Am J Cardiovasc Dis 2020;10(1):1-5
www.AJCD.us /ISSN:2160-200X/AJCD0104752

Original Article

Comparison on frequencies of pericardial effusion and tamponade following open heart surgery in patients with or without low negative pressure suction on chest tube

Farinaz Khodadadi[1], Sasan Gilani[1], Pouria Shoureshi[2]

[1]*School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran;* [2]*Department of Internal Medicine, Orange Park Medical Center, Florida, USA*

Received November 11, 2019; Accepted February 14, 2020; Epub April 15, 2020; Published April 30, 2020

Abstract: Introduction: Pericardial effusion and tamponade are accounted as the two most important complications following open-heart surgeries which are known to increase mortality and morbidity rates. Putting a low negative pressure suction on the chest tube of patients might be a useful way for better drainage and also reducing the occurrence of pericardial effusion and tamponade. In the present study, we aimed to compare the prevalence of pericardial effusion and tamponade in patients undergoing open-heart surgeries with and without low negative pressure suction on the chest tube. Methods: This clinical trial was performed in 2018-2019 in Tehran, Iran. 100 patients who were candidates for open-heart surgery were entered. After surgeries, patients were divided into two groups: group 1 had a low negative pressure suction on their chest tube and group 2 had no suction. Patients were then observed for clinical and imaging characteristics of pleural effusion and tamponade. Data were gathered and analyzed using SPSS software. Results: In the present study, we indicated that the prevalence of pericardial effusion is significantly lower in patients with low negative pressure on their chest tube (P=0.04). No significant differences were observed between two groups regarding to: frequency of tamponade and post-operative ejection fraction (P> 0.05). Conclusion: The usage of a low negative pressure suction on the chest tube following open cardiac surgeries is associated with a lower prevalence of pericardial effusion. We suggest that such systems could be commonly used in cardiac surgeries or surgeries of the thorax.

Keywords: Pericardial effusion, tamponade, suction, chest tube

Introduction

Cardiovascular diseases are still one of the leading causes of mortalities among different societies with a growing trend due to changes in lifestyle [1]. Cardiovascular diseases might indicate their symptoms in elderly or adolescents but studies indicated that they almost begin at in early age [2]. Epidemiologic studies have shown that the prevalence of cardiovascular diseases in Tehran is 37.5% among women between 30 to 79 years of age and 22.2% among men [3]. These data put emphasis on the importance of cardiovascular diseases among populations. Different therapeutic methods have been developed in order to reduce mortality and morbidity rates and some of these methods are invasive. Open cardiac surgeries are nowadays performed in different cardiac centers around the world with a growing trend [4]. Coronary artery bypass grafting (CABG) and valvular surgeries are accounted for the most common cardiac surgeries [5]. Open cardiac surgeries are also associated with some complications threatening patient's life during and after surgeries. During cardiac surgeries, some changes are performed on the coagulation system and make patients susceptible to some complications such as bleeding [6]. Pericardial effusion and tamponade are also reported to be some other common complications of cardiac surgeries that occur due to fluid concentrations around the heart [7, 8]. It should also be noted that risks of mortality, further complica-

tions, and morbidity are increased when a complication occurs in patients who have been under cardiac surgeries because most of these patients have at least one basic vascular problem and cannot endure increased load caused by pericardial effusion or tamponade [9].

Pericardial effusion is assumed to be one of the most important complications of cardiac surgeries which requires high precisions during surgeries and also using technical methods in order to prevent this complication [10, 11]. On the other hand, pericardial effusion could be presented as tamponade if the excessive fluid is collected around the heart and this issue can be diagnosed by clinical presentations, imaging studies such as echocardiography and invasive measurements of the pressure [12]. Hemodialysis, administration of anticoagulants, aneurysm and idiopathic pericarditis are known to be the most common risk factors of tamponade and pericardial effusion [13, 14]. Different surgical techniques have been developed to treat both pericardial effusion and tamponade. Administration of subxiphoid pericardiostomy is one of the best surgical techniques which help to ameliorate pericardial effusion by fluid drainage [15]. In this technique, catheters are administered after cardiac surgeries in the pericardial or pleural space of patients. There are also different details of performing this technique by heart surgeons [16].

Administration of a low negative pressure suction in order to provide better continuous drainage of discharges after surgeries is one of these new techniques which might help patients and reduce the duration of clinical improvements also in wound therapies [17, 18]. This method might also be able to change amounts of discharges and therefore, the outcome of surgeries [19]. This method has been previously used in different thorax surgeries especially lung surgeries but so far, very few previous studies have evaluated this method following cardiac surgeries. As a result, here we aimed to evaluate the administration of low negative pressure suction on the prevalence of pericardial effusion, tamponade and other complications of open cardiac surgeries in Tehran.

Methods and material

This clinical trial was performed on 100 patients who were candidates for open-heart surgery and were referred to Imam Khomeini hospital, Tehran in 2018. This study was approved ethically by the ethical committee of Tehran University of Medical Sciences. Patients were entered based on inclusion criteria and the final population was collected. Inclusion criteria were: being a candidate for open-heart surgery and performing the surgery by a single heart surgeon. Patients who had any history of heart surgeries, any hematologic or coagulation disorders or patients with systemic diseases including renal failure, respiratory failure or patients with a history of CVA and patients with pleural adhesion were not entered. Our exclusion criterion was any change in the surgical plan during heart surgery. Patients were entered and signed the informed consent and the plan of our study was explained to them by our research team. The demographic data of our patients were collected by questionnaires. All patients underwent cardiac surgeries and two chest tubes were administered for each patient, both located in pericardial space or one chest tube located in pericardial space and the other in left or right pleural space. Chest tube administration was performed as follows:

After surgery and before the closure of the mediastinal cavity, two slices were created under the xiphoid appendage on the midline, one to one and a half centimeters in size and the surgeon entered the cavity with a clamp. Next, both chest tubes were passed by clamping through the hole and guided outside. They were finally fixed to the patient's skin on the number 10 to 12 lines on the chest tube. Alternatively, one chest tube was administered using a slice under sternum on the midline and the other chest tube located on the left lateral side on the anterior axillary line between 8^{th} and 9^{th} intercostal space. Chest tubes were administered and fixed to the skin of patients. Patients were then divided into two groups: in the first group, a low negative pressure suction (-150 mmHg) was put on their chest tube after the surgeries and entering the intensive care unit (ICU) helping the drainage of discharges. The second group was observed routinely.

Patients were carefully observed for clinical presentations of pericardial effusion or tamponade after surgeries. Diagnosis of pericardial effusion and tamponade was performed based on clinical examination and echocardiography by expert cardiologists. Data regarding occur-

Table 1. Demographic data and duration of surgery between two groups

Variable		With suction (n=49)	Without suction (n=42)	*P*-value
Age (years)		64.38 ± 7.97	65.87 ± 7.98	0.52
Sex	Female	14 (28.6%)	11 (26.2%)	0.49
	Male	35 (71.4%)	31 (73.8%)	
Type of surgery	CABG	35 (71.4%)	25 (59.5%)	0.19
	Valve replacement	14 (28.6%)	17 (40.5%)	
Duration of surgery (minutes ± SD)		336.42 ± 76.05	317.43 ± 85.65	0.31

CABG: coronary artery bypass grafting.

Table 2. Prevalence of pericardial effusion and tamponade in two groups

Variable	With suction (n=49)	Without suction (n=42)	*P*-value
Frequency of tamponade	1 (2%)	4 (9.5%)	0.18
Duration of post-operative tamponade (hour ± SD)	40	42 ± 15.28	0.91
Frequency of pericardial effusion	0	4 (9.5%)	0.04
Duration of post-operative pericardial effusion (days ± SD)	0	32.35 ± 15.29	0.07
Duration of operation (minutes ± SD)	87.72 ± 21.06	100.35 ± 34.34	0.06
Post-operative ejection fraction (%)	45.79 ± 11.11	48.24 ± 10.12	0.32

rence of pericardial effusion and tamponade and other demographic data were then collected and analyzed with SPSS software to assess their prevalence.

Results

In this study, 100 patients were entered. 9 patients were excluded: 2 due to expiration and 7 due to changes in the surgery plan. In the end, the study was performed on 91 patients, 25 female, and 66 males. Patients were divided into two groups: the first group consisted of 49 and the second group had 42 patients. There was no significant difference between the two groups regarding age, sex and type of cardiac surgeries (P > 0.05). There was also no significant difference between the duration of surgeries of two groups of patients (P=0.31). The demographic data of patients are compared between two groups and summarized in **Table 1**.

Our data showed that 2% of patients with low negative pressure suctions had tamponade while on the other hand, 9.5% of patients without suction had tamponade. Pericardial effusion was observed in none of the patients who had suction on the chest tube and this problem was detected in 9.5% of patients who had no suction. There was no significant difference between the two groups regarding the prevalence of tamponade (P=0.13) but the prevalence of pericardial effusion was significantly lower in patients who had low negative pressure suction on their chest tube (P=0.04). Further analysis also showed no significant difference between the two groups regarding duration of post-operative tamponade, duration of postoperative pericardial effusion, duration of the operation and also ejection fraction (EF) (P > 0.05). These data are also summarized in **Table 2**. There was also no significant relationship between the type of cardiac surgery and the prevalence of tamponade and pericardial effusion (P > 0.05). No significant relation was also observed between sex and prevalence of tamponade and pericardial effusion (P > 0.05).

Discussion

Here we evaluated the effects of low negative pressure suction on the occurrence of pericardial effusion and tamponade after open cardiac surgeries and showed that prevalence of pericardial effusion is significantly lower in patients who had suctions on their chest tubes. There have been some previous studies on the effects of suction administration on chest tubes after thorax surgeries. Farhat and colleagues have performed a study in 2003 and evaluated the effects of suction administration on chest tubes of patients who had been under open-heart surgeries. In the end, they concluded that the administration of suction is associ-

ated with lower pain and faster progression and better drainage of discharges [20]. These results are in line with our results. One of the important points of our study is that here we used low negative pressure suction but in the study by Farhat and others, they used high negative pressure suctions with -700 mmHg pressure. Sanni and colleagues also performed a review study on the effects of suctions after thorax and lung surgeries. They reported that reduction in air leakage by the usage of suction was not reported in previous studies but this method can ameliorate the patient's condition and reduce recovering time along with positives effects in reducing the occurrence chance of pericardial effusion and tamponade [21]. These data are also in line with our study. Here we indicated a reduction in the occurrence of pericardial effusion following suction usage after open-heart surgeries.

On the other hand, usage of suction on chest tubes of patients has been reported to be associated in a reduction in discharges of patients and a faster amelioration in patients injured by trauma or those who had been under lung surgeries [22, 23]. Furthermore, Rajaraman Durai and others performed a study on patients undergoing heart surgeries in 2010. They evaluated different characteristics of chest tubes and reported that administration of negative pressure on the chest tube might be associated with reductions in complications of surgeries [24]. These data are also in line with our study.

There are also some conflicting reports from previous studies. Newcomb and colleagues had a study in 2005 in Australia evaluating the effects of low negative pressure suction on chest tubes of pediatrics undergoing cardiac surgery. They compared the results with drainage and vacuum bags. In this study, they reported that administration of suction on chest tubes has no privilege than simple vacuum bags and drainage and all these methods are safe and take part in the progression of patients [25]. These data are not in line with our study and this might be due to differences in the study population. This can be concluded that the administration of suctions might not be as benefit able in pediatrics and further studies are required. In 2016, Lang and others assessed former studies from 2001 to 2013 and reported that the usage of suction on chest tubes of patients undergoing lung surgeries is associated with reduced air leakage but cannot improve the clinical condition of patients [26]. These data are also not in line with our study. Here we indicated that putting a low negative pressure suction on chest tubes of patients undergoing cardiac surgeries is associated with decreased pericardial effusion and though, better clinical improvement of patients.

Conclusion

We suggest that the usage of suctions on chest tubes of patients undergoing cardiac surgeries is associated with decreased occurrence of pericardial effusion and surgeons should utilize this technique in cardiac surgeries and other thorax surgeries.

Disclosure of conflict of interest

None.

Address correspondence to: Sasan Gilani, School of Medicine, Isfahan University of Medical Sciences, Hezar Jarib Blvd, Isfahan, Iran. Tel: +989374568787; E-mail: gilanisasan@gmail.com

References

[1] Association AD. Cardiovascular disease and risk management. Diabetes Care 2016; 39: S60-S71.

[2] Sacks FM, Lichtenstein AH, Wu JH, Appel LJ, Creager MA, Kris-Etherton PM, Miller M, Rimm EB, Rudel LL and Robinson JG. Dietary fats and cardiovascular disease: a presidential advisory from the American Heart Association. Circulation 2017; 136: e1-e23.

[3] Mozaffarian D, Benjamin EJ, Go AS, Arnett DK, Blaha MJ, Cushman M, Das SR, De Ferranti S, Després JP and Fullerton HJ. Heart disease and stroke statistics-2016 update a report from the American Heart Association. Circulation 2016; 133: e38-e48.

[4] Masuda M, Okumura M, Doki Y, Endo S, Hirata Y, Kobayashi J, Kuwano H, Motomura N, Nishida H and Saiki Y. Thoracic and cardiovascular surgery in Japan during 2014. Gen Thorac Cardiovasc Surg 2016; 64: 665-697.

[5] Wang TK, Liao YB, Choi D, Harmos S, Haydcok D and Gerber I. Mitral valve surgery with or without coronary bypass grafting: eight-year cohort study. N Z Med J 2019; 132: 50-8.

[6] Boer C, Meesters MI, Milojevic M, Benedetto U, Bolliger D, von Heymann C, Jeppsson A, Koster

A, Osnabrugge RL and Ranucci M. 2017 EACTS/EACTA guidelines on patient blood management for adult cardiac surgery. J Cardiothorac Vasc Anesth 2018; 32: 88-120.
[7] Xu C, Feng D, Wang J and Cheng Z. Diagnosis and treatment of delayed large pericardial effusion after cardiac surgery. Biomed Res 2017; 28: 4087-4091.
[8] Hoit BD. Pericardial effusion and cardiac tamponade in the new millennium. Curr Cardiol Rep 2017; 19: 57.
[9] Gatti P, De Filippo O, Rettegno S, Iannaccone M, D'Ascenzo F, Lazaros G, Brucato A, Tousoulis D, Adler Y and Imazio M. P702 is pericardial effusion a negative prognostic marker? Eur Heart J 2018; 39: ehy564. P702.
[10] Meurin P, Lelay-Kubas S, Pierre B, Pereira H, Pavy B, Iliou M, Bussiere J, Weber H, Beugin J and Farrokhi T. Colchicine for postoperative pericardial effusion: a multicentre, double-blind, randomised controlled trial. Heart 2015; 101: 1711-1716.
[11] Yu PS, Ng VW, Lau RW and Ng CS. Massive pericardial effusion after Nuss procedure: to drain or not to drain? J Thorac Dis 2018; 10: E27.
[12] Appleton C, Gillam L and Koulogiannis K. Cardiac tamponade. Cardiol Clin 2017; 35: 525-537.
[13] Leiva EH, Carreño M, Bucheli FR, Bonfanti AC, Umaña JP and Dennis RJ. Factors associated with delayed cardiac tamponade after cardiac surgery. Ann Card Anaesth 2018; 21: 158.
[14] Sadeghi MM. Prevention of peri-operative cardiac tamponade for bleeding after CABG: risk factors, outcomes, and the effect of left partial pericardiotomy and early re-exploration. Biosci Biotech Res Asia 2016; 13: 2195-2200.
[15] Colak A, Becit N, Kaya U, Ceviz M and Kocak H. Treatment of pericardial effusion through subxiphoid tube pericardiostomy and computerized tomography-or echocardiography-guided percutaneous catheter drainage methods. Braz J Cardiovasc Surg 2019; 34: 194-202.
[16] Furst B, Chyong-jy JL, Hansen P and Musuku SR. Concurrent pericardial and pleural effusions: a double jeopardy. J Clin Anesth 2016; 33: 341-345.
[17] Venturi ML, Attinger CE, Mesbahi AN, Hess CL and Graw KS. Mechanisms and clinical applications of the vacuum-assisted closure (VAC) device. Am J Clin Dermatol 2005; 6: 185-194.
[18] Li C, Yuhong C and Ping F. Influence of negative pressure of suction under constant pressure ventilation on lung volume and respiratory mechanics in patients with mechanical ventilation. Chin Nurs Res 2016; 2016: 9.
[19] Özden D and Görgülü RS. Effects of open and closed suction systems on the haemodynamic parameters in cardiac surgery patients. Nurs Crit Care 2015; 20: 118-125.
[20] Farhat F, Ginon I, Lefevre M and Lu Z. Prospective randomized comparison between redon catheters and chest tubes in drainage after cardiac surgery. J Cardiovasc Surg (Torino) 2003; 44: 179.
[21] Sanni A, Critchley A and Dunning J. Should chest drains be put on suction or not following pulmonary lobectomy? Interact Cardiovasc Thorac Surg 2006; 5: 275-278.
[22] Ramanathan R, Wolfe LG and Duane TM. Initial suction evacuation of traumatic hemothoraces: a novel approach to decreasing chest tube duration and complications. Am Surg 2012; 78: 883-887.
[23] Memtsoudis SG, Rosenberger P and Sadovnikoff N. Chest tube suction-associated unilateral negative pressure pulmonary edema in a lung transplant patient. Anesth Analg 2005; 101: 38-40.
[24] Durai R, Hoque H and Davies TW. Managing a chest tube and drainage system. AORN J 2010; 91: 275-283.
[25] Newcomb AE, Alphonso N, Nørgaard MA, Cochrane AD, Karl TR and Brizard CP. High-vacuum drains rival conventional underwater-seal drains after pediatric heart surgery. Eur J Cardio-Thorac Surg 2005; 27: 395-400.
[26] Lang P, Manickavasagar M, Burdett C, Treasure T, Fiorentino F, Collaborative UCTR, Barua A, Batchelor T, Fewtrell J and Fitzmaurice G. Suction on chest drains following lung resection: evidence and practice are not aligned. Eur J Cardiothorac Surg 2015; 49: 611-616.