INVESTIGATION OF EFFECTS OF DIFFERENT DRAINAGE METHODS ON POSTOPERATIVE PLEURAL COMPLICATIONS AND PAIN IN OFF-PUMP SURGERY

FERHAT BORULU[1] and Yusuf Velioglu[2]

[1]Atatürk University
[2]Abant Izzat Baysal University Faculty of Medicine

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Abstract

ABSTRACT Background The aim of this study was to investigate whether the need for thoracic tubes placed in the intercostal space, which cause severe pain in postoperative period and serious problems in pulmonary rehabilitation, could be eliminated by Jackson drains placed in mediastinum in patients who undergo off-pump surgery. Method A prospective analysis of 135 patients who underwent routine off-pump isolated CABG surgery in our clinic between January 2017 and June 2018 was performed. 65 patients had subxiphoid mediastinal drains and intercostal chest drains, and 64 patients had one subxiphoid mediastinal drain and one mediastinal Jackson drain. Postoperative pain scores, analgesic needs of patients, radiologically, effusion and pneumothorax assessments were recorded and pleural complications requiring invasive intervention were compared. Results There was no difference between the groups in terms of age, gender and comorbidities. In terms of pain scoring and analgesia requirement at the first hour after intubation, there was a significant superiority in all follow-up periods in group 2 ($p<0.001$). In 2 patients in group 1 (3.1%) and in two patients in group 2 (3.07%) pleural effusion requiring intervention was detected. There was no significant difference between the two groups in terms of effusion pneumothorax, in terms of blood transfusion and other postoperative complications, postoperative whole blood replacement was higher in group 2 ($P = 0.002$). Conclusion Based on the results of the present study, we concluded that it was not necessary to insert intercostal chest tubes especially in off-pump surgery.

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Is thoracic tube required in coronary surgery?

Ferhat BORULU [1], Yusuf VELİOĞLU [2]

Institutions of authors

[1] Atatürk University, Medical Faculty, Cardiovascular Surgery Department, Erzurum, Turkey, fborulu@gmail.com

[2] Abant İzzet Baysal University, Faculty of Medicine Cardiovascular Surgery Department, Bolu, Turkey

yusufvelioglu@gmail.com

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Corresponding Author

Ferhat BORULU

Atatürk University, Medical Faculty,

Cardiovascular Surgery Department, Erzurum, Turkey,25100

Tel: +90 505 351 17 62

e-mail: fborulu@gmail.com

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Results

There was no difference between the groups in terms of age, gender and comorbidities. In terms of pain scoring and analgesia requirement at the first hour after intubation, there was a significant superiority in all follow-up periods in group 2 ($p<0.001$). In 2 patients in group 1 (3.1%) and in two patients in group 2 (3.07%) pleural effusion requiring intervention was detected. There was no significant difference between the two groups in terms of effusion pneumothorax, in terms of blood transfusion and other postoperative complications, postoperative whole blood replacement was higher in group 2 ($P = 0.002$).

Conclusion

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Key words : off-pump coronary surgery, jackson drain, chest tube, pain

Introduction

Cardiovascular diseases are still among the most important causes of mortality and morbidity. The frequency of coronary artery bypass grafting operations, which is the last stage in the treatment of this disease group, is increasing day by day. After cardiac surgery, there may be pain in the sternotomy area and chest where the chest tubes are placed, which may affect the respiratory physiotherapy of the patients. Therefore, control and reduction of pain is crucial to respiratory care, cough, early ambulation, and strengthening deep breath which is critical to pulmonary recovery (1, 2, 3). The location of the drainage catheters is therefore very important. In particular, the removal of chest tubes provides significant reductions in the severity of pain (4). However, it is clear that drain placement is necessary after these surgeries in order to drain the blood from the surgically traumatized areas of the patients and especially the areas where the internal mammarian artery is removed. Nonetheless, due to their firm and rigid structure, conventional chest tubes are capable of restricting postoperative breathing exercises for patients and thereby increasing hypoventilation and atelectasis. It is also thought that it may increase the use of analgesic agents. (5)

Due to their structure, the use of smaller and more flexible silicone drains can be as effective as larger and firm drains. (6) These drains are clog-resistant and cause less patient discomfort with their small size

and flexibility. In addition, an earlier study showed that the incidence of pericardial effusion, tamponade and postoperative AF was reduced compared to conventional large drains. (7) The aim of this study was to evaluate whether postoperative pain level changes and whether complications such as effusion and pneumothorax that require intervention arise because of the drainage placed in the thorax cavity either intercostal or subxiphoidal.

Patients and methods

Our study was performed between January 2017 and June 2018 by using two different methods of drainage systems in patients with isolated coronary artery disease who were operated in our clinic. The study was approved by the ethics committee(Decition no:2017/201) of our hospital. All patients were informed about the procedures and their consent was obtained.

Patients included in the study were divided into two groups and operated by the same surgical team. Patients were added to different groups based on the order of the surgery.

Exclusion criteria

- Patients requiring additional intervention other than coronary bypass

- Patients over 80 years of age

- Patients who did not use IMA for various reasons during the operation

- Patients who had to return to on-pump surgery for hemodynamic reasons during the operation

- Patients with chronic renal failure receiving dialysis treatment

- Patients who were taken to the operation urgently and who had used high doses of anticoagulants or antiaggregants

Patients in these groups were not included in the study.

Anesthesia and surgical technique

Anesthesia was performed using standardized drugs (midazolam, rocuronium, fentanyl and propofol) by the same team and in our institution. All patients were operated by median sternotomy. Internal mammarian artery was used in all patients. Saphenous vein was used for other vessels according to the number of diseased vessels. Off-pump surgery was performed in all patients. After appropriate heparinization, distal anastomoses were performed with octobus support and proximal anastomoses were performed with side clamp. After standard bleeding controls, one no. 32 classic drain and one Jackson drain (extending between the posterior part of the heart and the pericardium) were placed to the mediastinum of patients in group 1. No thorax drain was placed in this group of patients. In the other group (group 2), one no. 32 drain was placed in the mediastinum and one no. 36 drain in the left thorax (through the 5th or 6th intercostal space in the middle axillary region). The mediastinum was routinely closed in all of the patients in the same way.

Postoperative follow-up

All patients were transferred to the intensive care unit, and postero-anterior chest radiographs were obtained for both tube site control and pneumothorax. All patients were extubated at the appropriate time after routine intensive care follow-up. The pain assessment of the patients especially in the surgical area was started one hour after the intubation and evaluated in every 6 hour period using verbal pain category scale (Melzack and Katz 1992) indicated in Figure 1 and scores were recorded. Non-steroidal pain relievers were administered to patients who responded as feeling 2 and 3 pain levels. Narcotic analgesics (Tramadol 50 mg) were administered to patients who indicated a pain level of 4 and 5.

Intensive care follow-up was performed to the same standards. Antiaggregant and anticoagulant postoperative treatment was conducted similarly. Drains were pulled in the last 12 hours if there was less than

100 cc drainage. The first postero-anterior chest radiographs were obtained after the operation. Chest radiographs were renewed daily until discharge. After the patients were discharged, chest radiographs were taken at the 7th and 30th day controls to see if there was any effusion requiring intervention in the left thorax. Postero-anterior chest X-ray at discharge were obtained and both postero-anterior and left lateral radiographs in post-discharge controls were taken since they were able to show less amount of fluid. Thorax USG was performed on patients with suspicious appearance on direct radiographs as it is more sensitive and consultations from thoracic surgery department were conducted for the patients with effusion findings to discuss whether to intervene. In case of need, pleural drainage procedures were performed by the same surgical team.

Statistical analysis

Statistical analysis was performed by SPSS for Windows (SPSS, Inc., Chicago, IL, USA, version 23). Data were reported as appropriate in the form of mean ± standard deviation, median [IQR], or number (percent). Independent sample t-test, Chi-square test, Fisher's exact test, Mann-Whitney U-test, GLM, and repeated ANOVA measurements were used. Significance level was accepted as <0.05 in all tests.

Results

A total of 135 patients were included in our study. Five patients were excluded from the study because they did not attend the postoperative controls. One patient was excluded from the study because he returned to on-pump surgery due to hemodynamic disturbances. A total of 129 patients were evaluated. There was a significant increase in COPD (Chronic Obstructive Pulmonary Disease) in favor of group 2. A history of CVE (Cerebrovascular Events) indicated and elevation in group 1. There was no significant difference between the other variables (Table 1).

When the preoperative laboratory data were compared between the groups, albumin value was significantly higher in group 1 and calcium values were significantly higher in group 2. There were no significant differences in other baseline values (Table 2).

Effusion requiring drainage was detected in two patients at the first control after discharge in the group followed by Jackson drain and mediastinal drain with no thoracic tube. In the same group, one patient had minimal pneumothorax without intervention in the left thorax. In the other group, two patients underwent percutaneous thoracentesis because of significant pleural effusion at the first outpatient control, although there were no patients for pneumothorax. Frequency of these complications were not statistically significant between the two groups.

Although there were no significant differences in the amount of postoperative drainage and intraoperative and postoperative blood transfusion, FFP (Fresh Frozen Plasma) and fresh whole blood in the postoperative period were significantly higher in group 2 (Table 3.). Operation time, postoperative exubation time, postoperative atrial fibrillation frequency, and discharge times were similar in both groups. The number of vessels undergoing anatomic surgery and the length of ICU stay were significantly higher in group 1 (Table 4.). The verbal category scale for the pain assessment of the patients was found to be significantly higher in those who underwent classic chest drain in all evaluation periods in the first 48 hours (Table 5.). Based on this pain rating scale, non-steroidal analgesia and narcotic analgesia applications were significantly higher in group 2 (Table 6.).

Discussion

In patients undergoing open heart surgery, a drainage system is absolutely necessary to prevent tamponade due to accumulation in the pericardial area and to reduce pleural effusions. The chest drainage system did not change for years, especially because of the presence of serious complications. In the present study, we concluded that the need for postoperative chest drain placement, known as the traditional doctrine of open heart surgery, can be eliminated with a conventional drain and Jackson drain placed in the mediastinum, especially in the off-pump coronary bypass surgery.

In a study conducted by Guden et al in 2012, it was shown that both the subxiphoid and intercostal tract could be used to insert a chest tube. [8] Although there are early studies on different locations of the chest tube, no studies have been conducted on not placing drains into the thoracic cavity. Pericardial tamponade is the most feared complication after cardiac surgery. We were able to execute the study because we used mediastinal drains to eliminate this risk.

In a study by Frankel et al., no significant difference was evident in intensive care follow-ups between the patients who were using classical chest tube and flexible silastic drains (9). In our study, although there was a significant difference in terms of length of stay in the intensive care unit in favor of the patients in group 1, it did not affect our results since it was not one of the main evaluation points of this study.

There was a significant difference in pain scores and analgesia needs, especially in the postoperative follow-up period and until the drains were removed. There was a significant decrease in pain in the group without thoracic tube starting at the first hour after the intubation and in the type and amount of analgesia performed. In a study conducted by Bjessmo et al., no significant difference was reported in the assessment of pain with the use of two different drains (10). There are contradictory results in the literature on the subject. In fact, some studies support the results of our study (11, 12). Although there was a significant increase in the duration of ICU stay in group 1, significant improvements were observed in patients in this group who did not use conventional chest drain in terms of treatment compliance, mobilization, and compliance with respiratory physiotherapy exercises. These data suggest that this is due to low levels of pain and analgesic needs of patients. Pulmonary hypoventilation findings may occur due to decreased pulmonary function of patients due to trauma in bone and muscle during surgery. (13). In many studies, the location of the drain to be placed in the thoracic cavity has been studied and in our study, effusion which had to be performed thoracentesis on the postoperative 5th day was detected only in two patients after the drainage was not placed in the thorax cavity at all. Only one patient developed left minimal pneumothorax that did not require any intervention and regressed in the follow-up. In the same way, the necessity of thoracentesis was determined and applied to the two patients in the first group after discharge. This suggests that there is no significant difference in pleural complications. Our results are not congruent with a priori knowledge of the necessity of thoracic tube in classical surgical teaching.

Pleural effusions after cardiac surgery may be due to many causes. However, it is caused by leaks due to trauma in the inner wall of the thoracic wall triggered by removal of internal mammarian artery. Our study is not on the causes of effusion, but on whether there is a difference between drain types and accumulated fluid. It is suggested that the absence of a serious hemothorax is due to the fact that there is no adverse effect on the coagulation system in patients due to off-pump surgery and a good bleeding control within the operation.

In a study conducted in 2002, no significant difference was reported between flexible silastic drains and classical large drains in terms of pericardial tamponade and pleural effusion (12). In another study by Moss et al., similar effusion tamponade results were obtained for both drainage methods. In our study, there was no significant difference in terms of pleural effusion and pericardial tamponade despite the absence of thorax drainage.

One of the common problems after open heart surgery is cardiac arrhythmias with predominantly atrial fibrillation (14). There are studies indicating more common prevalence in off-pump surgery than classical on-pump surgery. Especially in the first 3 days after surgery there is a significant increase in its formation (15). Some studies indicated that the development of AF leaded a prolonged postoperative intensive care follow-up and discharge times (16,17,18). In our study, although the development of AF was higher in percentage, especially in the group with large thorax drainage, there was no difference between the groups. Since other factors that play a role in the development of atrial fibrillation have not been fully compared in our study, it is difficult to make a conclusive comment based only on the types of drains. The fact that there was no significant difference between the two groups in terms of operation times, postoperative intubation times, postoperative stroke and discharge times made it easier for us to compare postoperative pain and pleural complications.

When the laboratory data were compared between groups, aPTT and INR values in group 2 were higher in the preoperative period, which resulted in increased intraoperative TDP and postoperative fresh whole blood transfusion. This situation is incongruent with the studies reported in the literature. Since other parameters were not studied in terms of bleeding, no definitive interpretation could be remarked regarding this condition.

Limitations of the Study

There were a number of limitations in the present study. The first limitation was the detection of the amount of postoperative effusion by chest radiography which is known for non-sensitivity for liquids less than 200 ml. This evaluation is performed first by the cardiac surgery team, not by radiology. The second limitation was that not a completely blind follow-up of the patients was performed as the same team conducted the follow-ups. The effect of other sources of pain such as median sternotomy and saphenous incision location could not be included in the study.

Conclusion

We think that chest tube is not necessary especially in off-pump surgery because there is no significant difference between the two groups was observed in terms of pleural effusion and pneumothorax. In addition, there was a significant increase in postoperative pain score and need for analgesia. We do not use chest tubes in routine work in our clinic after the study was concluded.

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Authors Contrubutions:

FB: Study design, Data Collection, Data analysis, Manuscript Writing

YV: Data Collection, Data analysis

All authors read and approved the final version of the manuscript.

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Figure Legends:

Table 1. Preoperative demographic characteristics and clinical data

»

Age (year) Gender Male (n)(%) Female (n)(%) Diabetes Mellitus (n)(%) Hypertension (n)(%) COPD (n)(%) CRF (n)(%) F
Group 1: Mediastinum drain and Jackson drain COPD: Chronic Obstructive Pulmonary Disease CVE: Serebro Vascular Ev

Table 2. Preoperative laboratory values

WBC (K/mm$^{3)}$ Hemoglobin (g/L) Hematokrit (%) PLT (K/mm$^{3)}$ BUN (mmol / L) Creatine (µmol/L) Calcium (mmol / L
Group 1: Mediastinum drain and Jackson drain BUN: Blood urea nitrogen PT: Protrombin Time INR: International Norma

Table 3. Blood transfusion and drainage between groups

Intraoperative PLASMA FULL BLOOD ERYTHROCYTES Postoperative PLASMA FULL BLOOD ERYTHROCYTES P
Group 1: Mediastinum drain and Jackson drain

Table 4. Operational and postoperative follow-up parameters between groups

Operation time (hours) Number of vessels (n) Atrial fibrillation (n) (%) Extubation times (hours) Intensive care exit times
Group 1: Mediastinum drain and Jackson drain

Table 5. Comparison of pain scores between groups

	Group 1 Group 2	Group 1 Group 2	Group 1 Group 2	Group 1 Group 2	*P value*
	(n:64) (n:65)	**(n:64) (n:65)**	**(n:64) (n:65)**	**(n:64) (n:65)**	
After	After	2,23±0,496	2,23±0,496	0,001* 0,001*	0,001* 0,001*
extubation 1st	extubation 1st	2,83±0,525	2,83±0,525	0,001* 0,001*	0,001* 0,001*
hour 6th hour	hour 6th hour	1,84±0,672	1,84±0,672	0,001* 0,001*	0,001* 0,001*
12 hour 18	12 hour 18	2,81±0,564	2,81±0,564		
hour 24 hour	hour 24 hour	1,66±0,511	1,66±0,511		
48 hour	48 hour	2,71±0,455	2,71±0,455		
		1,27±0,445	1,27±0,445		
		2,37±0,548	2,37±0,548		
		1,17±0,380	1,17±0,380		
		2,14±0,503	2,14±0,503		
		1,11±0,315	1,11±0,315		
		1,90±0,530	1,90±0,530		
Group 1:	Group 2 :	Group 2 :			
Mediastinum	Mediastinal	Mediastinal			
drain and	drain and	drain and			
Jackson drain	intercostal chest	intercostal chest			
*Mann Whitney	drain	drain			
U test					

Table 6. Postoperative pain relief between the groups

	Group 1 Group 2	Group 1 Group 2	Group 1 Group 2	*P value*	*P value*
	(n:64) (n:65)	**(n:64) (n:65)**	**(n:64) (n:65)**		
After	After	17 (%26,6) 50	17 (%26,6) 50	17 (%26,6) 50	***0,001*** **
extubation 1rd	extubation 1rd	(%79,4) 10	(%79,4) 10	(%79,4) 10	***0,001*** **
hour (Narcotic	hour (Narcotic	(%15,6) 47	(%15,6) 47	(%15,6) 47	***0,001*** **
analgesia) 6th	analgesia) 6th	(%74,6) 1	(%74,6) 1	(%74,6) 1	***0,001*** **
hour (n)(%) 12	hour (n)(%) 12	(%1,6) 43	(%1,6) 43	(%1,6) 43	***0,001*** **
hour 18 hour	hour 18 hour	(%68,3) 0 25	(%68,3) 0 25	(%68,3) 0 25	***0,013*** **
24 hour 48	24 hour 48	(%39,7) 0 12	(%39,7) 0 12	(%39,7) 0 12	***0,001*** **
hour After	hour After	(%19,0) 0 6	(%19,0) 0 6	(%19,0) 0 6	***0,001*** **
extubation 1rd	extubation 1rd	(%9,5) 45	(%9,5) 45	(%9,5) 45	***0,001*** **
hour (Non	hour (Non	(%70,3) 11	(%70,3) 11	(%70,3) 11	***0,001*** **
steroid	steroid	(%17,5) 34	(%17,5) 34	(%17,5) 34	***0,001*** **
analgesia)6th	analgesia)6th	(%53,1) 17	(%53,1) 17	(%53,1) 17	***0,001*** **
hour (n)(%) 12	hour (n)(%) 12	(%27,0) 40 (%	(%27,0) 40 (%	(%27,0) 40 (%	
hour 18 hour	hour 18 hour	62,5) 17	62,5) 17	62,5) 17	
24 hour 48	24 hour 48	(%27,0) 17	(%27,0) 17	(%27,0) 17	
hour	hour	(%26,6) 36	(%26,6) 36	(%26,6) 36	
		(%57,1) 11	(%57,1) 11	(%57,1) 11	
		(%17,2) 45	(%17,2) 45	(%17,2) 45	
		(%71,4) 7	(%71,4) 7	(%71,4) 7	
		(%10,9) 44	(%10,9) 44	(%10,9) 44	
		(%69,8)	(%69,8)	(%69,8)	
Group 1:	Group 2 :	Group 2 :			
Mediastinum	Mediastinal	Mediastinal			
drain and	drain and	drain and			
Jackson drain **	intercostal chest	intercostal chest			
Pearson	drain	drain			
Chi-Square					

Figure 1. Verbal category scale (Melzack and Katz 1992)

Mild Discomforting Distressing Horrible Excruciating

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