Received: 19 September 2023 | Accepted: 19 March 2024

DOI: 10.1002/ams2.946

ACUTE MEDICINE & SURGERY WILEY

CASE REPORT

Coronary computed tomography–angiography for traumatic coronary artery transection

Kenta Nagashima[1] | **Tomohiro Hayashida**[2] | **Eiji Yamada**[3] | **Naoki Ishibashi**[1] | **Naoki Mimura**[4] | **Nobuhiro Kashitani**[1]

[1]Emergency Medical Center, Fukuyama City Hospital, Fukuyama, Japan

[2]Department of Cardiovascular Surgery, Fukuyama City Hospital, Fukuyama, Japan

[3]Department of Thoracic Surgery, Fukuyama City Hospital, Fukuyama, Japan

[4]Division of Medical Technology, Department of Radiology, Fukuyama City Hospital, Fukuyama, Japan

Correspondence
Kenta Nagashima, Emergency Medical Center, Fukuyama City Hospital, 5-23-1 Zao-cho, Fukuyama 721-8511, Japan.
Email: k.nagashima0704@gmail.com

Abstract

Background: Penetrating thoracic trauma with coronary artery transection is a lethal injury, but is rare. We report a case of a cardiac stab wound with coronary artery transection that was successfully treated after preoperative diagnosis.

Case Presentation: A 36-year-old man was transferred to our emergency department with a left chest stab wound. A coronary computed tomography-angiography scan, including coronary angiography, revealed left hemopneumothorax and left anterior descending branch transection, with ischemic changes in the left ventricular myocardium. Given the diagnosis of coronary artery transection and the absence of injury to the surrounding arteries, we were able to perform coronary artery bypass surgery using the left internal thoracic artery. The patient's postoperative course was good, and he was discharged on foot without major complications 18 days after surgery.

Conclusion: Unless a resuscitative thoracotomy is required, a preoperative computed tomography scan, including coronary angiography, may be useful for accurate preoperative diagnosis for patients at high risk of myocardial or coronary artery injury.

KEYWORDS

cardiac stab wound, complex cardiac injury, coronary artery transection, coronary computed tomography–angiography, penetrating thoracic trauma

INTRODUCTION

Penetrating cardiac trauma is a lethal injury, with only 25–50% of victims surviving long enough to reach hospital, according to a review of medical examiners.[1] Cardiac injuries are classified as simple myocardial injuries or complex injuries that contain major wounds or coronary artery injuries.[2] In some cases of chest-penetrating trauma, as well as cardiac injuries, other vital organs are damaged, such as the aorta, lungs, esophagus, and abdominal organs.[3] Multiple thoracic trauma involving injury to the coronary artery, as in the present case, is rare globally, and there are few reports of successful treatment.[4–6] We present a case of life-threatening penetrating chest trauma with myocardial injury, the complete transection of two coronary arteries, and lung injury, which were correctly diagnosed before surgery.

CASE PRESENTATION

A 36-year-old man suffering from schizophrenia stabbed himself in the left chest with a kitchen knife and was transported to our emergency department. The knife had been removed from the chest before his arrival at the emergency department. His vital signs upon arrival were Glasgow Coma Scale score, 12 (E3V3M6); blood pressure (BP), 99/79 mmHg; heart rate (HR), 102 beats per minute; and oxygen saturation, 96% with oxygen administered at 6 L per minute. There was a

skin wound of 3 cm just inside the left nipple and the bleeding had been stopped. A focused assessment with sonography for trauma (FAST) and chest X-ray examinations showed a small amount of pericardial effusion and left hemopneumothorax. Although we started fluid resuscitation with acetate Ringer's fluid and administered 2 g of tranexamic acid intravenously, the patient went into cardiac arrest at 14 min after arrival. We began advanced cardiovascular life support, including chest compression, tracheal intubation, and mechanical ventilation, and added volume resuscitation with blood transfusion. A chest drainage tube of 28 Fr. was inserted into the left side of the chest, and 1700 mL of blood was drained with the chest tube. The return of spontaneous circulation (ROSC) was achieved in one cycle of cardiopulmonary resuscitation with these procedures. Because the patient's hemodynamic state to fluid resuscitation was a responder and continued to be stable, we performed a computed tomography (CT) scan. We started the scan at 39 min after ROSC, when his BP was 121/91 mmHg and HR was 101 beats per minute. A focused assessment with CT for trauma (FACT) of a plain scan preceded by contrast CT revealed that the damage had reached the heart, so we decided to add coronary computed tomography–angiography (coronary CTA) with muscle relaxant and without rate control drugs. We diagnosed left anterior descending artery (LAD) transections with ischemic change (poor contrast in the endocardium) in the left ventricular myocardium, pericardial effusion, and left hemopneumothorax (Figure 1). Blood tests showed no elevation of cardiac markers, but ST-segment depression was observed with the II, III, and aVF leads on electrocardiography (ECG). Cardiac tamponade was deteriorating before surgery and the patient underwent an immediate thoracotomy (Figure 2). The approach of the thoracotomy was median sternotomy and the operative findings were a myocardial stab wound of 4 cm in the left ventricle myocardium (which did not reach the ventricular cavity), complete transections of the coronary artery at left anterior descending artery (LAD) #7 and the diagonal branch, and a stab wound in the left lung (segment 3; Figure 3). Myocardial suturing of the left ventricle stab wound with pledgets and off-pump coronary artery bypass grafting (CABG/left internal thoracic artery to LAD [LITA–LAD]) were performed. The diagonal branch was too small to bypass. A partial lung resection of segment 3 was performed after cardiac surgery. The patient's postoperative course was good. The tracheal intubation tube was removed 2 days after surgery. Follow-up cardiac sonography 7 days after surgery showed hypokinetic wall motion at the anterior lateral segment, but the left ventricle ejection fraction with Simpson's method was good, at 63.7%. Coronary CTA 10 days after surgery showed good flow at the graft vessel

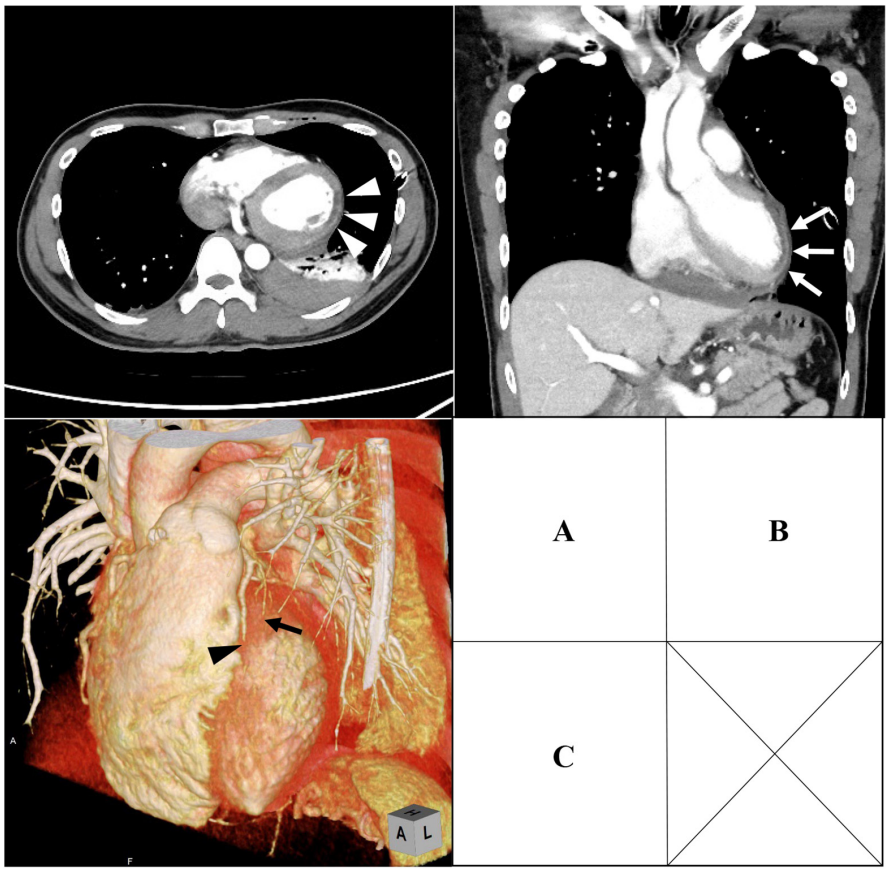

FIGURE 1 Preoperative computed tomography images. (A) Axial view of the chest. Arrowheads indicate poor contrast of the endocardium at the left ventricle myocardium. (B) Coronal view of the chest. Arrows indicate poor contrast of the endocardium at the left ventricle myocardium. (C) 3D image of the heart. The LAD #7 (arrowhead) and diagonal branch (arrow) have been transected. LAD, left anterior descending artery.

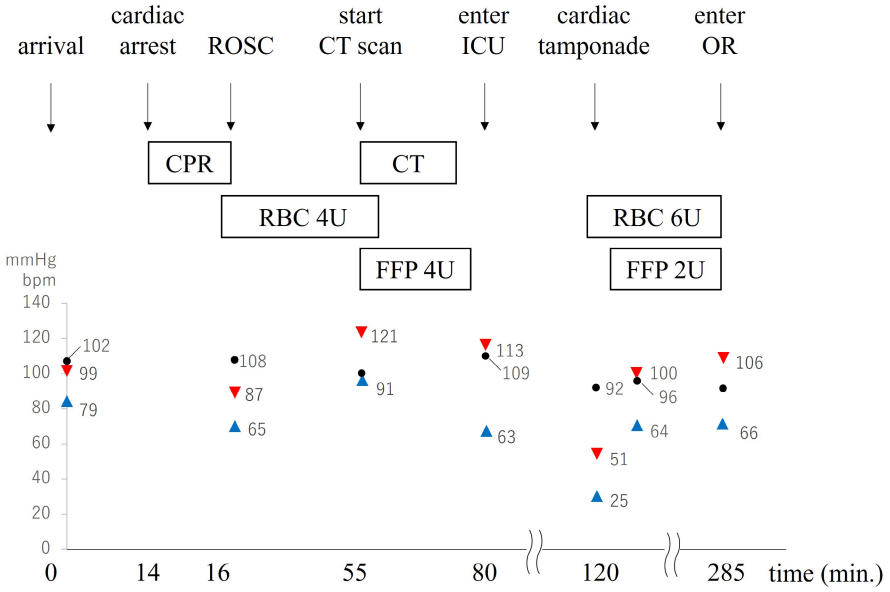

FIGURE 2 Time course. Red inverted triangle: systolic blood pressure (mmHg). Blue triangle: diastolic blood pressure (mmHg). Black circle: heart rate (bpm). CT, computed tomography; FFP, fresh frozen plasma; ICU, intensive care unit; OR, operation room; RBC, red blood cells; ROSC, return of spontaneous circulation; U, Japanese units.

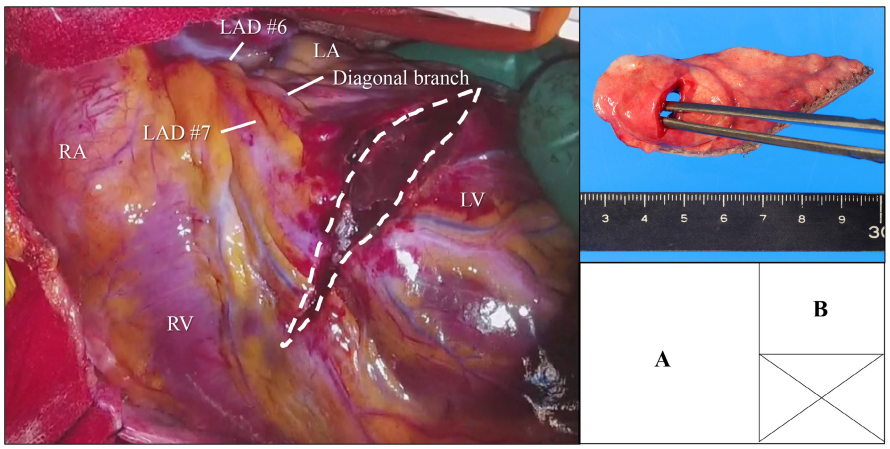

FIGURE 3 Operative findings. (A) Stab wound at the left ventricle (dashed line). The LAD #7 and the diagonal branch have been disrupted. (B) The excised left lung (segment 3) shows a penetrating stab wound. LA, left atrium; LAD, left anterior descending artery; LV, left ventricle; RA, right atrium; RV, right ventricle.

and no abnormal findings in the sutured region. At 18 days after the surgery, the patient was discharged on foot with no major complications. The total amount of blood infused was 14 Japanese units of red blood cells, 8 of fresh frozen plasma, and 10 of platelet concentrate.

DISCUSSION

Penetrating chest trauma, including coronary artery injury, is rare in Japan.[4,5] Consequently, doctors in Japan have little experience of treating severe penetrating cardiac injuries, even if having worked for a long period in an emergency department. However, if a stab wound is in Sauer's danger zone, as in the present case, cardiac injury should be assumed.[7] A war trauma report showed that 5.4% of patients with penetrating chest trauma have cardiac injuries, and 3.7% of patients with penetrating chest trauma have both cardiac and lung injuries.[3]

In the present case, we were able to diagnose the coronary artery transections before surgery. Unless a resuscitative thoracotomy is required, preoperative coronary CTA is useful for the following reasons. First, coronary CT angiography can diagnose coronary artery injury reliably, which can indicate whether CABG is necessary in addition to myocardial repair. Second, information on coronary and surrounding arteries assists in selection of the graft vessel. Because the CT showed that the LITA could be used in the present case, median sternotomy was started directly without laparotomy or femoral incision to prepare for graft vessels. Finally, contrast

CT scan can confirm the presence of damage at other sites. Coronary CTA is not usually performed in CT scans for trauma, even trauma in the chest. However, coronary CTA could be recommended for patients at high risk of myocardial or coronary artery injury if their hemodynamic state is stable and the modality is appropriate for the situation. The additional time required for CTA is several minutes. In the ECG synchronization technique of CT, especially retrospective ECG gating, breath-holding and the complete cessation of body movement are important, and a lower heart rate will ensure a more stable image. Drugs that promote bradycardia cannot be used in cases of traumatic shock. However, agent-induced bradycardia is unnecessary if the segmental reconstruction method (multicycle half reconstruction) is used to improve the temporal sensitivity profile. When employing the segment reconstruction method, images are created using identical heartbeat phase data from multiple heartbeats during the CT scan (Figure 4). Breath-holding and the complete cessation of body movement are important when employing the technique.[8] The administration of muscle relaxants with intubation before a CT scan to ensure breath-holding and to stop body movement completely may be one option to ensure clear images. In fact, we were able to accurately reconstruct the coronary artery injury with muscle relaxants and intubation. We used no agent to induce bradycardia in this patient.

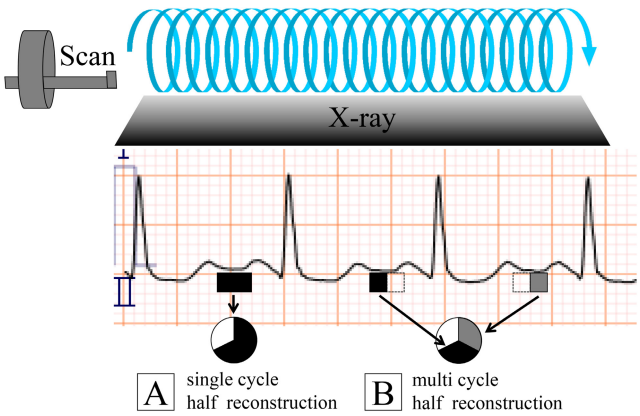

FIGURE 4 ECG gated retrospective image reconstruction. In retrospective ECG gating, X-ray data are acquired throughout the entire cardiac cycle, and only data acquired during the cardiac phase with the least motion are used for image reconstruction. The protocol for CT scanning and contrast agent is as follows. (1) Whole-body plane CT. (2) Arterial phase scans and coronary angiography scans using the ECG synchronization technique were performed from the chest to the pelvis. We administered 80 mL of iodine contrast agent at 3.5 mL/s, followed by an additional 20 mL of normal saline solution. The rotation time of the X-ray tube was 0.275 sec./rot., the detector collimation was 160 × 0.5 mm, and the helical pitch was 20. (3) Portal venous phase imaging was performed from the chest to the pelvis. (4) Equilibrium phase imaging was performed from the chest to the pelvis. (A) Single-cycle half-reconstruction. The temporal sensitivity profile of reconstruction depends on the rotation time of the X-ray bulb and is therefore not suitable for tachycardia cases in which the heart is at rest for a very short time. (B) Multi-cycle half-reconstruction (segment reconstruction). The segment data used to reconstruct the image are obtained from multiple heartbeats to improve the temporal sensitivity profile. This approach is suitable for tachycardia cases for which a still image cannot be obtained by single-cycle half-reconstruction. Since the image reconstruction is undertaken by combining short segment data, even the slightest body or breath motion can cause blurring of the image. The CT scanner was an Aquilion ONE/GENESIS Edition (Canon Medical Systems, Tochigi, Japan) and the injector was a Dual Shot GX 7 (Nemoto Kyorindo, Tokyo, Japan).

Ngatchou et al. reported that CT scans are useful in detecting pericardial fluid and abdominal injuries that cannot be detected with echography.[9] In the present case, we could not diagnose the myocardial stab wound with CT before surgery. However, the transection of the coronary arteries and myocardial subendocardial contrast failure were important findings on the CT scan, suggesting myocardial injuries. We also ensured there was no abdominal injury. These findings were valuable in selecting our treatment strategy.

There are several considerations to be made in the present case. It might have been necessary to perform resuscitative thoracotomy at the time of cardiac arrest (or just before arrest). Treatment such as pericardiocentesis or subxiphoid pericardial window for cardiac tamponade might have been performed prior to professional intervention by a cardiac surgeon. Thankfully, the patient's circulation was stabilized without such invasive interventions and we were able to diagnose a coronary artery transection by preoperative coronary CTA. We do not recommend this strategy for patients with unstable circulation, but emphasize that coronary CTA can diagnose coronary artery transection in patients with chest stab wounds. The patient in the present case experienced myocardial infarction due to the transections of two coronary arteries, but his postoperative cardiac function was good. We attribute his good clinical course to CABG and the successful revascularization of the myocardium.

CONCLUSION

We have reported a case of penetrating thoracic trauma with myocardial injury, the complete transection of two coronary arteries, and lung injury. Coronary CTA can diagnose coronary artery transection in patients with chest stab wounds before surgery. Unless a resuscitative thoracotomy is required, performing coronary CTA might be considered in patients with chest stab wounds.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflicts of interest relating to this article.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

ETHICS STATEMENT

Approval of the research protocol with approval no. and committee name: N/A.

Informed consent: Informed consent for the publication of clinical details and images was obtained from the patient and his family.
Registry and the registration no. of the study/trial: N/A.
Animal studies: N/A.

ORCID

Kenta Nagashima https://orcid.org/0000-0002-3436-2267

REFERENCES

1. Moore EE, Feliciano DV, Mattox KL. Trauma. 9th ed. New York: McGraw-Hill; 2021.
2. Hirshberg A, Mattox KL. Top knife: the art & Craft of trauma surgery. 1st ed. Shrewsbury: TFM Publishing; 2005.
3. Biocina B, Sutlic Z, Husedzinovic I, Rudez I, Ugljen R, Letica D, et al. Penetrating cardiothoracic war wounds. Eur J Cardiothorac Surg. 1997;11:399–405.
4. Kobayashi R, Namura O, Mimura S, Muraoka T. Two cases of penetrating cardiac injuries caused by stab wounds. Jpn J Cardiovasc Surg. 2021;50:368–73.
5. Tanaka H. Chest trauma: a report of 596 cases. Kyobu Geka. 1992;45(2):138–44.
6. Santavy P, Steriovsky A, Lonsky V. Delayed revascularization following complete transection of left anterior descending artery after a stab wound. Int J Surg Case Rep. 2015;6:241–3.
7. Sauer PE, Murdock CE. Immediate surgery for cardiac and great vessel wounds. Arch Surg. 1967;95:7–11.
8. Abbara S, Arbab-Zadeh A, Callister TQ, Desai MY, Mamuya W, Thomson L, et al. SCCT guidelines for performance of coronary computed tomographic angiography: a report of the Society of Cardiovascular Computed Tomography Guidelines Committee. J Cardiovasc Comput Tomogr. 2009;3(3):190–204.
9. Ngatchou W, Surdeanu I. Penetrating cardiac injuries in Belgium: 20 years of experience in university hospitals in Brussels. Acta Chir Belg. 2013;113:275–80.

How to cite this article: Nagashima K, Hayashida T, Yamada E, Ishibashi N, Mimura N, Kashitani N. Coronary computed tomography–angiography for traumatic coronary artery transection. Acute Med Surg. 2024;11:e946. https://doi.org/10.1002/ams2.946