated in the pleura (pleural effusion) occurred on the third postoperative day, and it was mostly observed on the left side of the lungs in the patients that underwent CABG + valve surgery.

Table 2: Prevalence of pleural effusion on chest radiography obtained approximately on the first, third, and seventh days after open cardiac surgery

Postoperative Day	Effusion Size	Only CABG		Only Valve		CABG + Valve	
		Right	Left	Right	Left	Right	Left
1	0	109(54%)	84(42%)	139(69.55%)	124(62%)	87(43.5%)	59(29.5%)
	1	49(24.5%)	59(24.5%)	45(22.5%)	43(21.5%)	63(31.5%)	78(39%)
	2	30(15%)	39(18.5%)	15(7.5%)	23(11.5%)	31(15.5%)	42(21%)
	3	8(4%)	23(12.5%)	4(2%)	8(4%)	9(4.5%)	13(7.5%)
	4	2(1%)	5(2.5%)	1(.5%)	3(1.5%)	8(4%)	10(5%)
	5	1(.5%)	2(1%)	1(.5%)	1(.5%)	2(1%)	1(.5%)
3	0	85(42.5%)	77(38.5%)	111(55.5%)	101(50.5%)	79(39.5%)	75(37.5%)
	1	51(25.5%)	64(32%)	49(24.55)	53(26.5%)	77(38.5%)	85(42.5%)
	2	39(17.5%)	42(21%)	23(12.5%)	31(15.5%)	3(1.5%)	43(21.5%)
	3	12(6%)	17(8.5%)	10(5%)	16(8%)	8(4%)	13(7.5%)
	4	8(4%)	11(5.5%)	5(2.5%)	9(4.5%)	2(1%)	5(2.5%)
	5	5(2.5%)	8(4%)	2(1%)	4(2%)	0(0%)	1(.5%)
7	0	125(62.5%)	107(53.5%)	147(73.5%)	131(65.5%)	99(49.9%)	84(42%)
	1	35917.5%)	41(20.5%)	23(12.5%)	29(14.5%)	31(15.5%)	42(21%)
	2	25(12.5%)	37(17%)	30(15%)	35(17.5%)	29(14.5%)	36(18%)
	3	9(4.5%)	13(6.5%)	5(2.5%)	13(7.5%)	21(10.5%)	29(14.5%)
	4	6(3%)	10(5%)	3(1.5%)	1(.5%)	9(4.5%)	11(5.5%)
	5	0(0%)	0(.0%)	2(.5%)	1(.5%)	2(1%)	3(1.5%)

Table 3: Prevalence of pleural effusion in the patients who received LIMA grafts compared with that in the patients who received only SVG grafts

Pleural Effusion (%)	LIMA ± SVG (n=380)	SVG Only (n=220)
None	95(45%)	345(90.7%)
Mild	65(29.5%)	23(6.3%)
Moderate	34(15.4%)	7(1.8%)
Severe	26(11.8%)	5(1.2%)

LIMA, Left internal mammary artery; SVG, Saphenous venous graft
Severe effusion = Grade 4,5 (>50% of the hemithorax)
Moderate effusion = Grade 3 (25%–50% of the hemithorax)
Mild effusion= Grade 2 (25% of the hemithorax)
No effusion = present on either side

Table 4: Prevalence of pleural effusion on chest radiography obtained day 7 after open cardiac surgery

	Only CABG (n=200)	Only Valve (n=200)	CABG + Valve (n=200)
Effusion present	50(25%)	30(15%)	90(45%)
No effusion present	150(75%)	170(85%)	110(55%)
χ^2	*P*=0.51	*P*=0.13	*P*=0.03

According to Table 4, the largest amount of fluid accumulated in the pleura was observed in the patients who underwent CABG + valve surgery. A statistically significant correlation was observed between the type of CABG + valve surgery and postoperative pleural effusion (*P* = 0.03).

Table 5: Mortality and morbidity in the patients with and without postoperative pleural effusion

	Without Pleural Effusion	With Pleural Effusion	*P* value
Mortality	0%	1.1%	< 0.0005
Mean intensive care unit stay (d)	3.4±2.71	12.15±6.71	< 0.002
Mean hospital stay (d)	8.13±2.13	25.29±8.57	< 0.004

The patients with pleural effusion had a longer ICU stay and a higher mortality rate, while the late appearance of pleural effusion was associated with a prolonged hospital stay (Table 5).

DISCUSSION

One of the most important reasons for the readmission of patients during the first months after CABG is pleural effusion. Upon the occurrence of pleural effusion symptoms, appropriate treatment is required before the development of a critical problem. [27, 28] Pleural effusion is associated with other postoperative complications and significantly increases the hospital and ICU length of stay. [21, 23, 28] There is no clear explanation for the high incidence of pleural effusion after cardiac surgery. It is believed that pleural effusion after open-heart surgery is related to the following factors: decreased lymphatic drainage; pericarditis; postpericardiotomy syndrome; the presence of chest tubes and enclosed lungs; pleural space trauma; congestive heart failure; trauma during surgery, which can lead to blood accumulation in the pleural space; immunological disorders, which can lead to pleural effusion development; atelectasis, which is not common; injury to the internal mammary artery; local hypothermia, which may cause pleural effusion; and previous respiratory problems. [3, 6, 12, 13, 16, 17, 21, 25, 28]

The results of the current study showed that 37% of the patients undergoing CABG, 25% of the patients undergoing heart valve surgery, and 20% of the patients undergoing combined valve and CABG showed a degree of pleural effusion in their chest radiograms after surgery. In this regard, Light et al [18, 27] showed that 63% of their patients undergoing CABG and 45% of their patients undergoing heart valve surgery experienced pleural effusion, which was severe in 10% of the cases. This fluid accumulation in the pleural cavity is usually due to the accumulation of eosinophil-rich blood exudates. It was also shown in a study by Light et al [18, 27] that 9.7% of the patients had severe pleural effusion, of which more than 25% were hemothorax. Peng et al [16] reported a post-CABG symptomatic pleural effusion rate of 3.1%. In our study, 4% of the patients experienced symptomatic pleural effusion on the first and third postoperative days, which were associated with disturbed gas exchange. Sadeghpour et al [29] reported that the incidence rate of symptomatic pleural effusion on the third day after open-heart surgery among their patients was 34%. El-Nahal et al [28] reported that 47% of their patients suffered pleural effusion after CABG. The results of their study showed no significant relationship between age, sex, type of surgery, diabetes, hypertension, the number of grafts, and pump type and pleural effusion after open-heart surgery. These results are compatible with the results of the study by El-Nahal et al. [28] Patients with pleural effusion had a long hospital and ICU length of stay as they needed more medical care and treatment such as thoracentesis. Labidi et al [17] also arrived at the same conclusion. Various studies have reported post-CABG pleural effusion rates of 42% to 89%. There are various theories on pleural effusion after cardiac surgery.

CONCLUSIONS

In the present study, 37% of the patients after CABG, 25% after valve surgery (MVR + AVR), and 20% after CABG + valve surgery developed pleural effusion. Most of the cases of pleural effusion after cardiac surgery are left-sided.

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Disclosure

The authors report no conflicts of interest in this work.

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