

# Timing of Chest Tube Removal After Coronary Artery Bypass Surgery

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**ABSTRACT** *Aim:* Assessing the impact of chest tube removal timing following a coronary artery bypass grafting surgery on the clinical outcome. *Methods:* Eighty-three consecutive patients were randomly assigned to either have the chest tube removed 24 hours (Group A) or 48 hours (Group B) postoperatively. Chest tubes were removed on the condition that drainage was less than 100 cc for the last 8 hours. Pre- and postoperative data were analyzed. *Results:* The following preoperative and intraoperative risk factors were more prevalent among Group A patients: previous MI (60.5% vs 40.7%,  $p = 0.11$ ), previous CVA (9.1% vs 0%,  $p = 0.11$ ), hypertension (72.7% vs 55.6%,  $p = 0.14$ ), pump time (111.6 min vs 96.8 min,  $p = 0.07$ ), and cross-clamp time (73.8 min vs 64.4 min,  $p = 0.07$ ). Postoperatively, there was a lower demand for analgesics in Group A (2.1 times for 12 hours at 36 hours vs 3.6  $p = 0.09$ ), lower white blood cell count (10,947 at 48 hours vs 11,576,  $p = 0.39$ ) a higher oxygen saturation (91.9% at 48 hours vs 88.9%,  $p = 0.07$ ), higher expiratory volumes (594 mL at 36 hours vs 514 mL  $p = 0.08$ ) and earlier mobilization (23% walking at 48 hours vs 4%,  $p = 0.01$ ). Pleural effusion and atelectasis were less frequent in Group A in both chest X-rays (66% vs 73%,  $p = 0.6$  and 64% vs 75%,  $p = 0.47$ , respectively) and CT scans (19% vs 41%,  $p = 0.1$  and 84% vs 96%,  $p = 0.42$ , respectively). There was no difference between the two groups in the prevalence of serous wound discharge and the length of hospital stay and there were no reported cases of pneumonia throughout the study. *Conclusion:* In cases where no excessive drainage accumulates, early removal of the chest tubes was found to be a policy that improves the postoperative outcome and decreases the need for supportive treatment such as analgetics, physiotherapy, nurse care, and oxygen. This policy did not involve significant residual effusions. (*J Card Surg* 2005;20:142-146)

The necessity of pericardial and pleural drainage after coronary artery bypass grafting (CABG) surgery is agreed upon worldwide. There is still some controversy regarding the number of drains needed and the sites of insertion,<sup>1-6</sup> but a standard algorithm determining the timing of drainage tube removal after CABG procedures has not yet been established. In many centers it is accepted to remove the tubes on the first postoperative day, under the condition that there is not more than 100 mL of drainage during the previous 8 hours.<sup>7</sup> In other centers, the drains are routinely left for more than 48 hours.<sup>8</sup> In this prospective randomized study, we try to evaluate the advantages and disadvantages of early and later chest tube removal in order to set up guidelines for a best-result timing.

## MATERIALS AND METHODS

### Study population

The study population included 83 consecutive patients who underwent isolated coronary artery bypass surgery at the Soroka University Medical Cen-

ter, Beer Sheva, Israel between April 2002 and August 2002. Patients undergoing re-do operations, off-pump surgery, CABG in association with heart valve repair or replacement, resection of a ventricular aneurism, or extracardiac surgical procedure were excluded.

Other exclusion criteria included:

1. Bleeding over 1000 mL in the first 24 hours postoperatively or bleeding that necessitated a reoperation.
2. Pre- or postoperative anticoagulation therapy.
3. Use of an intraaortic balloon pump.
4. Mechanical ventilation for over 24 hours postoperatively.
5. Surgeon's objection to include patient in the study.

This study received the approval of the institutional Helsinki Committee. All patients who had agreed to participate signed a consent form after receiving a detailed explanation about the nature and goals of the study.

The patients were randomized into two groups: in Group A (N = 46) patients' drains were removed within the first 24 hours postoperatively, whereas in Group B (N = 37) patients' drains were removed 48 hours postoperatively.

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Randomization was employed using closed envelopes assigning the patient to one of the two groups. These envelopes were opened after the operation. The drains were removed according to the randomization on the condition that there were not more than 100 mL drainage per compartment (mediastinal or pleural) in the last 8 hours. In the case of more than 100 mL of drainage, the patient was reevaluated every 8 hours, and the drains were removed once there was less than 100 mL of accumulated drainage per 8 hours.

**Anesthetic and operative techniques**

Fentanyl citrate (20–50 µg/kg) midazolam (2–3 mg) and isoflurane (0.5% to 2%) were used for induction and maintenance of anesthesia. Standard median sternotomy and aorta-right atrial cannulation were performed for cardiopulmonary bypass. Patients were either cooled to 28°C or remained normothermic (32–37°C).

Distal anastomosis were performed during aortic cross-clamp and cardioplegic arrest. Proximal anastomoses were performed using aortic side biting clamp. Blood cardioplegic solution was delivered in a 4:1 ratio. Cold cardioplegia (10°C) was utilized. Cardioplegia was delivered either antegrade via the aortic root and completed vein grafts or antegrade with the addition of retrograde administration via the coronary sinus. After cardioplegic induction, additional doses of 300–500 cc were administered after completion of each distal anastomosis. Two pericardial drainage tubes were inserted retrosternally and posteriorly, and a left pleural drain was inserted from the midline (subxiphoid).

**Data collection and statistical analysis**

Preoperative, intraoperative data (Table 1) the first 24 postoperative hours data (Table 2) and later postoperative data (Table 3) was collected and recorded into Microsoft Excel data sheet. SPSS for PC software was used for statistical analysis.

Outcomes of some interest were: respiratory status (O<sub>2</sub> saturation, maximal expiratory volume, chest X-ray, chest CT scan, and ambulation), pleural and pericardial effusions (PEFs) and atelectasis (chest X-ray, CT), drainage volume, infection (fever, WBCs), postoperative pain (need for analgesia), and hospital stay.

Chest X-rays and CT scans were interpreted by a radiologist, unaware of the treatment assignment.

Continuous variables were summarized as means ± standard deviation and categorical variables as absolute frequencies or proportions. Continuous variables were compared using Student's *t*-test, and categorical variables by chi-square.

**RESULTS**

The average drainage time for Group A patients was 29.3 ± 4.5 hours and for Group B 49.4 ± 5.2 hours.

**Preoperative and intraoperative parameters**

There were no statistically significant differences between the groups in any one of the preoperative parameters (Table 1). Nevertheless, in Group A, there was more preoperative premorbidity including: previous myocardial infarction, left main coronary artery disease, chronic renal failure, and hypertension. The pump time and cross-clamp time were longer in Group A.

**Postoperative parameters**

Postoperative parameters were divided into two time frames: the first 24 postoperative hours when all patients had chest tubes (Table 2) and 25–96 postoperative hours—when chest tubes were gradually removed (Table 3).

During the first 24 hours postoperatively (Table 2), when all patients had the drains, there was no substantial difference between the groups in all the parameters recorded except for pleural effusion in chest X-ray

**TABLE 1**  
**Preoperative and Intraoperative Parameters**

Significance	Group B (N = 37)	Group A (N = 46)	Parameter
	70%	72%	Male sex
	65 ± 9	64 ± 10	Age
	82 ± 14	77 ± 10	Weight
	20%	30%	Urgent operation
	2.6 ± 0.8	2.9 ± 0.7	NYHA average
	41%	51%	Myocardial infarction in past
	73%	78%	Three vessel disease
	24%	35%	Left main coronary artery disease
	32%	22%	Moderate or severe LV dysfunction
	27%	39%	Hypertension
	8%	7%	Previous CVA
	3%	10%	Renal failure (Cr > 1.7)
	74%	67%	Diabetes mellitus
	18%	23%	COPD
	32%	30%	Preoperative aspirin treatment
	105 ± 31	110 ± 33	Pump time (min)
	69 ± 19	74 ± 21	Cross clamp time (min)
0.05	3.6 ± 0.9	4.0 ± 1.0	Number of bypasses

NYHA = New York Heart Association; LV = left ventricle; CVA = cerebrovascular accident; COPD = chronic obstructive pulmonary disease.

**TABLE 2**  
**Postoperative Parameters in the First 24 hours Postoperatively**

Significance	Group B (N = 37)	Group A (N = 46)	Parameter
	35.8 ± 0.6	35.8 ± 0.9	Body temperature 24 hao*
	215 ± 73	212 ± 71	Amount of drainage (mL) 8 = 16 hao
	11.8 ± 3.4	11.2 ± 2.9	White blood cell count 24 hao
	4.1% ± 90.1	3.2% ± 91.0	Oxygen saturation 24 hao
	150 ± 525	168 ± 505	Maximal expiratory volume (mL) 24 hao
	31%	44%	Pleural effusion chest X-ray 24 hao
	58%	52%	Atelectasis in chest X-ray 24 hao
	10%	17%	Mobilization (sitting) 24 hao

\*hao = hours after operation.

24 hours postoperatively (44% of the patients in Group A vs 31% in Group B,  $p = ns$ ). Still, in Group A, there was a higher percentage of patients sitting at 24 hours postoperatively (17% vs 10%,  $p = ns$ ). This finding may be a result of the early chest tube removal in some of the patients in Group A.

During hours 25–96 postoperatively (Table 3), the drains were removed from patients in Group A and later on from Group B. During this period, the differences found between the two groups were more substantial. The patients' demand for analgesics (that was measured as units of analgetic medication demanded by the patient during a 12-hours period) was higher in Group

B at 36 ( $p = 0.09$ ), 48–72 hours postoperatively. At 96 hours, there was no difference between the groups.

The white blood cell count was higher in Group B at 48 hours postoperatively.

There was no difference between groups in respiratory rate but blood oxygen saturation at room air was higher in Group A in all of the recordings during that period ( $p = 0.07$  at 48 hours). Mean maximal expiratory volume was higher in Group A at 36 ( $p = 0.08$ ), 48–72 hours postoperatively.

Mobilization evaluation demonstrated earlier and more advanced mobilization in Group A patients throughout the first 96 postoperative hours.

**TABLE 3**  
**Postoperative Parameters 25–96 hours Postoperatively**

Significance	Group B (N = 37)	Group A (N = 46)	Parameter
	36.8 ± 0.5	36.5 ± 0.6	Body temperature 48 hao*
	36.7 ± 0.6	36.7 ± 0.5	Body temperature 72 hao
	36.8 ± 0.6	36.8 ± 0.5	Body temperature 96 hao
	182 ± 93	183 ± 121	Drainage (mL) 36 hao
	141 ± 87	145 ± 122	Drainage (mL) 48 hao
	101 ± 18	162 ± 123	Drainage (mL) 72 hao
0.09	3.6 ± 1.8	2.1 ± 1.4	Analgesic demand (units) 36 hao
	1.7 ± 0.9	1.1 ± 1.1	Analgesic demand (units) 48 hao
	0.9 ± 0.7	0.6 ± 0.7	Analgesic demand (units) 72 hao
	0.8 ± 0.9	0.8 ± 1.2	Analgesic demand (units) 96 hao
	11.5 ± 4.1	11.0 ± 3.4	White blood cell count 48 hao
	10.8 ± 2.6	10.5 ± 3.2	White blood cell count 72 hao
	9.4 ± 2.3	8.9 ± 2.4	White blood cell count 96 hao
0.07	88.9 ± 2.0	91.9 ± 1.4	Oxygen saturation 48 hao
	89.0 ± 5.1	91.0 ± 3.8	Oxygen saturation 72 hao
	91.8 ± 3.0	92.3 ± 2.5	Oxygen saturation 96 hao
0.08	514 ± 46	594 ± 51	Maximal expiratory volume (mL) 36 hao
	606 ± 79	691 ± 102	Maximal expiratory volume (mL) 48 hao
	670 ± 95	717 ± 84	Maximal expiratory volume (mL) 72 hao
	20 ± 2	20 ± 3	Respiratory rate (per min) 36 hao
	20 ± 2	20 ± 2	Respiratory rate (per min) 48 hao
	20 ± 2	20 ± 2	Respiratory rate (per min) 72 hao
	20 ± 2	19 ± 1	Respiratory rate (per min) 96 hao
	9%	14%	Pleural effusion chest X-ray 48 hao
	16%	24%	Pleural effusion chest X-ray 96 hao
	44%	38%	Atelectasis chest X-ray 48 hao
	30%	16%	Atelectasis chest X-ray 96 hao
0.03	14%	53%	Mobilization (walking) 48 hao
	44%	56%	Mobilization (walking) 72 hao
	69%	76%	Mobilization (walking) 96 hao
	54%	39%	Pleural effusion CT 72 hao
	38%	24%	Atelectasis CT 72 hao
0.1	14%	16%	Patients with serous wound discharge
	10.2 ± 5.5	9.5 ± 2.5	Hospital stay (days)

\*hao = hours after operation.

Chest X-rays demonstrated a slightly higher percentage of pleural effusion in Group A patients. An opposite finding was demonstrated in computerized tomography of the chest. Pericardial effusion demonstrated by CT scan 72 hours postoperatively was found at a very low grade in one patient only.

Chest X-ray preformed 48 to 96 hours postoperatively found a higher percentage of atelectasis in Group B patients. A chest CT performed 72 hours postoperatively demonstrated the same findings.

There were no differences between the groups in serous wound discharge. There were four reported cases of superficial wound infection. There were also no differences between the groups in the duration of hospital stay. Among the 83 patients participating in the study, there was no reported case of pneumonia during the postoperative period.

## DISCUSSION

Echocardiographic evidence of PEF is present in over 55% of postcoronary artery bypass surgery (CABG) patients on the sixth postoperative day.<sup>1</sup> The usage of pericardial drainage following CABG decreases the development of PEF and tamponade.<sup>1-4</sup> Some even advocate using two rather than one pericardial drain.<sup>4</sup>

In over 95% of CABG operations the internal mammary artery is used,<sup>5</sup> and the pleural space is opened. In these cases, a pleural drain is added.

Postoperative pain, augmented by the chest tubes, causes shallow and ineffective ventilation, a decrease in sputum evacuation and atelectasis. Thus, as essential as chest tubes are for chest drainage, they cause a simultaneous delay in respiratory rehabilitation. Several studies have been done in an effort to address this issue. One study which demonstrates the correlation between the position of the drain and the degree of pain reported by the patient, found that subxiphoid insertion of the pleural drain leads to less subjective pain, and therefore, to a significantly lower impairment of pulmonary function than insertion at the intercostal site.<sup>3</sup>

Another study examined the correlation between the duration of chest tube drainage and pulmonary function and respiratory rehabilitation in patients after video assisted wedge resection of the lung.<sup>6</sup> In this study, chest tubes were removed from one group of patients 90 minutes postoperatively and from the other group after the standard tube time (average of 3.3 days). The study shows that patients from the first group benefited from earlier respiratory rehabilitation, shorter hospital stays, less need of X-rays, and less analgesic use. The rate of postoperative complications did not differ between the two groups.

Despite its clinical importance there is no uniform policy concerning the duration of chest tube drainage after CABG. Hence, a randomized prospective study on the subject may have clinical implication for these patients' postoperative outcome.

In our study population, the two groups differed in preoperative parameters. In Group A (which had the chest tubes removed within the first 24 postoperative hours), there were more cases of previous myocardial infarction, previous CVA and hypertension. The dura-

tion of the operation and the cross-clamp time were both longer on average, parameters which predicted more postoperative complications in this group.<sup>9</sup> The longer operation in Group A may also have implications for postoperative bleeding<sup>10</sup> and lead to more postoperative effusions. This difference between groups may contribute to the fact that the advantage of leaving the chest tubes for 24 hours or less was not statistically significant in most parameters.

The rate of postoperative complications was relatively small in both groups. Pericardial effusion, for example, was observed in only one patient and there were no cases of pneumonia or deep sternal wound infection. This may have also contributed to the non-significance of most of the findings in this study.

During the first 24 postoperative hours, when all patients still had chest tubes, no differences in respiratory parameters were found between the two groups. The main differences between the two groups were found during postoperative hours 25-96, a period in which the drains were gradually removed from most of the patients—initially from patients in Group A.

The patient's demand for analgesics is one of the objective parameters for the his/hers degree of pain. Here, we found a statistically significant higher demand for analgesics in Group B patients, most probably resulting from the prolonged presence of the drains. Later, at 96 hours, analgesics demand was similar in both groups, a fact supporting our assumption concerning the correlation between the presence of drains and the degree of pain.

The incidences of atelectasis demonstrated both on chest X-rays and in CT as well as white blood cell count were higher in Group B patients. Atelectasis is caused by pain that prevents the patient's coughing and deep breathing. Prolonged chest drainage worsens the pain, increases the incidence of atelectasis and as a result causes an elevation of the white blood cell count.

All other recorded parameters including blood oxygen saturation, maximal expiratory volume, mobilization, and radiologic parameters showed significant advantage to early chest tubes removal.

We expected to find higher rates of pleural and pericardial effusions in Group A where the drains were removed early, but chest CT demonstrated the opposite, with higher rates of pleural effusion in Group B. This could imply that long stay of chest tubes may induce production of pleural and pericardial effusions, whereas the chest tubes lose their effectiveness due to occlusion of the tube by blood clot.

No significant difference was found between the two groups in the incidence of serious wound discharge.

The length of hospital stay was similar in both groups, despite the higher preoperative morbidity and longer operations in Group A that were expected to prolong these patients' hospitalization. The early chest tube removal in Group A may have contributed to their relatively early release. It must be noted that there is a hospital policy prohibiting the discharge of a patient within the first six postoperative days regardless of his/her medical condition. This factor may have also contributed to the similarity in hospital stay duration between the two groups.

### CONCLUSION

The limitation of this study was the relatively small number of patients. Nevertheless, this was a randomized prospective study, double blind for the staff that recorded the data (e.g., radiologist, physiotherapist, etc.) and hence the importance of its findings.

Early chest tube removal has been found to be a policy that improves the postoperative outcome, on the condition that they are not removed in case of a significant amount of drainage. This policy does not involve significant residual effusions.

We thereby conclude that early chest tube removal improves the postoperative outcome and decreases the need for supportive medical care postoperatively such as analgesics, physiotherapy, oxygen, and nursing treatment.

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