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Effect of Timing of Chest Drain Removal on Postoperative Results in Aortic Surgery

Omar Abdelaziz Mohamed Dawoud, Said Abdel-Aziz Badr Soliman,
Ahmed Mohamed Kamel Mohamed*, Hussein Mohamed Hussein Derbala
Department of Cardiothoracic Surgery, Faculty of Medicine, Cairo University, Egypt
***Corresponding author:** Hussein Mohamed Hussein Derbala, **Mobile:** (+20) 01030706434,
Email: husseinderbala@kasralainy.edu.eg

ABSTRACT

Background: Cardiovascular diseases remain a leading cause of morbidity and mortality worldwide, with aortic pathologies presenting unique challenges in surgical management.

Objective: To evaluate the effect of timing of chest drain removal on postoperative results in aortic surgery.

Patients and methods: This retrospective research has been performed on 50 cases that were divided into 2 main groups: Group (A) involved 25 cases who had chest tube removal and followed up postoperatively within 48 hours or less, and group (B) included 25 patients who underwent chest tube removal and followed up postoperatively after 48 hours.

Results: Postoperatively, pericardial effusion was reported in 8 patients in group A and 2 cases in group B, while 17 cases in group A and 23 cases in group B reported not to have pericardial effusion. A statistically significant variance has been observed among both groups (p-value equal to 0.034).

Conclusion: Late removal of chest tubes significantly reduces the frequency of pericardial effusion following aortic surgery, as shown by the lower rates in patients with delayed removal. While early removal improves comfort by reducing pain and analgesic use, late removal ensures more thorough drainage, particularly in high-risk patients, minimizing fluid accumulation. Although early removal does not increase the risk of complications like atrial fibrillation, delayed removal plays a crucial role in preventing pericardial effusion and optimizing postoperative outcomes in certain patient populations.

Keywords: Chest drain, Aortic surgery, Pericardial effusion.

INTRODUCTION

Cardiovascular diseases remain a leading cause of morbidity and mortality worldwide, with aortic pathologies presenting unique challenges in surgical management. Aortic surgery, encompassing procedures such as aortic valve replacement, aortic root reconstruction, and thoracic aortic aneurysm repair, has evolved significantly over the past decades. Despite advancements in surgical techniques and perioperative care, postoperative management following these complex interventions continues to be a critical determinant of patient outcomes. Central to this management is the use and timely removal of chest drains, a practice that has garnered increasing attention in recent years because of its potential impact on patient recovery and complication rates [(1)].

Chest drains play a vital role in the immediate postoperative period following aortic surgery. These devices are instrumental in evacuating blood, serous fluid, and air from the thoracic cavity, thereby preventing life-threatening complications such as cardiac tamponade, pleural effusion, and pneumothorax. The importance of effective drainage cannot be overstated, as the accumulation of even small volumes of fluid or air can significantly compromise cardiopulmonary function in the delicate postoperative state [(2)].

The Enhanced Recovery After Surgery (ERAS®) Society and the European Society of Thoracic Surgeons have advocated for early removal of chest drains as part of a comprehensive strategy to promote faster recovery and reduce the incidence of drainage-related complications. This recommendation aligns with the broader shift in surgical care towards minimizing invasive interventions and accelerating patient rehabilitation. However, the application of these guidelines to aortic surgery patients requires careful consideration, given the heightened risk of postoperative bleeding and fluid accumulation associated with these procedures [(3)].

The rationale for investigating the timing of chest drain removal in aortic surgery is multifaceted. Firstly, the high incidence of postoperative complications related to fluid accumulation in the thoracic cavity, particularly pericardial effusion, underscores the need for optimized drainage strategies. Pericardial effusion, if unrecognized or inadequately managed, can rapidly progress to cardiac tamponade, a life-threatening condition that demands immediate intervention. The volume and duration of chest drainage are critical factors influencing the development of such effusions, making the timing of drain removal a key decision point in postoperative care [(4)].

Secondly, the existing literature presents conflicting evidence regarding the ideal timing for chest drain removal, particularly in the context of aortic surgery. While some studies suggest that early removal can reduce infection rates and improve patient comfort, others argue that a more conservative approach might be necessary to prevent fluid re-accumulation and other complications. This inconsistency in the evidence base highlights the need for targeted research focusing specifically on aortic surgery patients, where the stakes of postoperative

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management are exceptionally high due to the complexity and invasiveness of the procedures [(5-9)].

This research aimed to assess the effect of the timing of chest drain removal on postoperative results in aortic surgery.

PATIENTS AND METHODS

This retrospective research has been performed on 50 cases that were divided into 2 main groups: group (A) involved 25 cases who had chest tube removal and followed up postoperatively within 48 hours or less, and group (B) included 25 patients who underwent chest tube removal and followed up postoperatively after 48 hours.

Inclusion Criteria: Age above 18 years, both sexes, and patients undergoing aortic surgery (aneurysm or dissection either involving the aortic valve or not).

Exclusion criteria: patients who didn't fulfill the chest tube output criteria for early removal of the tubes, patients who had reoperation because of bleeding, ischemia, or other reasons before the chest tubes were removed, and patients who had other associated surgeries, CABG, or mitral or tricuspid valve surgeries.

Sample size

Sample size calculation was done by MedCalc® Statistical Software version 20.009 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2021). With 80% power, a 5% confidence limit, and an expected AUC of the ROC curve of prediction of the 30-day mortality of at least 0.758, 4 cases were added to overcome drop-out. Therefore, 50 patients were included in the study.

Operative Details

All the cases had standard bypass procedures with membrane oxygenation and moderate hypothermia.

Supracoronary Ascending Aortic Replacement (SCAAR) involved excising the diseased portion of the ascending aorta and replacing it with a synthetic graft. The aorta was typically transected above the sinotubular junction and just proximal to the innominate artery. The native aortic valve was preserved and might be resuspended if necessary. The coronary arteries usually remained attached to the native aortic root.

The **Bentall procedure** began with excision of the diseased aortic root, including the valve and proximal ascending aorta. A composite graft (consisting of a prosthetic valve attached to a vascular graft) was then sewn into place. The coronary arteries were detached from the native aorta and reimplanted into the graft using the button technique. This procedure created a new aortic root with the prosthetic valve at its base.

The **David Procedure** (valve-sparing root replacement) started similarly to the Bentall, with removal of the diseased aortic root but carefully preserving the native aortic valve leaflets. A graft was tailored to create neo-sinuses, and the preserved valve was reimplanted within this graft. The coronary arteries were then reattached to the graft. This technique required precise sizing and suturing to ensure proper valve function within the new aortic root. At the completion of the operation, all cases had at least 2 commercially available 40 French mediastinal chest tubes connected to an underwater seal jar. In addition, one or two pleural tubes have been placed when the pleural space has been opened. All chest tubes were actively drained by nurses as needed.

Postoperative Monitoring

Postoperative monitoring involved routine chest X-rays within 12–24 hours and earlier if respiratory issues arose. Group A (N=25) had chest tubes removed within 48 hours, while group B (N=25) had removal after 48 hours. Chest tube output was recorded hourly, with re-exploration indicated if output exceeded 300 mL/hour for two consecutive hours or if signs of cardiac tamponade appeared. Patients were mobilized upright on the first postoperative day to aid mediastinal drainage. Additional chest X-rays were conducted on postoperative day three and at a four-week follow-up. Transthoracic echocardiography (TTE) was performed 3–5 days' post-surgery to assess residual pericardial or mediastinal effusion, with effusion categorized by size and the inferior vena cava measured in most patients according to standard guidelines.

Ethical approval:

This study has been approved by the Cairo Faculty of Medicine's Ethics Committee. Following receiving of all information, signed consent was provided by each participant. The study adhered to the Helsinki Declaration throughout its execution.

Statistical analysis

Software called SPSS version 28.0 was used to code and input the data. Quantitative data were described using mean ± SD, whereas categorical variables were summarized using relative frequencies (percentages) and frequencies (number of cases). To compare groups, the unpaired t test was used for quantitative data and X^2-test was used for categorical data comparison. Statistical significance was defined as P-values less than 0.05, and the exact test was employed when the anticipated frequency was less than 5.

RESULTS

The mean age in group A was 51.48 years (SD ±7.90), and in group B it was 55.80 years (SD ±4.40). In group A, 64% were males while in group B, 60% were males (Table 1).

Table (1): Preoperative Demographic and Clinical Characteristics

Characteristic	Group A (< 48 Hrs)	Group B (> 48 Hrs)
Number of patients	25 patients	25 patients
Age (Mean ± SD)	51.48 ± 7.90	55.80 ± 4.40
Sex		
Male (%)	16 (64%)	15 (60%)
Female (%)	9 (36%)	10 (40%)
Diabetes Mellitus (DM)		
Diabetic (%)	9 (36%)	13 (52%)
Hypertension (HTN)		
Hypertensive (%)	17 (68%)	15 (60%)
Marfan Syndrome		
Patients with Marfan syndrome (%)	8 (32%)	4 (16%)

Postoperatively, pericardial effusion was reported in 8 patients in group A and 2 cases in group B. The amount of effusion was not indicated for re-exploration but just follow-up. A statistically significant variance has been observed among both groups (p-value equal to 0.034, Figure 1).

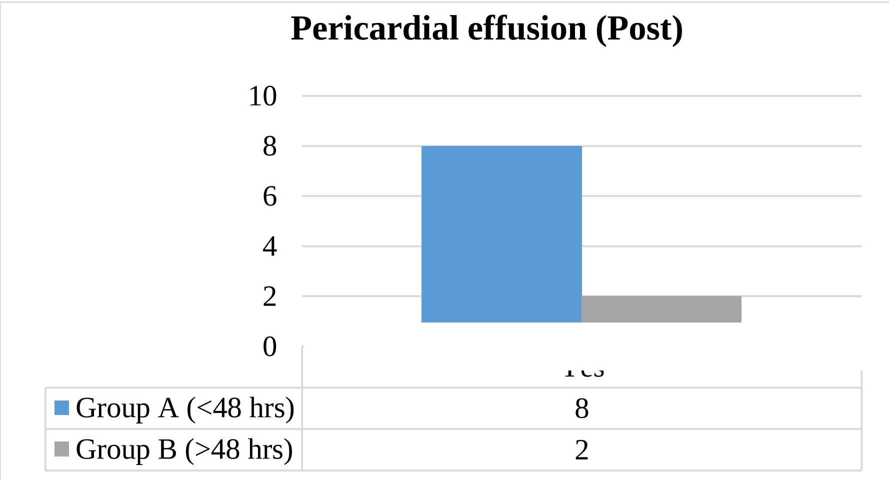

Figure (1): Pericardial effusion (post) in both groups.

Postoperatively, atrial fibrillation was reported in 2 patients in group A and 6 cases in **group B.** A statistically insignificant variance has been observed among both groups **(**p-value equal to 0.247, Figure 2).

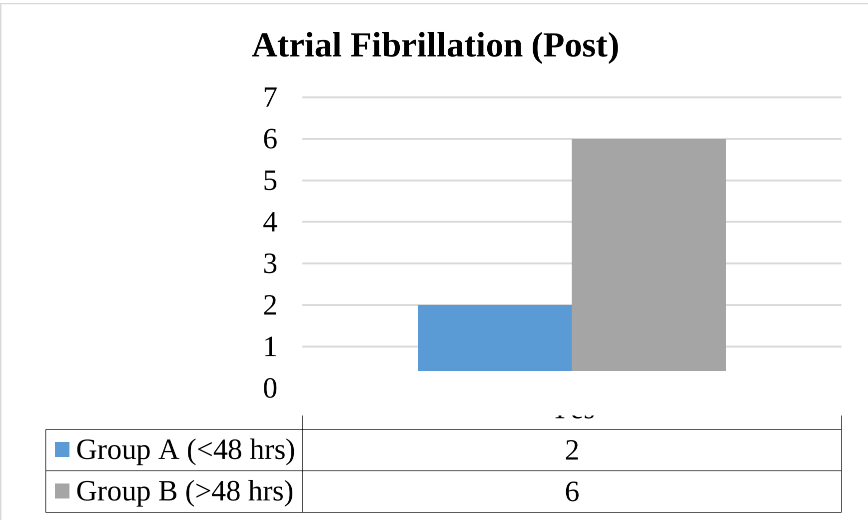

Figure (2): Atrial fibrillation (post) in both groups.

Postoperatively, mediastinitis was reported in one patient in each group (P=1.00, Figure 3).

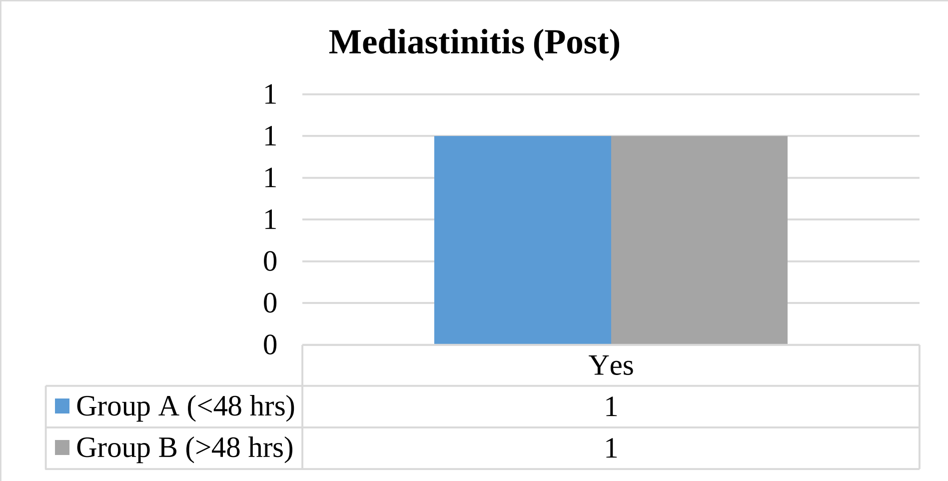

Figure (3): Mediastinitis (post) in both groups.

Re-exploration was reported in 3 cases in group A and one case in group B; re-exploration was due to severe pericardial effusion and cardiac tamponade. A statistically insignificant variance has been observed among both groups (p-value equal to 0.609, Figure 4).

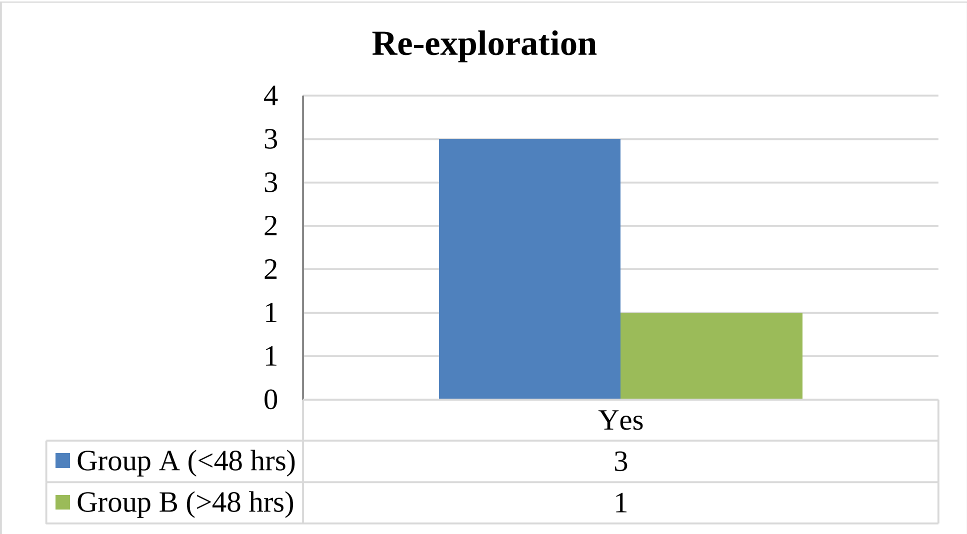

Figure (4): Re-exploration in both groups.

Regarding patients that suffered severe pain and were managed with pethidine or morphine, there were 2 cases in group A and 5 cases in group B. A statistically significant variance has been observed among both groups (p-value equal to 0.001, Table 2).

Table (2): Pain Severity and Administration of Analgesics among Both Groups:

			Group A (Less than 48 Hrs)	Group B (More than 48 Hrs)
Pain severity and Administration of Analgesics	Severe pain/High analgesia doses	Count	2	5
		% within group	8%	20%

A statistically insignificant variance has been observed among both groups in either ICU stay or hospital stay (p >0.05, Table 3).

Table (3): ICU and hospital stay among both groups:

	Groups	**Mean**	**S. Deviation**
ICU Stay (in Days)	Group A (Less than 48 Hrs)	2.44	0.71
	Group B (More than 48 Hrs)	2.80	0.87
Hospital Stay (in Days)	Group A (Less than 48 Hrs)	4.44	0.71
	Group B (More than 48 Hrs)	4.80	0.87

DISCUSSION

In our study, we found a statistically significant variance in the frequency of pericardial effusion among the two groups. Group A, which had chest tubes removed within 48 hours, experienced a higher incidence of pericardial effusion (8 patients) compared to group B, where chest tubes were removed after 48 hours (2 patients). The difference was significant (p=0.034), suggesting that earlier removal of chest tubes might lead to insufficient drainage, potentially causing residual fluid to accumulate in the pericardial cavity.

Gercekoglu *et al.* [(4)] performed prospective and retrospective research to evaluate whether the timing of chest tube removal influences the development of pericardial effusion. They found a statistically insignificant variance in the incidence of significant pericardial effusion between early removal (after the appearance of serosanguineous drainage) and delayed removal (after 48 hours). Their study suggests that early removal, when done carefully with attention to drainage characteristics, does not inherently increase the risk of effusion.

El-Akkawi *et al.* [(10)] conducted a cluster-randomized trial comparing chest tube removal on the day of surgery (within 10 hours) versus on the first postoperative day (24 hours). Their study found insignificant variance in the incidence of pleural or pericardial effusions among early and delayed removal groups, but they did note that more than a quarter of their patients required subsequent drainage for effusion, regardless of the removal timing. This finding suggests that while early removal might not drastically increase effusion risk, it may not prevent it either.

The higher incidence of pericardial effusion in group A in our study supports the hypothesis that early chest tube removal may lead to insufficient drainage of fluids, particularly in patients who are predisposed to fluid accumulation due to complex or high-risk surgeries such as aortic dissection repairs. However, other studies, like those of **Abramov *et al.*** [(11)] and **Gercekoglu *et al.*** [(4)]**,** suggest that under well-monitored conditions, early removal does not necessarily increase effusion risk, especially if the drainage volume criteria are strictly followed.

In our study, group A (early chest tube removal within 48 hours) required significantly less postoperative analgesia than group B (delayed chest tube removal beyond 48 hours). The pain levels were notably lower in group A, with more patients reporting mild or no pain compared to group B, where a higher number of patients experienced severe pain. Specifically, 84% of group A patients reported mild pain, while only 40% of group B experienced the same. In contrast, 28% of group B patients reported severe pain, compared to only 4% in group A, a statistically significant variance (p-value equal to 0.001). This decreased need for analgesia in group A indicates that early removal of chest tubes may help alleviate postoperative discomfort and allow patients to mobilize more comfortably, which is a key factor in recovery.

The relationship between early chest tube removal and reduced pain has been well documented in several studies, aligning with our findings.

Abramov *et al.* [(11)] similarly found that early chest tube removal led to lower analgesic requirements in their study on coronary artery bypass surgery. They reported a reduction in the frequency of analgesic use in the first 36 hours' post-surgery, with group A patients requiring 2.1 doses of analgesia every 12 hours compared to 3.6 doses in group p B (p=0.09). This reduction in pain medication was attributed to the quicker removal of mechanical irritation from the chest tubes. Our study corroborates this, showing that patients in group A, with earlier chest tube removal, experienced less discomfort and therefore needed fewer pain medications.

Atrial fibrillation (AF) happened in 2 cases (8%) in group A and 6 cases (24%) in group B, but this difference wasn't statistically significant (p=0.247). Mediastinitis, a serious infection of the chest cavity, was reported in 1 patient in each group, making the incidence of mediastinitis equal and without statistical significance (p=1.00). Re-exploration due to complications such as bleeding was required in 3 cases in group A and 1 patient in group B. However, this difference wasn't statistically significant (p-value equal to 0.609).

Dang Van *et al.* [(2)] investigated the use of digital chest drainage systems compared to traditional analog systems. They found that while digital systems allowed for earlier removal of chest tubes and reduced overall drainage time, this did not result in increased postoperative complications, including AF and re-exploration. Their study suggested that modern drainage systems can facilitate safe, early removal without increasing the risks associated with delayed drainage. This highlights that, with adequate monitoring, early removal does not compromise patient safety.

The duration of ICU and hospitalization was shorter in the early removal group in our study, although the variance wasn't statistically significant. This is consistent with the findings of **Abramov *et al.*** [(11)], who also reported shorter hospital stays in the early removal group, facilitating earlier discharge and reducing healthcare costs. Conversely, **El-Akkawi *et al.*** [(10)] found insignificant variance in hospital stay among the two groups. These mixed results highlight the complexity of factors influencing length of stay, such as postoperative complications, patient recovery trajectories, and institutional discharge protocols.

Mirmohammad-Sadeghi *et al.* [(12)] similarly found that early removal of chest tubes after coronary artery bypass graft (CABG) surgery did not lead to an increase in serious complications like mediastinitis or re-exploration. They concluded that early chest tube removal, when performed under controlled conditions, does not elevate the risk of common postoperative issues, further supporting the findings from our study.

Moss *et al.* [13] conducted a randomized trial comparing early and delayed mediastinal drain removal in patients undergoing aortic or valve surgery. They found insignificant variance in the incidence of atrial fibrillation, mediastinitis, or other complications such as tamponade between the two groups. This aligns with our findings, reinforcing the idea that early chest tube removal doesn't inherently elevate the risk of postoperative complications when conducted under proper clinical criteria.

CONCLUSION

Late removal of chest tubes significantly reduces the frequency of pericardial effusion following aortic surgery, as shown by the lower rates in patients with delayed removal. While early removal improves comfort by reducing pain and analgesic use, late removal ensures more thorough drainage, particularly in high-risk patients, minimizing fluid accumulation. Although early removal does not increase the risk of complications like atrial fibrillation, delayed removal plays a crucial role in preventing pericardial effusion and optimizing postoperative outcomes in certain patient populations.

Conflict of interest: None.
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