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ORIGINAL ARTICLE

Management and characteristics of significant Post-CABG pleural effusions requiring intervention and their clinical outcomes.

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ABSTRACT… Objective: To evaluate the characteristics, management approaches, and clinical outcomes of significant post-CABG pleural effusions, with emphasis on effusion type and predictors of intervention. **Study Design:** Retrospective Observational study. **Setting:** Peshawar Institute of Cardiology, Peshawar. **Period:** January 2024 to December 2025. **Methods:** A total of 100 post-cardiac surgery patients with clinically significant pleural effusions were included. Data on demographics, surgical details, pleural fluid characteristics, interventions, complications, and outcomes were extracted from electronic medical records and analyzed using descriptive statistics in SPSS version 23. **Results:** The cohort was predominantly male (75%) with a mean age of 58.30 ± 9.06 years. Most patients had moderate (64%) or large (32%) effusions. Transudative effusions predominated (74%), while 26% were exudative. Chest tube drainage was the most common intervention (74%). Procedure-related complications were uncommon (3%) but were significantly associated with exudative effusions (p = 0.047). Radiological lung expansion was achieved in 93% of patients. **Conclusion:** Post-CABG pleural effusions are predominantly transudative and can be managed safely with pleural drainage. Chest tube drainage remains the preferred approach, while exudative effusions warrant closer monitoring due to a higher complication risk.

Key words: Cardiac Surgery, Chest Tube Drainage, Coronary Artery Bypass Grafting, Pleural Effusion.

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INTRODUCTION

Coronary artery bypass grafting (CABG) remains a cornerstone revascularization strategy for patients with advanced coronary artery disease, significantly improving survival and quality of life. Despite advances in surgical techniques and perioperative care, postoperative pulmonary complications continue to contribute substantially to morbidity following CABG. Among these, pleural effusion is one of the most frequently encountered complications, with reported incidences ranging from 10% to 90% depending on diagnostic timing and imaging modality.[1,2] While the majority of post-CABG pleural effusions are small and self-limiting, a significant proportion of patients develop clinically important effusions that cause dyspnea, hypoxemia, chest pain, delayed mobilization, prolonged hospitalization, and increased healthcare utilization.[3]

These significant effusions often persist beyond the early postoperative period or require diagnostic or therapeutic intervention, making them particularly relevant to postoperative management. The pathophysiology of post-CABG pleural effusions is complex and multifactorial. Proposed mechanisms include surgical pleural injury, internal mammary artery harvesting, systemic inflammatory response, postoperative bleeding, fluid overload, diaphragmatic dysfunction, and immune-mediated processes such as post-cardiac injury syndrome (PCIS).[4,5] Early effusions are commonly haemorrhagic or exudative, whereas late effusions tend to be lymphocyte-predominant and inflammatory, often developing weeks to months after surgery.[3] The severity, biochemical profile, and physical characteristics of pleural fluid may therefore provide important clues to the underlying pathology.

Significant post-CABG pleural effusions have been associated with adverse clinical outcomes, including prolonged mechanical ventilation, atrial fibrillation, infection, rehospitalization, and extended intensive care and hospital stays, particularly among patients requiring invasive interventions such as

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thoracentesis or chest tube insertion.

Management strategies range from conservative measures, including diuretics and anti-inflammatory therapy, to invasive procedures such as ultrasound-guided thoracentesis or tube thoracostomy. Recent evidence highlights the role of ultrasound guidance in improving procedural safety and diagnostic yield, as well as the importance of pleural fluid analysis in excluding infection or malignancy in persistent effusions.[6,7] Despite the clinical burden of post-CABG pleural effusions, considerable variability exists in practice regarding indications for intervention, timing, and duration of management. Moreover, robust data linking effusion characteristics, management strategies, and postoperative outcomes remain limited, particularly in regional clinical settings.[8] Therefore, this study aims to evaluate the characteristics, management approaches, and clinical outcomes of significant post-CABG pleural effusions requiring intervention, using adjusted analytical models to better understand their impact on patient recovery and to inform evidence-based postoperative care.

OBJECTIVES

To evaluate the characteristics, management, and clinical outcomes of significant post-CABG pleural effusions, including the impact of effusion type, patient factors, and predictors for the choice of intervention (chest tube versus thoracentesis).

METHODS

This is a retrospective observational study conducted to evaluate the characteristics, management, and clinical outcomes of significant post-CABG pleural effusions, including the impact of effusion type, patient factors, and predictors for the choice of intervention (chest tube versus thoracentesis). The study was carried out at the Peshawar Institute of Cardiology (PIC), Department of Pulmonology, from January 2024 to December 2025. A total of 100 post-cardiac surgery patients who developed pleural effusion and met the inclusion criteria were included in the study using Non-probability sampling technique.

Inclusion Criteria

- All patients who underwent cardiac surgery (CABG or valve procedures) and subsequently developed clinically significant pleural effusion requiring intervention during the study period.

Exclusion Criteria

- Patients with pre-existing chronic pleural disease.
- Patients with incomplete hospital records or missing key clinical data.

Data Collection Procedure

Clinical data were retrospectively extracted from hospital Electronic Medical Records (EMR). Demographics, including age, sex, and comorbidities (diabetes, hypertension, chronic kidney disease), were recorded. Surgical details encompassed the type of cardiac surgery (CABG or valve replacement), the number of grafts, and use of the internal mammary artery. Pleural effusion characteristics, including time of onset, laterality, volume, biochemical profile (transudative vs. exudative), fluid color, and cytology, were documented. Management details included the type of intervention (thoracentesis or chest tube), duration of drainage, and adjunctive medications. Clinical outcomes, including ICU and hospital stay, respiratory complications, recurrence, infections, need for re-intervention, and mortality, were also recorded. The independent variables included effusion type, demographics, comorbidities, and surgical factors, and the dependent variables comprised the choice of intervention, hospital stay duration, complications, and clinical outcomes.

Data Analysis

Data were analyzed using SPSS version 23. Descriptive statistics summarized demographics, effusion characteristics, and management strategies (mean ± SD for continuous variables; frequencies and percentages for categorical variables). Comparative analyses between groups (transudative vs. exudative effusions, thoracentesis vs. chest tube) used Chi-square or Fisher's exact test for categorical variables and t-test or Mann–Whitney U test for continuous variables. Multivariate logistic regression identified predictors of intervention type and factors associated with prolonged hospital stay or complications. A p-value <0.05 was considered statistically significant.

Ethical Approval

The study was conducted after approval from the Institutional Review Board (IRB) of Peshawar Institute of Cardiology (IRC/25/205/24-12-25). Patient confidentiality was maintained by de-identifying all records and using coded data for analysis.

RESULTS

The Figure-1 presents the baseline characteristics of the 100 patients included in the study. The mean age of the participants was 58.30 years with a standard deviation of 9.06 years, indicating that the sample was generally young but with a considerable variation in age.

Regarding gender distribution, the majority of participants were male (75%), while females comprised (25%) of the sample. This shows that the study population was predominantly male. Overall, the table provides a clear overview of the participants age and gender at baseline.

Size of Pleural Effusion

Among the 100 post-CABG patients with pleural effusion requiring intervention, the majority presented with moderate-sized effusions, accounting for 64 patients (64%). Large pleural effusions were observed in 32 patients (32%), while mild effusions were relatively uncommon, occurring in only 4 patients (4%).

This distribution indicates that most patients undergoing intervention had clinically significant pleural effusions, with nearly one-third presenting with large effusions that likely contributed to respiratory symptoms and the need for procedural management.

Type of Pleural Drainage Procedure

Chest tube drainage was the most commonly employed intervention, used in 74 patients (74%), whereas pigtail catheters were utilized in 26 patients (26%).

Within the chest tube group, 24 French (Fr) chest tubes were the most commonly used, accounting for 33.0% of all cases, followed by 20 Fr chest tubes and 16 Fr chest tubes. This reflects clinician preference for larger-bore chest tubes in patients with significant pleural effusions following cardiac surgery.

Procedure-Related Complications

Procedure-related complications were rare. The majority of patients (97%; n = 97) experienced no complications. Trapped lung occurred in 2 patients (2%), while retention of a pigtail catheter fragment during extubation was observed in 1 patient (1%). These findings demonstrate that pleural interventions were generally safe.

A significant association was observed between effusion type and procedure-related complications ($\chi^2 = 6.12$, $p = 0.047$). Specifically, trapped lung occurred only in exudative effusions (7.7% of exudative cases), whereas pigtail retention occurred in 1.4% of transudative cases. This suggests that exudative effusions may carry a higher risk of procedural complications.

Pleural Fluid Characteristics

Hemorrhagic fluid was the most common finding (54%; n = 54), followed by deep straw (25%; n = 25) and straw-colored fluid (19%; n = 19). Turbid fluid was rare (2%; n = 2). Transudative effusions accounted for the majority of cases (74%; n = 74), while 26% (n = 26) were exudative.

A significant association was found between effusion type and fluid color ($\chi^2 = 12.59$, $p = 0.006$). Turbid fluid was exclusively seen in exudative effusions, whereas straw-colored fluid was more common in transudative effusions, highlighting the potential clinical utility of fluid appearance in differentiating effusion types.

Nature of Pleural Effusion (Transudative vs Exudative)

Among the 100 post-CABG patients included in the study, transudative pleural effusions were the predominant type, identified in 74 patients (74%). Exudative pleural effusions were observed in 26 patients (26%).

This distribution indicates that the majority of pleural effusions requiring intervention following coronary artery bypass grafting were transudative

in nature, likely reflecting postoperative fluid shifts and systemic factors. However, a substantial proportion of patients developed exudative effusions, suggesting localized pleural inflammation or postoperative complications in this subgroup.

Clinical outcomes following pleural intervention were generally favorable. The majority of patients (93 patients; 93%) demonstrated radiological lung expansion after the procedure. A small proportion of patients (4 patients; 4%) were discharged without a follow-up chest radiograph, based on satisfactory clinical improvement.

Adverse outcomes were uncommon. An opaque hemithorax was observed in 1 patient (1%), while referral to thoracic or cardiothoracic surgery was required in 3 patients (3%). Overall, these findings indicate a high procedural success rate in the management of significant post-CABG pleural effusions.

FIGURE-1

Baseline characteristics of patients (n=100)

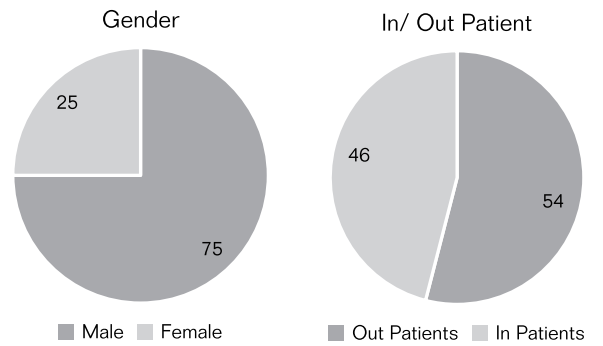

FIGURE-2

Pleural fluid characteristics/ transudative/exudative

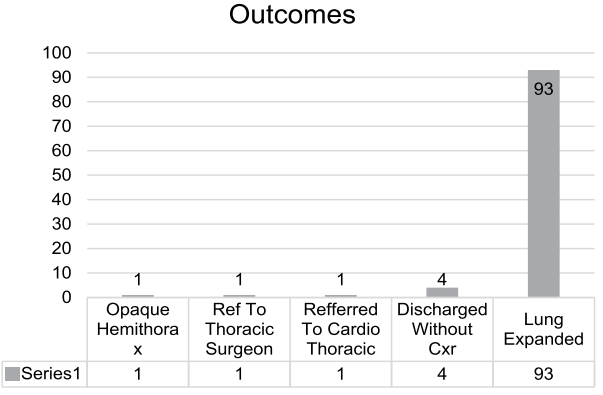

TABLE-I

Detail assessment of Pleural effusion in post CABG patients

Clinical Outcomes		P-Value
Size of Effusion		
Large Effusion	32%	0.329
Mild Effusion	4%	
Moderate Effusion	64%	
Chest Tube Vs Pigtail		
20 Size Tube	1%	0.306
20 Size Tube	5%	
14 Size Tube	1%	
16 Size Tube	9%	
20 Size Tube	24%	
21 Size Tube	1%	
24 SIZE TUBE	33%	
PIGTAIL	26%	
Complication		
N/A	97%	0.047
Pigtail Piece Left During Extubation	1%	
Trapped Lung	2%	
Procedure-Related Complications		
Color Of Fluid		
Deep Straw	25%	0.006
Hemorrhagic	54%	
Straw Colour	19%	
Turbid	2%	

DISCUSSION

Pleural effusion is a common postoperative complication following coronary artery bypass grafting (CABG), with reported incidences ranging from 40% to 90%, although only a subset becomes clinically significant and requires intervention.[9] In the present study, most patients requiring intervention presented with moderate to large pleural effusions, highlighting that clinically relevant effusions tend to be substantial in size and symptomatic. This finding aligns with previous reports indicating that larger effusions are more likely to cause dyspnea and impaired lung expansion, prompting procedural management.[5]

The predominance of male patients in this cohort mirrors the gender distribution commonly observed

in CABG populations worldwide and is consistent with earlier post-cardiac surgery pleural effusion studies.[10] Although the mean age in this cohort was relatively young compared with Western CABG populations, the pathophysiological mechanisms of postoperative pleural effusion remain similar, largely driven by fluid shifts, inflammation, and surgical trauma.

Transudative effusions accounted for nearly three-quarters of cases in this study, supporting the concept that most post-CABG pleural effusions are related to systemic factors such as volume overload, heart failure, and altered oncotic pressures rather than localized pleural disease.[11] However, the substantial proportion of exudative effusions underscores the role of pleural inflammation, internal mammary artery harvesting, and postoperative bleeding in a notable subset of patients.[9]

Chest tube drainage was the most frequently utilized intervention, reflecting clinician preference for more definitive drainage in moderate to large effusions. Previous studies have demonstrated that large-bore chest tubes are often favoured in post-surgical settings due to faster drainage and lower risk of blockage, particularly in haemorrhagic effusions.[12]

Procedure-related complications were infrequent, confirming the overall safety of pleural interventions after CABG. Importantly, the significant association between exudative effusions and complications such as trapped lung is consistent with prior literature indicating that inflammatory pleural processes increase the risk of pleural peel formation and incomplete lung re-expansion.[13] The strong association between effusion type and fluid color also reinforces the clinical value of gross fluid appearance as an initial indicator of underlying pathology.

Clinical outcomes were favorable, with successful lung expansion achieved in the majority of patients. These results align with contemporary evidence suggesting that timely and appropriate pleural intervention leads to excellent radiological and clinical recovery in post-CABG patients, with only a small proportion requiring surgical referral.[14]

CONCLUSION

Significant pleural effusions after CABG are usually transudative and moderate to large, often requiring intervention. Chest tube drainage is the most effective treatment, particularly for large or hemorrhagic effusions, with low complication rates. Early identification and appropriate management lead to high success and favorable outcomes.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Muhammad Imran Khan:** Conceptualization of study design.
2	**Jamshed Alam:** Idea generation.
3	**Abdul Nasir:** Critical review.
4	**Haider Zaman Khan:** Data analysis.
5	**Asma Qudrat:** Manuscript writing.
6	**Muhammad Zohaib Ikram:** Data collection.