Original Article

Comparison of Risk Factors Between Mediastinitis and Sternal Dehiscence After Adult Cardiac Surgery

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ABSTRACT

Background: Mediastinitis is a severe complication after cardiac surgery. The aim of this study was to determine the incidence of postoperative mediastinitis, the predictors of mediastinitis, and sternal dehiscence in adult cardiac surgery patients.

Methods: In this retrospective study, the records of 60 patients were evaluated regarding mediastinitis and dehiscence after cardiac surgery in a referral cardiovascular hospital in Tehran, Iran.

Results: In the present study, 4360 patients underwent surgery over 18 months from September 2017 through March 2019. Of this total, 60 patients with a diagnosis of mediastinitis and sternal dehiscence were included in the study's analysis. In our investigation, 1.03% of the cases (45/4360) had mediastinitis and 0.3% (15/4360) cases experienced sternal dehiscence. Among the many risk factors that were examined, there were significant differences between the mediastinitis and dehiscence groups regarding diabetes mellitus (P =0.007), a history of preoperative chronic kidney disease (P =0.02), a history of myocardial infarction (P =0.002), a history of arrhythmia before cardiac surgery (P =0.02), reoperation due to postoperative bleeding (P =0.07), the number of patients transferred to the ICU with the sternum left open (P <0.001), postoperative pulmonary complications (P =0.007), and postoperative arrhythmias (P =0.04).

Conclusions: There were significant differences between the mediastinitis and dehiscence groups regarding diabetes mellitus, a history of preoperative chronic kidney disease, myocardial infarction and arrhythmias before cardiac surgery, reoperation due to postoperative bleeding, the number of patients transferred to the ICU with the sternum left open, postoperative pulmonary complications, and postoperative arrhythmias. ***(Iranian Heart Journal 2021; 22(3): 6-12)***

KEYWORDS: Mediastinitis, Dehiscence, Cardiac surgery, Risk factors

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Cardiac surgeries are widely performed today. They include coronary artery bypass graft surgery (CABG), heart valve surgery, and congenital heart disease surgery. Cardiac surgeries can have many complications, one of the most serious of which is mediastinitis and deep sternal wound infection. A median sternotomy prepares an appropriate approach for the implementation of cardiopulmonary bypass in cardiac surgeries. Nonetheless, several studies have indicated that mediastinitis after a sternotomy occurs in 1% to 5% of patients, with a rate of morbidity of up to 50%, an increased length of hospital stay, [1, 2] and a mortality rate of 14% to 47%. [1, 3, 5]

Mediastinitis is a devastating complication of cardiac operations, with a significant socioeconomic impact and morbidity. [6] The reported risk factors include the use of the mammary artery for revascularization, long duration of surgery, the extreme use of electrocoagulation or bone wax, reoperation because of bleeding, hospital-acquired pneumonia, peripheral infections, prolonged mechanical ventilation, peripheral infections, diabetes mellitus, age, obesity, and chronic obstructive pulmonary disease (COPD). [1, 3, 5, 8, 9]

This study aimed to determine the institutional incidence of mediastinitis in a referral cardiovascular hospital and to identify the risk factors for mediastinitis in the pre-, intra-, and postoperative periods.

METHODS

The present single-center retrospective study was conducted at the Rajaie Cardiovascular Medical and Research center, Tehran, Iran. The study proposal was approved by the institutional ethics committee (code No. IR.RHC.REC.1398.043). All the study patients were aged between 18 and 90 years. Totally, 4360 patients underwent cardiac surgeries using cardiopulmonary bypass over 18 months, from September 2017 through March 2019. Of this total, 60 patients had postoperative mediastinitis and dehiscence. Data were collected from patients' medical records. The inclusion criteria were as follows: patients aged between 18 and 90 years who underwent cardiac surgeries by cardiopulmonary bypass, elective surgeries, urgent surgeries, first surgeries, or redo surgeries. The exclusion criteria consisted of incomplete file information and death during or early (within 48 h) after surgery. The data were analyzed using SPSS, version 23.0, for Windows (SPSS IBM Inc, Chicago, IL). The categorical variables were analyzed using the χ^2 or Fisher exact test. The independent samples *t* test was applied to compare the mean values between the 2 groups of mediastinitis and dehiscence. The statistical significance level was considered at a *P*-value of 0.05 or less.

RESULTS

In this study, from 4360 patients who underwent cardiac operations over 18 months, 60 patients experienced mediastinitis or sternal dehiscence. Thus, the frequency of mediastinitis was calculated to be 1.03% (45/4360), and sternal wound dehiscence was calculated to be 0.3% (15/4360). The mean age of the patients was 59.3 ± 12.9 years old, and the mean body mass index was 29.8 ± 4.4. No statistically significant relationships were seen between hypertension, hyperlipidemia, and hypothyroidism and mediastinitis and dehiscence; however, there was a significant relationship between diabetes mellitus and mediastinitis and dehiscence (*P* =0.007) (Table 1). Moreover, there were no significant relationships between preoperative anemia, pulmonary and gastrointestinal problems, and preoperative peripheral vascular diseases and mediastinitis and dehiscence. There were significant relationships between the 2 groups vis-à-vis a history of preoperative chronic

kidney disease (*P* =0.02), a history of myocardial infarction before cardiac surgery (*P* =0.002), and arrhythmias before cardiac surgery (*P* =0.02), but no significant relationship was detected concerning a history of cerebrovascular accidents between the 2 groups (*P* =0.9) (Table 1). The results revealed no significant relationship between an ejection fraction of less than 35% and mediastinitis and dehiscence (*P* =0.8), nor was there a significant relationship between emergency cardiac surgeries and mediastinitis and dehiscence (*P* =0.8) (Table 1). Further, no statically significant relationships were found between the type of cardiac surgery and mediastinitis and dehiscence (*P* =0.3) (Table 3). There were also no significant relationships between the use of inotropic drugs during cardiac surgery and reoperation due to postoperative bleeding and mediastinitis and dehiscence (Table 1), nor were there any significant relationships between the number of grafts performed during CABG, the use of the left internal mammary artery, and the use of the bilateral internal mammary artery and mediastinitis (Table 3). In this study, 291 patients were transferred to the intensive care unit (ICU) with the open sternum; and of these patients, 40 cases developed mediastinitis and dehiscence (13.1%). Therefore, a significant relationship existed between the open sternum and mediastinitis and dehiscence (*P* <0.001). There were no relationships of statistical significance between the transfusion of blood, platelet, or fresh frozen plasma and mediastinitis and dehiscence. There was a significant relationship between postoperative pulmonary problems, arrhythmias, and mediastinitis and dehiscence (*P* =0.04), whereas no significant relationships were observed between the 2 groups regarding postoperative gastrointestinal problems and kidney disease (Table 2). The mean time between primary surgery and referral due to dehiscence was 26.3 ± 24.09 days, and the interval between the initial disease and referral due to mediastinitis was 82.6 ± 219.8 days.

Table 1. Relationship between pre-intracardiac surgery variables and mediastinitis and dehiscence

Variables	Dehiscence	Mediastinitis	*P*-value
HTN	11 (18.3%)	35 (58.3%)	0.7
DM	3 (8.3%)	27 (33.3%)	0.007
Hyperlipidemia	5 (5%)	20 (45.3%)	0.4
Hypothyroidism	2 (3.3%)	4 (6.7%)	0.6
History of anemia	2 (3.3%)	6 (10%)	0.9
Pulmonary disease before surgery	8 (13.3%)	20 (33.3%)	0.5
CKD before surgery	8 (13.3%)	10 (16.7%)	0.02
Digestive disease before surgery	2 (3.3%)	11 (18.3%)	0.3
Peripheral vascular disease	1 (1.7%)	2 (3.3%)	0.7
Addict	1 (1.7%)	5 (8.3%)	0.6
Smoker	6 (10%)	17 (28.3%)	0.8
History of MI	6 (10%)	3 (5%)	0.002
arrhythmia before surgery	6 (10%)	6 (10%)	0.02
History of CVA	3 (5%)	9 (15%)	0.9
Ejection fraction <35%	2 (3.3%)	5 (8.3%)	0.8
Kind of surgery (emergency)	3 (5%)	10 (16.7%)	0.8
Reoperation due to bleeding	6 (10%)	8 (13.3%)	0.07
Inotrope use during and after surgery	11 (18.3%)	25 (41.7%)	0.2
balloon pump	2 (3.3%)	2 (3.3%)	0.2

HTN, Hypertension; DM, Diabetes mellitus; CKD, Chronic kidney disease; MI, Myocardial infarction; CVA, Cerebrovascular accident

Table 2. Relationship between post cardiac surgery variables and mediastinitis and dehiscence

Variables	Dehiscence	Mediastinitis	*P*-value
Pulmonary problem after surgery	11 (18.3%)	15 (25%)	0.007
CKD after surgery	8 (13.3%)	14 (23.3%)	0.1
Dialyze after surgery	2 (3.3%)	3 (5%)	0.4
Digestive problem after surgery	2 (3.3%)	9 (15%)	0.5
Arrhythmia after surgery	5 (8.3%)	5 (8.3%)	0.04

CKD, Chronic kidney disease

Table 3. Relationship between cardiac surgery variables and mediastinitis and dehiscence

Variables	Dehiscence	Mediastinitis	Total	*P*-value
kind of Surgery				
CABG	9 (15%)	33 (55%)	42 (70%)	0.3
CABG + AVR	0	3 (5%)	3 (5%)	
CABG + MVR	1 (1.7%)	1 (1.7%)	2 (3.3%)	
CABG + MVR + AVR	1 (1.7%)	0	1 (1.7%)	
CABG + MVR + TVR	0	1 (1.7%)	1 (1.7%)	
MVR + AVR	0	1 (1.7%)	1 (1.7%)	
Bentall	1 (1.7%)	2 (3.3%)	3 (5%)	
AVR	3 (5%)	2 (3.3%)	5 (8.3%)	
ASD + PAPVC repair	0	1 (1.7%)	1 (1.7%)	
ASD	0	1 (1.7%)	1 (1.7%)	
Total	15 (25%)	45 (75%)	60 (100%)	
Number of Grafts				
0	4 (6.7%)	7 (11.7%)	11 (18.3%)	0.8
2	1 (1.7%)	4 (6.7%)	5 (8.3%)	
3	5 (8.3%)	14 (23.3%)	19 (31.7%)	
4	5 (8.3%)	18 (30%)	23 (38.3%)	
5	0	2 (3.3%)	2 (3.3%)	
Total	15 (25%)	45 (75%)	60 (100%)	
LIMA	11 (18.3%)	37 (61.7%)	48 (80%)	0.4
BIMA	1 (1.7%)	0		0.2

CABG, Coronary artery bypass grafting; MVR, Mitral valve replacement; AVR, Aortic valve replacement; TVR, Tricuspid valve replacement; ASD, Atrial septal defect; PAPVC, Partial anomalous pulmonary venous return; LIMA, Left internal mammary artery; BIMA, Bilateral internal mammary artery

DISCUSSION

Mediastinitis is a severe and rare complication of cardiac surgeries, with significant costs and morbidity. [6] Mediastinitis after a sternotomy is classified into different types. [7] Infection occurs within 2 weeks or 2 to 6 weeks after surgery, even without the presence of risk factors. It may present in the first 2 weeks, with 1 to 2 risk factors, or it may occur for the first time more than 6 weeks after the initial surgery. Other studies have categorized mediastinitis after sternotomies as sternal dehiscence without infection and with infection and have divided it into several types, including the limitation of infection to soft tissue, sternal osteomyelitis, and retrosternal infection. [1] Mediastinitis increases treatment and morbidity costs. The most frequent signs and symptoms of mediastinitis are increased white blood cell counts, fever, drainage from the wound site, positive cultivation, and localized wound changes. Risk factors include the use of the mammary

artery for revascularization, the excessive duration of surgery, the excessive use of bone wax or electrocoagulation, reoperation due to bleeding, nosocomial infections, long mechanical ventilation, peripheral infections, diabetes mellitus, age, obesity, and COPD. [1, 3, 5, 8-10]

The most common organism is *Staphylococcus aureus*, seen in 60% of cases, followed by other Gram-negative microorganisms such as *Serratia marcescens*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*. A number of studies have shown that *Candida albicans* is the cause of 14% of the cases of mediastinitis after sternotomy. [1, 4, 11-14]

One study showed that the incidence of mediastinitis was 0.34%, and the incidence of sternal dehiscence without mediastinitis was 0.55%. The essential risk factors for mediastinitis were postoperative pneumonia (P =0.006), urinary tract infection (P =0.02), and the use of intra-aortic balloon pumps (P =0.027). Risk factors for sternal dehiscence without infection were age over 60 years (P =0.01), postoperative pneumonia (P =0.003), antiplatelet agent use (P =0.006), and beta-blocker use (P =0.0001). The incidence rates of and risk factors for mediastinitis and sternal dehiscence were different in this study. Pneumonia after surgery was the only risk factor common to the 2 groups. [7] Nevertheless, in our study, among the many risk factors that were examined, we found significant differences between the mediastinitis and dehiscence groups regarding diabetes mellitus (P =0.007), a history of preoperative chronic kidney disease (P =0.02), a history of myocardial infarction (P =0.002), a history of arrhythmias before cardiac surgery (P =0.02), reoperation due to postoperative bleeding (P = 0.07), the number of patients transferred to the ICU with the sternum left open (P <0.001), postoperative pulmonary complications (P =0.007), and postoperative arrhythmias (P =0.04). In another study, 1700 patients undergoing cardiac surgery were sequentially evaluated, and 49 variables were evaluated retrospectively. The authors reported mediastinitis progression in 55 patients, and 3 of the 49 variables were significant predictors of progression to mediastinitis: obesity, COPD, and the bilateral grafting of the mammary artery. Additionally, diabetes mellitus, the CCS class, and the number of fresh frozen plasma units that the patients received during the operation were effective variables. [6]

In another study on 1322 patients, 56 (4.2%) developed mediastinitis. Of these, 26 patients (46.4%) were at high risk for mediastinitis and 15 (26.8%) were at very high risk for mediastinitis. In that study, 3 variables were clearly different: reoperation, COPD, and obesity. [15] Another investigation was performed on 1298 patients, 62.6% of whom were men. Diabetes mellitus was reported in 18.3%. The authors reported the occurrence of postoperative mediastinitis in 38 patients (2.9%), of whom 6 (15.8%) died. The variables identified as mediastinitis predictors in these patients were obesity (P =0.008), COPD (P =0.007), and diabetes mellitus (P =0.009). The internal mammary artery graft was detected as a risk factor only when associated with obesity. [16] Therefore, the measures suggested for the prevention of this occurrence could be the identification of the risk factors and the minimization of these risk factors pre-, intra-, and postoperatively. In terms of prevention, patients should be kept away from microorganisms by reducing the length of hospital stay, especially before surgery, preventing the colonization of microorganisms in the hospital environment, performing asepsis treatment, minimizing the use of electrocautery, exercising care in

manipulating tissues, preventing trauma to the sternum as much as possible, performing homeostasis, assessing equipment used in the operating room or the ICU, and examining catheters, drains, and surgical dressings. [17] The Society of Thoracic Surgeons Practice Guidelines on antimicrobial prophylaxis in cardiac surgeries suggests that a cephalosporin be given within 60 minutes from skin incision and that it be continued for 24 to 72 hours. First-generation (cefazolin), second-generation (cefamandole and cefuroxime), and third-generation (cefotaxime) cephalosporins have been defined to be efficient in reducing surgical site infections in cardiac surgeries; nonetheless, the preference of one class over another has not been established. [18, 19]

CONCLUSIONS

In this study, several risk factors were investigated, and significant differences were found between the mediastinitis and sternal dehiscence groups regarding diabetes mellitus, a history of preoperative chronic kidney disease, myocardial infarction and arrhythmias before cardiac surgery, reoperation due to postoperative bleeding, the number of patients transferred to the ICU with the sternum left open, postoperative pulmonary complications, and postoperative arrhythmias.

Limitations

Incomplete file information and death during or early (within 48 h) after surgery can be considered the salient limitations of the present study.

REFERENCES

1. Oakley E, Wright J. Postoperative mediastinitis: classification and management. Ann Thorac Surg. 1996; 61:1030-6.
2. Malani P, Dyke D, Pagani F, Armstrong W, Chenoweth C. Successful treatment of vancomycin resistant enterococcus faeciummediastinitis associated with left ventricular assist device. Ann Thorac Surg. 2003;76:1719-21
3. Tavolacci M, Merle V, Josset V, Bouchart F, Litzler P, Tabley A. Mediastinitis after coronary artery bypass graft surgery: influence of the mammary grafting for diabetic patients. J Hosp Infect. 2003;55:21-5
4. Rissner I, Ueland T, Aukrust P, Lundbladt R. Complement activation and cytokine and chemokines release during mediastinitis. Ann Thorac Surg. 2003; 75:981-5.
5. Bitkover C, Cederlund K, Aberg B, Vaage J. Computed tomography of the sternum and mediastinum after median sternotomy. Ann Thorac Surg. 1999;68:858-63
6. Claudius Diez, Daniel Koch, Oliver Kuss, Rolf-Edgar Silber,Ivar Friedrich and JochenBoergermann.Risk factors for mediastinitis after cardiac surgery-a retrospective analysis of 1700 patient,Journal of cardiothoracic surgery 2007, 2:23
7. Guillermo Careaga Reyna, Georgina G. Aguirre Baca, Luz E. Medina Concebida, Gabriela BorrayoSánchez,- Guillermo Prado Villegas, and Rubén ArgüeroSánchez.Risk Factors for Mediastinitis and Sternal Dehiscence After Cardiac Surgery,RevEspCardiol. 2006;59(2):130-5
8. Bitkover C, Gardlund B. Mediastinitis after cardiovascular operations: a case-control study of risk factors. Ann Thorac Surg. 1998;65:36-40
9. Combes A, Trouillet J, Baudot J, Mokhtari M, Chastre J, Gibert C. Is it possible to cure mediastinitis in patients with major postcardiac surgery complications? Ann Thorac Surg. 2001; 72: 1592-7
10. Aghdaii, N., Ziyaeifard, M., Faritus, S.Z., Azarfarin, R.Hemodynamic responses to two different anesthesia regimens in compromised left ventricular function patients undergoing coronary artery bypass

graft surgery: Etomidate-midazolam versus propofol-ketamine. Anesthesiology and Pain MedicineVolume 5, Issue 3, 22 June 2015, Article number e27966, 6p

11. Ziyaeifard, M.a, Alizadehasl, A.a, Aghdaii, N.a, Sadeghi, A.aEmail Author, Azarfarin, R.a, Masoumi, G.b, Golbargian, G.a Heparinized and saline solutions in the maintenance of arterial and central venous catheters after cardiac surgery.Anesthesiology and Pain MedicineVolume 5, Issue 4, 1 August 2015, Article number e23963, 5p

12. de Feo M, de Santo L, Romano G, Renzulli A, della Corte A, Utili R, et al. Treatment of recurrent staphylococcal mediastinitis: still a controversial issue. Ann Thorac Surg. 2003;75:538-42

13. Rissnes I, Abdelnoor M, Baksaas S, Lundblad R, Svennevig J. Sternal wound infections in patients undergoing open heart surgery: randomized study comparing intracutaneous and transcutaneous suture techniques. Ann Thorac Surg. 2001; 72:1589-91.

14. The Parisian Mediastinitis Study Group. Risk factors for deep sternal wound infection after sternotomy: a prospective, multicenter study. J ThoracCardiovasc Surg. 1996;111:1200-7

15. Fabiana dos Santos Oliveira, LetíciaDelfino Oliveira de Freitas, EneidaRejaneRabelo-Silva, Laura Maggi da Costa, Renato AbdalaKaramKalil, Maria Antonieta Pereira de Moraes.Predictors of Mediastinitis Risk after Coronary Artery Bypass Surgery: Applicability of Score in 1.322 Cases.Arq Bras Cardiol. 2017; 109(3):207-212

16. João Carlos GUARAGNA1, Luciane Maria FACCHI2 , Carolina Guerra BAIÃO3, Ivana Beatrice Mânica da CRUZ4, Luiz Carlos BODANESE5, Luciano ALBUQUERQUE6, João Batista PETRACCO7, Marco Antônio GOLDANI8.Predictors of mediastinitis after cardiac surgery.Rev Bras Cir Cardiovasc 2004; 19(2): 165-170

17. Sampaio DT, Alves JCR, Silva AF, Lobo Jr NC, Simões D, Faria W, et al. Mediastinitis after cardiac surgery: treatment using omental flap. Braz J Cardiovasc Surg. 2000; 15(1):23-31.doi: http://dx.doi.org/10.1590/S0102-76382000000100004.

18. Faritous Z, Aghdaie N, Yazdanian F, Azarfarin, R, Dabbagh A. Perioperative risk factors for prolonged mechanical ventilation and tracheostomy in women undergoing coronary artery bypass graft with cardiopulmonary bypass. Saudi Journal of Anaesthesia 2011 5(2), pp. 167-169.

19. Paolo Cotogni, Cristina Barbero, Mauro Rinaldi,Deep sternal wound infection after cardiac surgery:Evidences and controversies, World J Crit Care Med 2015 November 4; 4(4): 265-273