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A different approach to chest tube drainage after cardiac surgery: A study on the usage of a single versus separate drain vials

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ABSTRACT

Background: Pericardial and pleural space drainage and decompression is crucial after cardiac surgery. The aim of this study was to evaluate the efficiency and adequacy of chest tubes that are connected to single closed underwater drainage system compared to two separate closed drainage systems. **Patients and Methods:** A total of 100 patients that underwent cardiac surgery were included in this study. Patients were divided into two groups according to chest tube status. In Group 1 ($n = 50$), two chest tubes were connected to a single closed underwater drainage vials. In Group 2 ($n = 50$), the tubes were connected to two separate closed underwater drainage vials. **Results:** The mean age of patients was 63 ± 7.26 years. 56 of them were female. Age, gender, and risk factors were similar between groups. In Group 1, 43 patients underwent coronary artery bypass surgery, four patients underwent aortic valve surgery, and three patients underwent mitral valve surgery. In Group 2, 46 patients underwent coronary artery bypass surgery, three patients underwent aortic valve surgery, and one patient underwent mitral valve surgery. Groups were evaluated for the drainage quantity from the chest tubes every 12 h. The need for blood transfusion, rate of a reoperation due to bleeding, duration of postoperative stay in intensive care unit, length of hospitalization, chest tube removal time, and the rate of mortality were also registered. No meaningful difference was found between the two groups ($P > 0.05$).**Conclusions:** In cardiac surgery, using a single closed underwater drainage system would be sufficient for postoperative follow-up. It provides better mobilization of the patients and decreases the cost of overused thorax drain vials.

KEY WORDS: Cardiac surgery, chest tube, drainage

INTRODUCTION

Regarding the postoperative follow-up period of cardiac surgery, monitoring the amount of bleeding is important. Chest tubes that are inserted into pericardial and pleural space enable drainage and decompression with the help of a closed underwater drainage system. It prevents complications likely to occur such as cardiac tamponade, hemothorax, and pneumothorax [1,2].

Patients have a number of intervention and follow-up parameters such as artery catheter, central venous pressure catheter, intravenous fluid infusion, urinary catheter. However, implementing two separate closed underwater drainage systems challenge patient mobilization and respiratory physiotherapy in the postoperative period. It also increases the follow-up parameters and are likely to pave the ground for uncalled errors. It also causes an increase in the costs. Considering all these findings, we endeavored to evaluate whether one closed underwater drainage system implementation would be sufficient although patients have two chest tubes.

PATIENTS AND METHODS

A total of 100 successive patients that underwent open heart surgery, between October 2009 and March 2011 at Ahi Evren Thoracic and Cardiovascular Surgery Training and Research Hospitals were involved in this study. They were made into two groups. In Group 1 ($n = 50$), two thorax tubes of the patients were connected to one closed underwater drainage vials, while in Group 2 ($n = 50$), it was connected to two separate closed underwater drainage bottles. During the postoperative period, the efficiency and adequacy of thorax drain were evaluated in each group. One mediastinum and a chest tube of number 32 and number 36 were inserted into the thorax space after the surgery for all of the cases. These chest tubes were connected to a single underwater drainage system (Group 1)in the case of 50 patients; and to two independent and separate underwater drainage systems (Group 2) in the case of 50 patients. A uniform chest tube and underwater drainage receptacle were used for all of the cases. Likewise, tube thoracostomy was implemented for all patients; one being on the mediastinum and the other being on the left thorax. All underwater drainage receptacles were set to 100 cc water level, and physiological saline solution was put in them. Bed level heights were set to be minimum one meter for each patient during the postoperative intensive care follow-up. In the case of those that underwent coronary bypass surgery, the act values were standardized during the intensive care monitoring to ensure they are the same as the value while the patents go into the surgery. In the case of those, however, that underwent valve surgery, low molecular weight heparin (LMWH) in combination of Coumadin were administered on the first day until sufficient International normalized ratio (INR) value was obtained. If the INR value ranged between 2 and 2,5 after 3 days, LMWH was cut out, and treatment continued by administering Coumadin. Patients that were taken to surgery urgently and applied with thrombolytic, anti-aggregant, fibrinolytic before the surgery were excluded from the study.

Bedside routine chest radiography (CR) was performed for all patients, once they were taken to intensive care. For the follow-up, the mediastinum width was taken as a criterion for the CR, and the subsequent control CRs were evaluated accordingly. EKO support was provided for those that had high drainage amount whose blood pressure dropped, in whom an effusion and tamponade were suspected. The cases were taken to a surgery again depending on the hourly drainage amount exceeding 300 ml, tamponade-effusion condition, and clinic.

Statistical Analysis

The data were analyzed using the Statistical Package for the Social Sciences version 15.0 software package. Frequency and distribution analyses were used to describe the data, and the Mann–Whitney U tests and Fisher test were utilized to examine the differences between the groups.

RESULTS

Average age of 100 patients that underwent a cardiac surgery was 63 ± 7.26. 60 of them were male, and 40 of them were female. No meaningful difference was found between the two groups in terms of age, gender, and coronary artery and valvular disease risk factors ($P > 0.05$). Of the 50 patients in Group 1, 43 patients underwent coronary artery bypass surgery, four patients underwent aortic valve surgery, and three patients underwent mitral valve surgery. Of the 50 patients in Group 2, 46 patients underwent coronary artery bypass surgery, three patients underwent aortic valve surgery, and one patient underwent mitral valve surgery. No meaningful difference was found between the surgical interventions of the two groups ($P > 0.05$). Similarly, no significant difference was found for hemostasis parameters considered in the preoperative period between the cases ($P > 0.05$) [Table 1]. Both groups were evaluated for the drainage quantity from the chest tubes every 12 h. Blood transfusion volume, rate of a repeated operation depending on bleeding, duration of stay in intensive care unit in the postoperative period and total hospitalization duration, chest tube removal length, and rate of mortality were also assessed. No meaningful difference was found between them ($P > 0.05$) [Table 2]. The patients were further followed for 1 year after discharge. No mortality or morbidity was detected in each group during the 1-year follow-up period.

DISCUSSION

Passive thorax drainage systems enable air and liquid discharge during expiration, functioning as a unidirectional drainage system. Closed underwater drainage systems used in open heart surgery are examples of a passive system. The thoracic cage is small at the expiration, a slight positive pressure represses excess air and liquid out of the pleural space into the water through the chest tubes. Water inside the drain vial prevents air from reaching back to the thoracic cavity again during inspirium [3,4]. The simplest system is the method in which a single drain vial is used. We used 2000 ml standard vial. It is equipped with two tubes; one being short and the other being tall. Terminal of the tall tube is under the liquid in the vial, and the exposed terminal is connected to the chest tube. Terminal of the short tube, however, opens up to the atmosphere while the other terminal opens up into the vial. The vial itself should

Table 1: Characteristics of included participants

Patient demographics and comorbidities	Group 1 (one closed underwater drainage system) (n=50)	Group 2 (two separate closed underwater drainage system) (n=50)	P value
Age (years, mean±SD)	58.9±8.0	62.1±6.0	P=0.109
Male/female	32/18	28/22	P=1.00
Hypertension (n, [%])	13 (26)	17 (34)	P=0.063
Hyperlipidemia (n, [%])	19 (38)	13 (26)	P=0.071
Diabetes mellitus (n, [%])	7 (14)	4 (8)	P=0.177
Smoking (n, [%])	19 (38)	14 (28)	P=0.141
Coronary artery patients (n, [%])	43 (86)	46 (92)	P=0.061
Aortic valve patients (n, [%])	4 (8)	3 (6)	P=0.287
Mitral valve patients (n, [%])	3 (6)	1 (2)	P=0.070
Prothrombin time (s)	101.3±12.9	100.5±10	P=0.758
INR	1.11±0.23	1.07±0.17	P=0.367

INR: International normalized ratio, SD: Standard deviation

Table 2: Postoperative data

Postoperative follow-up parameters	Group 1 (n=50)	Group 2 (n=50)	P value
30-day mortality	3	2	P=0.582
Chest tube output (ml/12 h)	706.2±154.1	680.7±101.7	P=0.488
Fresh frozen plasma (unit/patient)	2.44±0.73	1.16±0.76	P=0.103
Chest re-opening for bleeding	1	1	P=0.647
Platelets units (unit/patient)	0.27±1.16	0.0±0.0	P=0.123
Total blood products (unit/patient)	2.83±0.94	1.83±0.88	P=0.062
Length of ICU stay (hours)	48.6±47.9	35.7±34.3	P=0.242
Length of hospital stay (days)	6.86±3.04	5.97±1.99	P=0.279
Chest tube removal duration (hours)	48±12	48±16	P=1.000

ICU: Intensive care unit

be below the chest level of the patient, so that it is drained for pericardial and pleural liquid gravity [4,5]. In this study, the distance between the chest level and the drain was kept one meter for all the patients.

In some cases, air and blood mixing in the same vial generate foam, which challenges the drain follow-up. The single chest tube might also be connected to dual-vial system. The first vial is anhydrous, accumulates the incoming drainage from thorax, enabling air to proceed towards underwater drainage vial. The underwater part remains at a fixed level. In this case, extra dead space is added. It is added to the patient's dead space, and respiratory load increases. It is likely to cause the air to back away into thorax during inspirium [4,5]. Although we connected two chest tubes to a single vial via a connector, we did not observe foam formation due to blood and air mixing into one another. Nor did we observe a massive air leak.

Closed underwater drainage system should function uninterruptedly and continuously. Its function might be hampered by some technical problems such as tube curling, stuck with a coagulum or closed orifice of the short tube inside the drainage vial. If remains unnoticed, it may cause cardiac tamponade, hemothorax or pneumothorax [2,6,7]. Although we did not encounter a technical problem, two patients from Group 1 and one patient from Group 2 had a bleeding complication. We observed cardiac tamponade in one of our patients in Group 1. These three patients underwent surgical revision. A surgical focus was found as responsible for the bleeding and repaired. One of the patients was bleeding from saphenous vein graft, and two patients were bleeding from the internal mammarian artery. The patient with cardiac tamponade was found to have a distal anastomosis leakage. All bleeding focuses were surgically repaired in all three patients. There was no numerical difference in terms of bleeding complications between the groups. This might be due to the conveniently working both systems for blood and air drainage. However, a case of cardiac tamponade was observed in one patient.

Despite proper drainage, what was the reason for the cardiac tamponade in Group 2 patient? Was it related to a single drainage system? If the patient was connected to separate vials, would cardiac tamponade occur again? In fact, the problem was correlated with the existence of bleeding that exceeded drainage capacity because the chest tubes and the system were found to be open during the second surgery for revision. This made us conclude that the manipulations within the surgical area independent from the drainage system cause cardiac tamponade development to a greater extent. On the other hand, insufficient drainage system is likely to have resulted in cardiac tamponade as well. Nevertheless, the variable of single underwater versus dual underwater receptacle does not lead to cardiac tamponade. What matters is not the number of underwater drain bottles but whether the drainage is sufficient.

The tubes that were inserted into the thorax and mediastinum are connected to single underwater drainage system through the Y-connector. We observed from the former patients' follow-up that even Y-connector size inhibits acceptable drainage when single underwater receptacle is used. We therefore used appropriately sized Y-connector that enables standard adequate drainage in this study. When we used single underwater drainage container, usage of inappropriate size of Y-connector eliminated the aforecited pressure negativity, and the tubes were becoming unable to maintain the physiological conditions.

Postoperative intensive care period after the surgery is crucial. The patient follow-up should be evaluated extensively from hemodynamic parameters to chest tubes. In our study and at the time of routine cares, we set the distance between the drainage receptacle and the patient's bed minimum as 100 cm. We believe that this distance is physiologically ideal for the treatment. We observed in our study that insufficient drainage for all patients follow-up proves this.

Pulmonary physiotherapy is a method that is often used for preventing postoperative pulmonary complications and for treatment. A physiotherapist should have knowledge about the surgical techniques and specific complications arising out of it. Existing pulmonary disease, smoking, advanced age, and obesity increase postoperative pulmonary complication risks. Immobilization and lack of preoperative training also contribute the increased the risk of complication. Existence of risks also determines intensity of postoperative physiotherapy. Furthermore, such patients have a number of interferences and follow-up parameters such as artery catheter, central venous pressure catheter, intravenous fluid infusions, and urinary catheter [8,9]. These are the factors that challenge the treatment to be implemented. We think that using two separate closed underwater drainage systems challenges patient mobilization during the postoperative period, increase the follow-up parameters and paves the ground for uncalled and potential errors.

In conclusion, we have a strong belief that single closed underwater drainage system would be sufficient for the postoperative follow-up in case of patients that underwent open cardiac surgery and were subject to routine tube thoracostomy. Furthermore, usage of a single thorax drain vial decreases the cost by half, which should not be disregarded by means of feasibility.

REFERENCES

1. Agati S, Mignosa C, Gitto P, Santo Trimarchi E, Ciccarello G, Salvo D, *et al*. A method for chest drainage after paediatric cardiac surgery: A prospective randomized trial. J Thorac Cardiovasc Surg 2006;131:1306-9.
2. Shalli S, Saeed D, Fukamachi K, Gillinov AM, Cohn WE, Perrault LP, *et al*. Chest tube selection in cardiac and thoracic surgery: A survey of chest tube-related complications and their management. J Card Surg 2009;24:503-9.
3. Laws D, Neville E, Duffy J, Pleural Diseases Group, Standards of Care Committee, British Thoracic Society. BTS guidelines for the insertion of a chest drain. Thorax 2003;58 Suppl 2:ii53-9.
4. Miller KS, Sahn SA. Chest tubes. Indications, technique, management and complications. Chest 1987;91:258-64.
5. Yıldızeli B, Yüksel M. Plevra hastalıklarında cerrahi teknikler. Toraks Dergisi 2002;3:27-41.
6. Kesieme EB, Dongo A, Ezemba N, Irekpita E, Jebbin N, Kesieme C.

Tube thoracostomy: Complications and its management. Pulm Med 2012;2012:256878.
7. Dev SP, Nascimiento B Jr, Simone C, Chien V. Videos in clinical medicine. Chest-tube insertion. N Engl J Med 2007;357:e15.
8. Sarıkaya S. Preoperative and postoperative pulmonary physiotherapy. Türkiye Fiziksel Tıp Rehabilitasyon Derg 2006;52:123-8.
9. Yurdalan SU. Cardiopulmonary physiotherapy in cardiac surgery. Türkiye Klinikleri J Surg Med Sci 2007;3:69-72.

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