Crit Care Shock (2022) 25:103-108

Delayed sternal closure: Lifesaving procedure in coronary artery bypass grafting

Prieta Adriane[1], Ardiyan[1], Rudyanto Sedono[1]

Abstract

Delaying sternal closure in cardiac surgery is one of the life-saving decisions for patients in an intraoperative life-threatening condition with no access to extracorporeal membrane oxygenation (ECMO) therapy. Apart from the perioperative period, delayed sternal closure carries the risk of severe postoperative complications. Postoperative care is a difficult challenge faced by intensivists in the intensive care unit (ICU) and requires good cooperation with the various units involved. We report a case of delayed sternal closure during coronary heart bypass surgery in a 59-year-old woman who had intraoperative problems and failed intra-aortic balloon pump (IABP) insertion. The patient was treated for 18 days in the ICU and 5 days in the intermediate ward before discharge from the hospital.

Key words: Delayed sternal closure, coronary artery bypass grafting, postoperative complications.

Introduction

Delaying sternal closure (DSC) in cardiac surgery is an effective procedure in the management of patients with post-cardiotomy instability and mediastinal edema, with an incidence ranging only from 1.2-4.2% in the adult surgical literature due to severe postoperative complications. (1) We report a case of delayed sternal closure during coronary heart bypass surgery in a 59-year-old woman who had intraoperative problems and failed intra-aortic balloon pump (IABP) insertion.

Case report

A 59-year-old female patient, weight 57 kg, height 150 cm, with a history of hypertension, uncontrolled type 2 diabetes mellitus, two episodes of non-ST elevation myocardial infarction (NSTEMI), underwent urgent coronary artery bypass grafting (CABG) surgery. The patient was admitted from the emergency department due to severe angina and treated in the cardiac intensive care unit for five days before the surgery. On the day of surgery, her initial progress was uneventful from induction of anesthesia to initiation of cardiopulmonary bypass (CPB) machine. During CPB weaning, the surgeon encountered graft failure that worsened cardiac contractions leading to hemodynamic instability. CPB was reinitiated to repair the vascular graft. However, after the second CPB weaning trial, cardiac contractions did not improve, and the surgeon decided to insert an intra-aortic balloon pump (IABP). But after two IABP installation attempts were failed, then the procedure was canceled. The patient's heart was increasingly edematous with unstable hemodynamics and uncontrollable bleeding which worsened when the sternum was positioned for closure. Then it was decided to delay primary sternal closure, drainage tubes were placed, and the open chest wall was covered with a sterile dressing which was sutured to the open chest wound with 2-layered transparent dressings. The patient was discharged from the operating room with an unstable hemodynamic condition, low mean arterial pres-

[1] Universitas Indonesia - Cipto Mangunkusumo General Hospital Jakarta, Indonesia, National Cardiovascular Center Harapan Kita, Jakarta, Indonesia

Address for correspondence:
Prieta Adriane
Department of Perioperative Intensive Cardiac Surgery and Anesthesia, National Cardiovascular Center Harapan Kita
Jl. Letjen S. Parman Kav. 87, Jakarta, Indonesia
Tel: +6285220040006
Email: prietaadriane@gmail.com

sure, high doses of inotropic and vasopressors, severe acidosis, and hyperlactatemia, then admitted to the intensive care unit (ICU).

In the ICU, the patient was sedated and paralyzed with midazolam and vecuronium drip, and analgesia was achieved using morphine infusion. Prophylactic antibiotic, cefazolin 1 gram/8 hours, was given and then changed on the second postoperative day based on the procalcitonin result. Blood and sputum cultures were performed. According to the culture results, additional antifungal and antibiotics were added to the regimen.

While monitoring the intrathoracic drainage production, transfusion of blood components, and weaning of inotropic and vasopressor support was carried out carefully. Diuresis was maintained with furosemide infusion for a daily negative balance. On day 4 in the ICU, the patient showed cardiac rhythm of atrial fibrillation, and transthoracic echocardiography documented impaired cardiac contraction due to clots in several places. Debridement was done in the operating room, but when the surgeon tried to close the sternum, the patient became bradycardic and hypotensive. Then, it was decided to keep delaying the sternal closure and performed bridging using a sterile syringe to support the sternum.

Four days afterward, the patient's condition stabilized, with minimal supportive agents, drainage production, and bleeding. Lactate serum level was decreased significantly from the first postoperative days (**Figure 1**). Primary sternal closure was planned in the operating room on day 8 and was successfully performed without any significant problems. The patient was readmitted to the ICU.

A paralytic agent was stopped to observe the patient's response when awake. When she woke up, she was restless and unstable, and the intensivist consulted a neurologist under suspected cerebrovascular complications. Neuroprotective agents were introduced along with liberation bundles to improve the patient’s neurological condition. Mechanical ventilation was weaned carefully according to the patient’s improvement. Physiotherapy gradually began to be given more actively. Since day 12, the patient was trained to breathe spontaneously, alternating with ventilator support, and accompanied by active physiotherapy. On day 15 the patient was successfully extubated, with adequate spontaneous breathing.

Three days after extubation, the patient was transferred to the surgical intermediate room. During treatment in the intermediate room, the patient's condition was stable, we were able to decrease drugs doses. Renal function improved, food intake began to increase, sepsis improved, and no fever. On the fifth day after discharge from the ICU, the patient was discharged from the hospital to continue therapy on an outpatient basis.

Discussion

Our case report showed successful but difficult postoperative management of DSC in CABG patients. CABG is the surgery of choice for coronary heart disease with low mortality and morbidity worldwide. Nevertheless, its complexities lead to complications during surgery or postoperatively. (2,3)

Intraoperatively, our patient encountered graft failure which led to impaired cardiac contractions, cardiac edema, failed IABP installation, and intraoperative bleeding. These problems caused unstable hemodynamics and when the surgeon tried to conduct primary sternal closure, her blood pressure dropped as the edematous heart was squeezed into its chamber, resulting in a tamponade-like condition. The surgeon decided to perform DSC, which involves open-chest management. DSC is a life-saving procedure that must be carried out immediately before the cardiac condition worsens since when the edematous heart tissue is squeezed, it causes myocardial ischemia and irreversible infarction. The decision facilitated the cardiac reaction to contract. "Failure to save", or failure to rescue which is failure to quickly identify the onset of complications so that effective treatment can be initiated, has become a highly debated topic related to surgical safety. (2)

The longer duration of open chest management (OCM) is significantly associated with an increased probability of 30-day mortality. In the study of Anderson et al in 87 patients who developed OCM, the mortality rate was higher at 6.2 days compared to 3.2 days. OCM duration of more than 6 days was directly associated with an increased risk of death up to 2.6 times higher and indicated the poor condition of the patient after the surgical outcome. The increased mortality rate was observed with the prolonged duration of OCM reflecting the severity of the patient's illness, caused by surgical injuries and poor baseline conditions. DSC for some time will increase the risk of complications, mainly infection, which will worsen the patient's condition. Therefore, it is crucial to prevent infection and close the sternum as soon as possible in patients with DSC. (4,5)

This patient underwent sternal closure on day 8 postoperatively, after achieving the following conditions before sternal closure: (4)

- Hemodynamic stability in the last 24 hours and inotropic support below 2 micrograms per minute or equivalent doses of other inotropic

drugs. The patient was at minimal vasopressor support at the time of sternal closure.

- Negative fluid balance target. On day 8 in the ICU, the patient's cumulative fluid balance was -5198 cc (**Figure 2**).
- Adequate coagulation status. Normal levels of hemoglobin, platelets, activated partial thromboplastin time (aPTT), and fibrinogen before sternal closure.
- Improvement of respiratory conditions and normal arterial blood gases. This was also accompanied by normal lactate values.

The main concern of DSC is infection since an open sternum wound exposes the chest cavity. Infection also can originate from the lungs under mechanical ventilation, causing ventilator-associated pneumonia (VAP). Infection markers were fever, leukocytosis, and increased procalcitonin. The patient was diagnosed with sepsis on day 2, adjustment from the prophylactic antibiotics with empiric antibiotics after performing sputum and blood cultures. The first culture taken on day 2 obtained from sputum isolates indicated there were positive yeast cells and Staphylococcus hominis cultures, while results from blood isolates showed there was no bacterial growth. The antibiotics given were meropenem 2 grams thrice a day intravenously and levofloxacin 750 mg once a day, and antifungal therapy. The second sputum culture taken on day 8 revealed methicillin-resistant Staphylococcus epidermidis (MRSE) bacteria culture results, and the antibiotics were adjusted to include vancomycin 1 gram twice a day, while levofloxacin was discontinued. (6,7)

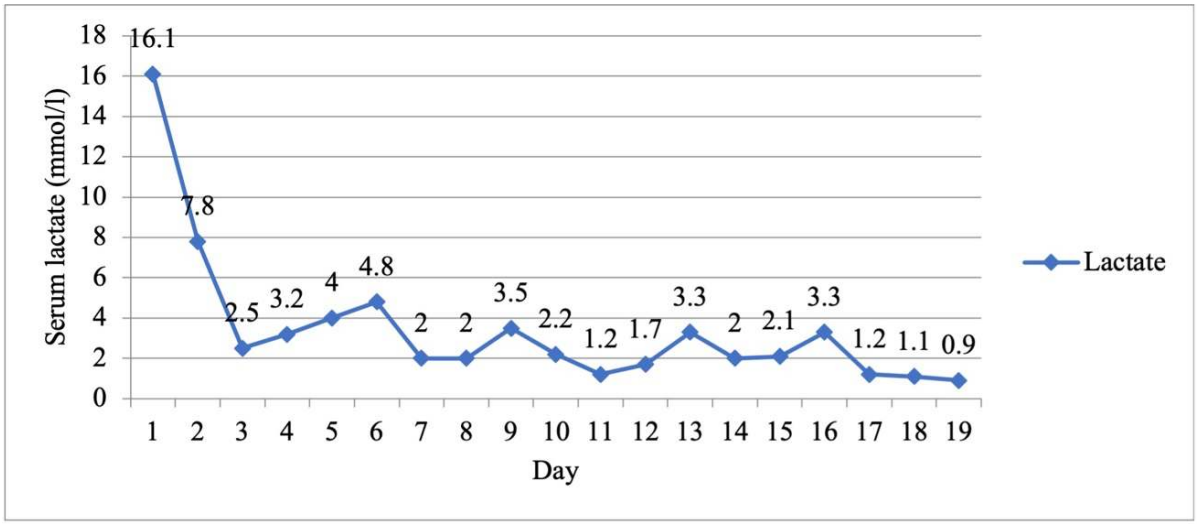
The patient's response to antibiotics was good and sepsis improved slowly. The last culture on day 13 showed a positive culture result for Acinetobacter baumanii, with resistance to multiple drugs, so we decided to continue the last regimen of antibiotics while monitoring the patient’s daily leucocytes level.

Mechanical ventilation was weaned after sternal closure. The ventilator weaning process was complicated by the presence of cerebrovascular complications. Neurologic complications are known to increase morbidity and mortality in any type of cardiac surgery, which can lead to life-long functional disabilities, mandating extensive health care, and placement in long-term care facilities. (8)

Conclusions

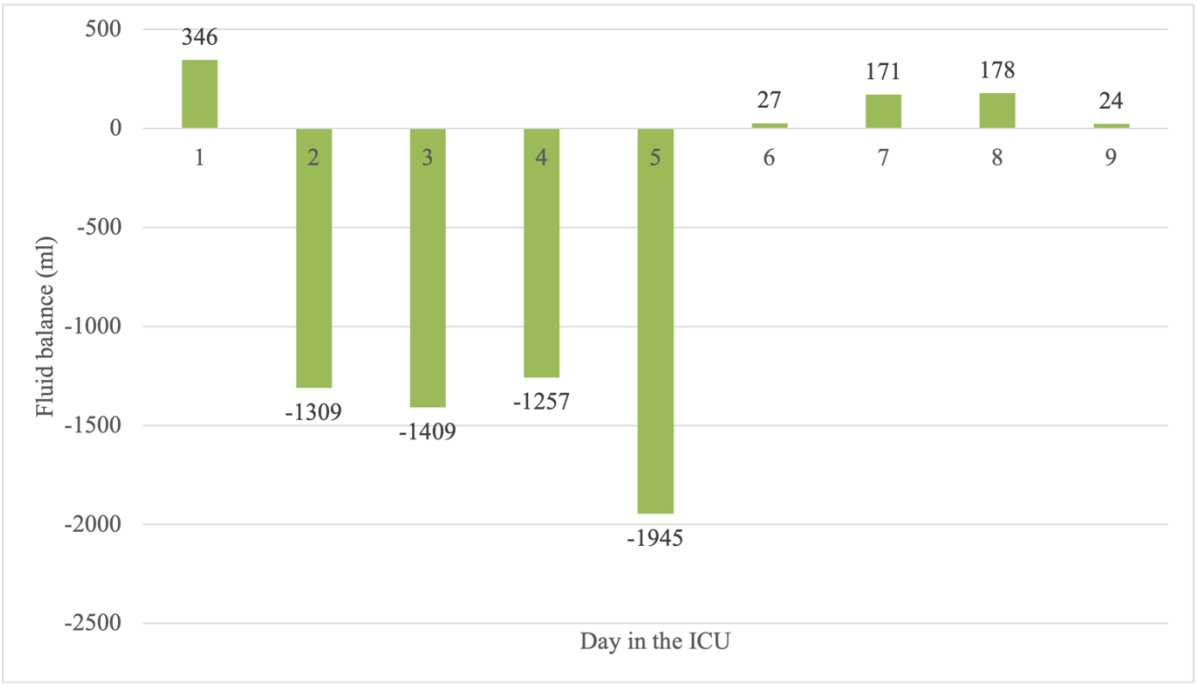
After the failure of all attempts to achieve hemodynamic stability, DSC with open chest management is one of many lifesaving procedures. Despite severe complications which accompanied DSC, a good consideration for DSC with open chest management still has a good prognosis for the patient.

Figure 1. Daily serum lactate values in the ICU



Legend: ICU=intensive care unit.

Figure 2. Daily fluid balance in the ICU before sternal closure



Legend: ICU=intensive care unit.

References

1. Saadat S, Schultheis M, Romero J, Azzolini A, Odroniec K, Dombrovskiy V, et al. Delayed sternal closure in cardiac surgery. J Clin Exp Cardiolog 2015;6:375.
2. Bellandi T, Tartaglia R, Forni S, D'Arienzo S, Tulli G. Adverse events in cardiac surgery, a mixed methods retrospective study in an Italian teaching hospital. J Eval Clin Pract 2017;23:839-47.
3. Dos Santos CA, de Oliveira MAB, Brandi AC, Botelho PHH, de Cassia Menin Brandi J, Dos Santos MA, et al. Risk factors for mortality of patients undergoing coronary artery bypass graft surgery. Rev Bras Cir Cardiovasc 2014;29:513-20.
4. Nadarjah NK, Mohd Arif MN, Hamzah MK. Delayed sternal closure in cardiac surgery. SAS J Surg 2018;4:308-14.
5. Wong JK, Joshi DJ, Melvin AL, Aquina CT, Archibald WJ, Lidder AK, et al. Early and late outcomes with prolonged open chest management after cardiac surgery. J Thorac Cardiovasc Surg 2017;154:915-24.
6. Boeken U, Feindt P, Schurr P, Assmann A, Akhyari P, Lichtenberg A. Delayed sternal closure (DSC) after cardiac surgery: outcome and prognostic markers. J Card Surg 2011;26:22-7.
7. Eckardt JL, Wanek MR, Udeh CI, Neuner EA, Fraser TG, Attia T, et al. Evaluation of prophylactic antibiotic use for delayed sternal closure after cardiothoracic operation. Ann Thorac Surg 2018;105:1365-9.
8. Nearman H, Klick JC, Eisenberg P, Pesa N. Perioperative complications of cardiac surgery and postoperative care. Crit Care Clin 2014;30:527-55.

This page is intentionally left blank