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Early chest tube removal after coronary artery bypass graft surgery

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Abstract
Background: There is no clear data about the optimum time for chest tube removal after coronary artery bypass surgery. **Aim:** The aim of this study was to assess the impact of the chest tube removal time following coronary artery bypass grafting surgery on the clinical outcome of the patients. **Material and Methods:** An analysis of data from 307 patients was performed. The patients were randomized into two groups: in group 1 (N=107) chest tubes were removed within the first 24 hours after surgery, whereas in group 2 (N=200), chest tubes were removed in the second 24 hours after surgery. Demographics, lactate and pH at the beginning, during and after the operation, creatinine, left ventricular ejection fraction, inotropic drugs administration, length of ICU stay, and mortality data were collected. Respiratory rate and pain level was assessed. **Results:** In these surgeries, the mean± standard deviation for the aortic clamping time was 49.18±17.59 minutes and cardiopulmonary bypass time was 78.39±25.12 minutes. The amount of heparin consumed by the second group was higher (P <0.001) which could be considered as an important factor in increasing the drainage time after the surgery (P =0.047). The pain level evaluated 24 hours post-operation was lower in the first group, and the difference in the pain level between the 2 groups evaluated 30 hours post-operation was significant (P=0.016). The mean time of intensive care unit stay was longer in the second group but it was not statistically significant. **Conclusion:** Early extracting of chest tubes after coronary artery bypass graft surgery when there is no significant drainage can lead to pain reduction and consuming oxygen is an effective measure after surgery toward healing; it doesn't increase the risk of creation of plural effusion and pericardial effusion.

Keywords: Timing, chest tube removal, coronary artery bypass graft surgery

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Introduction
Recovery from cardiac surgery is associated with a number of unpredictable events, including the preoperative clinical state of patient, disease burden, type of surgery, and postoperative analgesia. A chest tube (CT) is inserted after cardiac surgery to ensure that fluid and air drain fluently from the chest cavity [1;2]. To reduce severe cardiac and respiratory complications related to the abnormal accumulation of air and fluids, CTs need to remain in place as long as necessary [3;4]. Keeping CTs in place, however, is associated with increased pain and discomfort for the patient, mechanical irritation of the heart and pericardium, and an increased incidence of infection [5]. There is a need to determine the optimum duration of a CT remaining in place after surgery to

maximize the effectiveness of chest drains while minimizing associated adverse outcomes. Although some studies have shown that early chest tube removal after cardiac surgery, especially coronary artery bypass grafting surgery (CABG), is a policy that improves the postoperative outcomes, the CT must not be removed in cases with significant amount of drainage [6]. Other studies showed that early chest tube removal after video-assisted thoracoscopic surgical wedge resection of peripheral pulmonary tissue appears to be a safe and cost-effective practice if strict criteria for CT removal are met [7;8]. However, there is no clear data about the optimum time of chest tube removal after coronary artery bypass graft surgery (CABG). The aim of this study was to assess the impact of chest tube removal time following coronary artery bypass graft surgery on the clinical outcome of the patients.

Material and Methods

Study population

The study population included 307 consecutive patients who underwent isolated coronary artery bypass surgery at Sina Hospital, a nongovernmental hospital in Isfahan, Iran, between April 2007 and September 2008. Patients undergoing second operations, off-pump surgery, CABG in association with heart valve repair or replacement, or resection of a ventricular aneurysm were excluded. Other exclusion criteria were as follows: bleeding over 1000 mL in the first 24 hours post-operatively or bleeding that required a reoperation; use of an intraaortic balloon pump; mechanical ventilation for more than 24 hours post-operatively; surgeon objection to the inclusion of any patient in the study. This study received the approval of the ethical committee of the Delasa Research Center. 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 1 (N=107) patient's CTs were removed within the first 24 hours after surgery, whereas in group 2 (N=200) patient's CTs were removed in the second 24 hours after surgery if chest tube drainage was less than 40 cc per 4 hour. The anesthetic and surgical techniques were identical in both groups.

All patients had their central venous lines and urinary catheters removed on the second postoperative day and were mobilized normally. Complete blood count, plasma urea and electrolytes, ECG (electrocardiography), and chest X-rays were performed on the day of discharge. The criteria for early discharge included normal pulse and physical examination, normal blood pressure, absence of pyrexia, hemoglobin value of greater than 8 g/dL, normal white cell count, normal blood urea and electrolytes, and satisfactory ECG and chest X-ray. All patients had to be fully mobilized. Patients were visited by his/her surgeon at discharge time and three days after discharge at the office.

Anesthesia and surgery management

Premedication included morphine sulfate (0.1-0.15 mg/kg), promethazine (0.15 mg/kg) intramuscularly administered one hour before the induction of anesthesia. Anesthesia was induced with an intravenous infusion of remifentanil (1 µg/kg per minute) and a midazolam bolus of 0.2 mg/kg. Cisatracurium besylate (0.15-0.2 mg/kg) was then administered to allow tracheal intubation. The anesthesia was maintained with a continuous infusion of remifentanil (dose ranging from 0.1 mg/kg per minute and midazolam (0.1 mg/kg per hour).

Surgery methods

After standard median sterotomy, veins, left internal mammary artery and radial artery were harvested. Aorta-right atrial cannulation was performed for cardiopulmonary bypass. In all patients aortic crass clamping and mild hypothermia (34˚C) were used. After distal anastomosis, aortic clamp was opened and proximal anastomosis was performed using aortic side biting clamp. Two chest tubes were inserted in mediastional and left pleral spaces.

Data collection and definitions

The following data were collected and analyzed: demographic data, left ventricular ejection fraction (LVEF) before surgery, respiratory rate, Oxygen saturation, pain level according to VAS, analgesic administration, pleural effusion and length of ICU stay.

Statistical analysis

Data were collected and stored on a computer database. A trained team checked recorded information for missing values and data entry errors. Statistical analysis was done with SPSS 15 (SPSS, Inc. Chicago, IL). The demographic data are presented as frequencies and percentages. A *P*-value ≤.05 was considered to be statistically significant.

Results

In this study, 307 patients who underwent CABG were evaluated. In the first group, chest tubes were removed in the first 24 hours after surgery, and in the second group the chest tubes were removed in the second 24 hours after surgery. Mean chest tube removal time in group 1 was 22.80±3.47 hours, and in group 2 was 40.13±3.85 hours (*P* <.001). The patients were 67.1% male and 32.9% female with a mean age of 59.60±9.24 years old. Table 1 shows the characteristics of the study population. A total of 36.5% of these patients had diabetes mellitus (DM), 39.4% had a history of previous myocardial infarction (MI), and 2.3% had a history of previous cerebrovascular accident (CVA). The rate of aspirin, Plavix (clopidogrel) and warfarin intake before the surgery was 87.6%, 0.3% and 3.9%, respectively. Heparin was used by 16% of subjects before the operation. According to the preoperation parameters, the two groups did not have statistically significant differences, although the first group's rate of DM, MI and CVA was greater than the second group (Table 1).

In addition to age and sex, the most important risk factors which can intensify the complications of CABG are considered to be DM, history of previous MI and CVA,

Table 1 Demographics of prospective study population

Parameter	Group A(n = 107)	Group B(n = 200)	Total(n = 307)	P-value
Age (year)	58.72±8.63	60.08±9.54	59.60±9.24	0.22
Male Sex	71	65	67.1	0.28
DM	40.2	34.5	36.5	0.32
MI	45.8	36	39.4	0.09
CVA*	2.8	2	2.3	0.69
Aspirin use	92.5	85	87.6	0.056
Plavix use	0	0.5	0.3	>0.05
Warfarin use	2.8	4.5	3.9	0.55
Pre Heparin use	12.1	18	16	0.18
Post Heparin use	43.4	68.5	59.8	**0.**000
Morphine in First 24 hours	87.9	91.5	90.2	0.31
Acetaminophen in First 24 hours	67.3	63.8	65	0.54
Pethedine in First 24 hours	26.2	34.2	31.4	0.15
Indometacin in First 24 hours	8.4	3.5	5.2	0.07
Morphine in First 48 hours	51.4	56.3	54.6	0.41
Acetaminophen in First 48 hours	24.3	31.2	28.8	0.21
Pededine in First 48 hours	15.9	21.1	19.3	0.27
Indometacin in First 48 hours	3.7	1	2	0.19
Surgical treatment of plural feign	3.7	4.5	4.2	0.05
Presents of complication	3.7	5.5	4.9	0.59

and left ventricular dysfunction. The mean consumption of anti-platelet and anti-coagulation drugs, which increase the risk of bleeding after surgery, is shown for each group separately. Mean ejection fraction (EF) was 51.19±10.77% for both groups. Aortic clamping and CPB time (expressed in minutes) were used to evaluate the complexity of surgery. Mean aortic clamping time was 49.18±17.59 minutes and cardiopulmonary bypass (CPB) time was 78.39±25.12 minutes % for the first group. The second group's aortic clamping and cardiopulmonary bypass (CPB) times were greater than and significantly different from those in the first group, with P =.001 and P <.001, respectively. To evaluate the effects of chest tube retention on respiration and the patients' pain after the surgery, these parameters were evaluated 24 and 48 hours after surgery, and the values are shown in Table 2 and 3.

Respiratory functions of the patients were evaluated with respiratory rate (RR) and oxygen saturation (O_2 Sat). A patient's pain was graded using the Visual Analogue Scale (VAS), and the average amount of administered analgesics was recorded. However, the amount of heparin consumed by the second group was higher (P <.001), which could be an important factor in increasing the drainage time after the surgery. The respiration rate, evaluated 12, 24 and 48 hours after the surgery, was not different between the groups. Oxygen saturation was measured 12, 24 and 48 hours after the surgery, and was higher in the first group during all post-operation evaluations. This difference was statistically significant in the evaluations that were performed during the first 24 hours after the surgery (P =.047). Pain level according to VAS was evaluated 6, 12, 18, 24, 30, 36, 42 and 48 hours after the surgery. The pain level evaluated 30 hours post-operation was significantly different between the 2 groups (P =.016), but was not significantly different at any other time point, although the pain level evaluated 24 hours post-operation was lower in the first group. The mean time of ICU stay was longer in the second group, but it was not significantly different between the groups (Table 3). There were no reported cases of pericardial effusion throughout the study. Pleural effusion was not frequent in both groups.

Discussion

Our results revealed that early chest tube removal following a coronary artery bypass graft surgery affects the clinical outcomes of patients. We showed that the mean drainage volume and time in group 2 (later chest tube removal) was significantly greater than group 1 (earlier chest tube removal). The possible relationship between the duration of postoperative drainage and the time of chest tube removal was first studied by Smulders and colleagues. They demonstrated that CT duration and its associated with drainage volume. They suggested that because of this, and because a long period of drainage causes discomfort for the patient, mechanical irritation to the heart and the pericardium, and an increased risk of infection, it’s highly recommended removing drains as soon as their efficacy has peaked, preferably on the first postoperative day [9].The factors influencing the time of postoperative chest tube removal are multifactorial, and the best time to remove the chest tube is difficult to determine. Surgeons have suggested several possible correlations between the time of chest tube removal and postoperative morbidity [10]. In early chest tube removals, slow bleeding persists and may cause a gradual accumulation of blood in the pericardial and plural spaces [11].Differences in total drainage volume may be attributed to patient characteristics, intraoperative factors, technical variations, CT placement duration, or a combination of all these factors [9]. The variation in

Table 2 Comparison of preoperative and postoperative variables of retrospective study population

Parameter	Group A (n = 107)	Group B (n = 200)	Total (n = 307)	P-value
Ejection Fraction	50.14±10.59	51.76±10.86	51.19±10.77	0.21
Clump time	44.76±17.04	51.58±17.47	49.18±17.59	0.001
Pump time	68.78±16.83	83.58±27.27	78.39±25.12	<0.001
Chest tube removing time	22.80±3.47	40.13±3.85	34.01±9.09	<0.001
Chest tube drainage in first 24 hours	321.07±169.15	502.40±303.81	439.00±278.14	<0.001
Chest tube drainage in second 24 hours	-----------	121.04±120.85	----------	-------
RP 12 hour	16.21±1.64	15.95±2.17	16.04±2.00	0.29
RP 24 hour	16.07±1.52	16.27±1.73	16.199±1.66	0.34
RP 48 hour	16.37±1.99	16.21±1.17	16.26±1.51	0.36
Pa CO_2 12 hour	38.42±4.77	39.69±5.68	39.25±5.41	0.048
Pa CO_2 24 hour	38.05±5.28	39.13±4.86	38.76±5.03	0.07
Pa CO_2 48 hour	41.02±5.79	40.99±4.59	41.00±5.03	0.96
Pa O_2 12 hour	96.58±32.04	93.16±29.44	94.34±30.35	0.35
Pa O_2 24 hour	74.19±15.54	73.59±17.04	73.81±16.51	0.77
Pa O_2 48 hour	70.30±12.42	69.66±18.28	69.88±16.47	0.75
Sa O_2 12 hour	95.18±3.45	94.95±3.04	95.03±3.19	0.47
Sa O_2 24 hour	93.37±3.17	92.31±4.96	92.68±4.44	0.047
Sa O_2 48 hour	90.72±8.55	88.63±11.63	89.36±10.69	0.078
ICU Stay	42.83±3.15	43.64±4.65	43.34±4.17	0.13

Parameter	*Group A (n = 107)*	*Group B (n = 200)*	*Total (n = 307)*	*P-value*
Ejection Fraction	50.14±10.59	51.76±10.86	51.19±10.77	0.21
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RP 24 hour	16.07±1.52	16.27±1.73	16.199±1.66	0.34
RP 48 hour	16.37±1.99	16.21±1.17	16.26±1.51	0.36
Pa CO_2 12 hour	38.42±4.77	39.69±5.68	39.25±5.41	0.048
Pa CO_2 24 hour	38.05±5.28	39.13±4.86	38.76±5.03	0.07
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Pa O_2 12 hour	96.58±32.04	93.16±29.44	94.34±30.35	0.35
Pa O_2 24 hour	74.19±15.54	73.59±17.04	73.81±16.51	0.77
Pa O_2 48 hour	70.30±12.42	69.66±18.28	69.88±16.47	0.75
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ICU Stay	42.83±3.15	43.64±4.65	43.34±4.17	0.13

Table 3 Visual Analogue Scale after surgery in study population

Parameter	Group A (n = 107)	Group B (n = 200)	Total (n = 307)	*P* value
Visual Analogue Scale 6 hour	4.72±2.16	4.48±2.14	4.56±2.14	0.38
Visual Analogue Scale 12 hour	2.93±2.48	3.44±2.60	3.26±2.57	0.07
Visual Analogue Scale 18 hour	1.88±2.64	1.76±2.52	1.80±2.56	0.77
Visual Analogue Scale 24 hour	2.23±2.78	2.45±2.71	2.37±2.73	0.39
Visual Analogue Scale 30 hour	2.22±2.49	2.93±2.57	2.69±2.56	**0.**016
Visual Analogue Scale 36 hour	2.38±2.53	2.55±2.62	2.49±2.59	0.61
Visual Analogue Scale 42 hour	1.04±2.32	1.87±2.47	1.50±2.42	0.17
Visual Analogue Scale 48 hour	1.19±2.21	1.69±2.42	1.51±2.35	0.32
Visual Analogue Scale after ICU	4.98±2.36	5.20±2.35	5.12±2.35	0.31

outcomes according to patient gender in cardiac surgery candidates is well established. Women had significantly less CT drainage than men despite a longer duration of CT placement and in the context of minimal difference in their body mass indices.

We also focused on respiratory function by respiratory rate (RR) and oxygen saturation (O_2 Sat) as outcome measures. However the RR, evaluated 12, 24 and 48 hours after the surgery, was not different between the groups. Oxygen saturation was higher in the first group in all of the post-operation evaluation times (P =.047). On the other hand, the amount of heparin that was administered to the second group was higher (P <0.001)**,** which could be an important factor in increasing the drainage time and volume after the surgery. Pain level evaluated 24 hours after the operation was lower in the first group. The mean intensive care unit (ICU) stay period was longer in the second group but was not statistically significant.

The findings reported in this article provide a valuable contribution to the body of existing knowledge regarding postoperative cardiac surgical patient management. However, larger prospective studies may be necessary to determine the optimum time for CT removing after CABG.

Conclusion

Early extracting of chest tubes after coronary artery bypass graft surgery when there is no significant drainage can lead to pain reduction and consuming oxygen is an effective measure after surgery toward healing; it doesn't increase the risk of creation of plural effusion and pericardial effusion.

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References

1 Abramov D, Yeshaaiahu M, Tsodikov V, Gatot I, Orman S, Gavriel A, et al. Timing of chest tube removal after coronary artery bypass surgery. J Card Surg 2005 Mar; 20(2):142-146.
2 Ochroch EA, Gottschalk A, Augoustides JG, Aukburg SJ, Kaiser LR, Shrager JB. Pain and physical function are similar following axillary, muscle-sparing vs. posterolateral thoracotomy. Chest 2005 Oct; 128(4):2664-2670.
3 Gercekoglu H, Aydin NB, Dagdeviren B, Ozkul V, Sener T, Demirtas M, et al. Effect of timing of chest tube removal on development of pericardial effusion following cardiac surgery. J Card Surg 2003 May; 18(3):217-224.
4 Fibla JJ, Molins L, Simon C, Perez J, Vidal G. Early removal of chest drainage after videothoracoscopic lung biopsy. Interact Cardiovasc Thorac Surg 2006 Oct; 5(5):581-583.
5 Bryan AJ, Angelini GD. Postoperative drainage and pericardial effusion. Ann Thorac Surg 1990; 50(2):330.
6 Bryan AJ, Angelini GD. Postoperative drainage and pericardial effusion. Ann Thorac Surg 1990 Aug; 50(2):330.
7 Russo L, Wiechmann RJ, Magovern JA, Szydlowski GW, Mack MJ, Naunheim KS, et al. Early chest tube removal after video-assisted thoracoscopic wedge resection of the lung. Ann Thorac Surg 1998 Nov; 66(5):1751-1754.
8 Viquerat CE, Hansen RM, Botvinick EH, Dae MW, Wiener-Kronish JP, Matthay MA. Undrained bloody pericardial effusion in the early postoperative period after coronary bypass surgery: a prospective blood pool study. Am Heart J 1985; 110(2):335-341.
9 Smulders YM, Wiepking ME, Moulijn AC, Koolen JJ, van Wezel HB, Visser CA. How soon should drainage tubes be removed after cardiac operations? Ann Thorac Surg 1989 Oct; 48(4):540-543.
10 Light RW. Malignant pleural effusions. In: Light RW, ed. Pleural diseases. 2nd edt. Philadelphia: Lea and Febiger, 1990:97-115.
11 Kolsi K, Frikha I, Kolsi M, Khannous M, Masmoudi S, Salah Kechaou M, Sahnoun Y, Karoui A. The effects of drainage with a Redon versus a conventional drain on postoperative pain and blood loss after valve replacements. J Cardiovasc Surg 2004; 45:565-568.