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Critical anterior mediastinal hematoma without internal mammary artery injury caused by cardiopulmonary resuscitation: A case report^{☆☆}

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ABSTRACT

Background: Massive anterior mediastinal hematoma due to chest compression during cardiopulmonary resuscitation is often caused by internal mammary artery injury. However, critical massive anterior mediastinal hematoma without damage to major blood vessels is extremely rare. We report a case of life-threatening anterior mediastinal hematoma without internal mammary artery injury during extracorporeal cardiopulmonary resuscitation.

Case presentation: A 70-year-old man was transferred to our emergency department because of ventricular fibrillation arrest. Manual chest compressions and venous extracorporeal membrane oxygenation were applied in the angiography room. Acute myocardial infarction was diagnosed, and percutaneous coronary intervention with stent placement was performed. Despite the establishment of venous extracorporeal membrane oxygenation flow, the hemodynamics were unstable. Computed tomography revealed a massive anterior mediastinal hematoma compressing the right heart system and causing obstructive shock. Although local incision and anterior mediastinal hematoma drainage were tried for resolving obstructive shock, the patient's anemia did not improve, and there was still continuous hemorrhaging from the drainage tube. A median thoracotomy was then performed. There was no injury of the main trunk of the internal mammary artery but only hemorrhaging from the sternal fracture site. The patient's hemodynamics and anemia improved after hemostasis and gauze packing. Re-thoracotomy for gauze removal and sternal closure was performed three days post-hospitalization.

Conclusions: It is important to consider hemorrhaging and unstable hemodynamics in patients who receive extracorporeal cardiopulmonary resuscitation. Therefore, a thoracotomy may take precedence over intravascular treatment for restoring hemostasis when there is no information regarding the bleeding site, such as the presence of extravasation.

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Background

Sternal fracture and anterior mediastinal hematoma (AMH) are common complications of chest compression during cardiopulmonary resuscitation (CPR) [1,2]. Internal mammary artery (IMA) injury due to chest compression is uncommon but causes life-threatening massive AMH [3]. However, currently, there are no reports that delineate massive AMH resulting from sternal fractures without IMA injury. We report a case of life-threatening, massive AMH without IMA injury caused by chest compression during extracorporeal cardiopulmonary resuscitation (ECPR).

Case presentation

A 70-year-old man with hypertension collapsed and was transferred to our emergency department because of ventricular fibrillation (VF). Although a paramedic attempted electrical defibrillation three times during transportation, VF continued after hospital admission. Cardiopulmonary resuscitation (CPR), by manual chest compression and intravenous amiodarone 300 mg, was performed. Venous extracorporeal membrane oxygenation (VA-ECMO) was immediately applied in the angiography room. Simultaneously, additional electrical defibrillation was performed, and spontaneous circulation returned. The duration of chest compressions from prehospital bystander CPR to establishment of ECMO was 45 min. Coronary angiography confirmed 99% stenosis of the left anterior descending coronary artery (LAD) and percutaneous coronary intervention with stent placement was performed. Dual anti-platelet therapy was also administered for acute coronary syndrome. Despite the establishment of VA-ECMO flow, the patient's hemodynamics were unstable, and anemia progressed. Computed tomography (CT) revealed a massive AMH compressing the right atrium and right ventricle (Fig. 1). The patient was diagnosed with obstructive shock and transported to the resuscitation room from the CT room. Local incision and AMH drainage were performed to resolve obstructive shock. A drainage tube was placed in the anterior mediastinum, and approximately 1000 mL of the hematoma was drained. Although the patient's hemodynamics temporarily improved, there was continuous hemorrhaging from the drainage tube at about 200 mL per hour. Furthermore, the patient's anemia did not improve despite continuous blood transfusion. Thus, the patient was transported to the operating room, and a median thoracotomy was performed. Intraoperative findings revealed a sternal fracture (Fig. 2) and hemorrhage from the small vessels or periosteum of the fracture site. The main trunk of the IMA remained intact. The injured blood vessels were cauterized with an electric knife, and the hematoma was removed. This thoracotomy was completed with gauze packing and simple closure as a damage control surgery because of coagulopathy due to massive hemorrhage and VA-ECMO support. After achieving hemostasis, the patient's hemodynamics and anemia improved. Re-thoracotomy for gauze removal and sternal closure was performed three days post-hospitalization. Since the patient was out of coagulopathy, unfractionated heparin continuous administration was started to maintain optimal activated clotting time (ACT). VA-ECMO was withdrawn six days post-hospitalization, and no hematoma was observed in the anterior mediastinum on postoperative CT (Fig. 3). The patient was discharged on day 52 after receiving treatment for myocardial infarction.

Discussion

AMH without IMA injury as a complication of CPR can prove life-threatening upon applying VA-ECMO. Although rare, IMA injuries caused by chest compressions have been reported [3]. IMA injuries induce AMH and obstructive or hemorrhagic shock [4,5].

Sternum or rib fractures are often observed as complications of chest compression during CPR and cause a small amount of AMH [1,2]. However, fractures without IMA injuries are less likely to cause life-threatening AMH.

VA-ECMO for ECPR is useful for cardiogenic shock or cardiac arrest [6]. Anticoagulation during VA-ECMO is still controversial [7]. It is reported that patients with bleeding can be managed with discontinuation of anticoagulation without increased risk of early



Fig. 1. Preoperative computed tomography findings. Chest computed tomography shows a massive anterior mediastinal hematoma squeezing the right heart system (arrow).

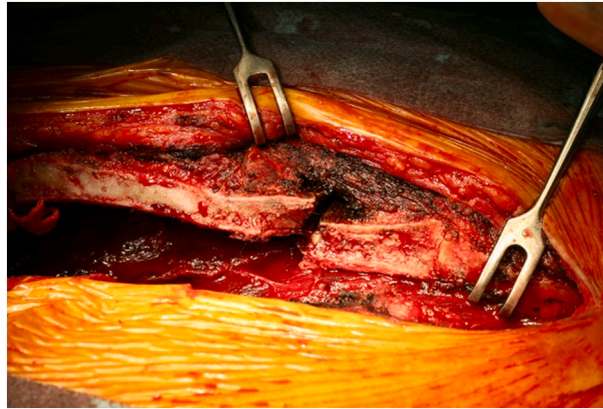


Fig. 2. Operative findings.
Sternal fracture and bleeding from the surrounding area during the operation.

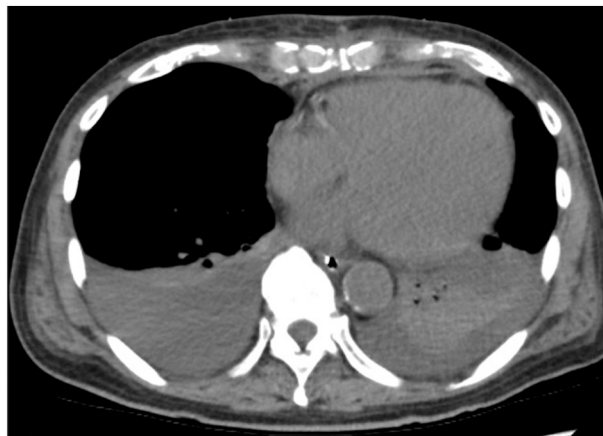


Fig. 3. Postoperative computed tomography findings.
Computed tomography shows no anterior mediastinal hematoma on postoperative day 23.

oxygenator occlusion or intravascular thrombotic events [8]. Anticoagulant therapy should not be given to patients with life-threatening hemorrhage. Coagulopathy with ECMO is a major complication leading to serious hemorrhagic events. In our case, coagulopathy due to VA-ECMO was considered to promote bleeding at the sternal fracture site, therefore anticoagulant therapy was not administered until the patient's condition stabilized. It is important that anticoagulation effects should be measured precisely, using tests such as ACT, and should be discontinued in case of coagulation abnormalities, thrombocytopenia, and bleeding [8].

CT is useful for detecting AMH, and contrast-enhanced CT can diagnose IMA injury based on contrast agent extravasation [9]. In this case, CT was performed to identify the cause of shock and massive AMH. However, contrast-enhanced CT could not be performed because of unstable hemodynamics.

Median thoracotomy and transcatheter arterial embolization (TAE) as intravascular treatments are intervention options for IMA injury [10]. TAE is less invasive than thoracotomy and is considered the first line of intervention, but TAE cannot stop bleeding in areas other than the arteries. Therefore, TAE should only be selected when enhanced CT shows extravasation, while thoracotomy is preferred when extravasation is absent on enhanced CT or enhanced CT cannot be performed. If contrast-enhanced CT had been performed in the present case, TAE could have been considered, regardless of extravasation. However, prompt thoracotomy is helpful in either case and should be the first choice when patient hemodynamics are unstable and there is insufficient time to investigate extravasation. Thoracotomy could also be more useful when there are suspicions of coagulopathy and bleeding from the fracture stump or tissues.

Conclusions

This case highlights the possibility of hemorrhaging that does not commonly occur during CPR while using ECMO. If unexplained hemodynamic instability occurs during ECMO, prompt CT and treatment intervention are required.

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Declaration of competing interest

None.

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References

- [1] J.P. Krischer, E.G. Fine, J.H. Davis, E.L. Nagel, Complications of cardiac resuscitation, *Chest* 92 (1987) 287–291.
- [2] A. Deliliga, F. Chatzinikolaou, D. Koutsoukis, I. Chrysovergis, P. Voultos, Cardiopulmonary resuscitation (CPR) complications encountered in forensic autopsy cases, *BMC Emerg. Med.* 19 (2019) 23.
- [3] K. Kim, E. Kim, D.H. Lee, Cardiac tamponade due to internal mammary artery injury after cardiopulmonary resuscitation: a case report, *Am. J. Emerg. Med.* 36 (525) (2018) e1–e2.
- [4] Z. Zeng, Y. Chen, Y. Song, F. Lin, Internal mammary artery injury during percutaneous coronary intervention: a case report, *BMC Cardiovasc. Disord.* 18 (2018) 222.
- [5] P.M. Rodgers-Fischl, G. Makdasi, S. Keshavamurthy, Extrapericardial tamponade after blunt trauma, *Ann. Thorac. Surg.* 111 (2021) e49–e50.
- [6] R. Cheng, R. Hachamovitch, M. Kittleson, J. Patel, F. Arabia, J. Moriguchi, F. Esmailian, B. Azarbal, Complications of extracorporeal membrane oxygenation for treatment of cardiogenic shock and cardiac arrest: a meta-analysis of 1,866 adult patients, *Ann. Thorac. Surg.* 97 (2014) 610–616.
- [7] K.L. Wood, B. Ayers, I. Gosev, N. Kumar, A.L. Melvin, B. Barrus, S. Prasad, Venoarterial-extracorporeal membrane oxygenation without routine systemic anticoagulation decreases adverse events, *Ann. Thorac. Surg.* 109 (2020) 1458–1466.
- [8] Y.S. Chung, D.Y. Cho, D.S. Sohn, W.S. Lee, H. Won, D.H. Lee, H. Kang, J. Hong, Is stopping heparin safe in patients on extracorporeal membrane oxygenation treatment? *ASAIO J.* 63 (2017) 32–36.
- [9] T. Braatz, S.E. Mirvis, K. Killeen, N.I. Lightman, CT diagnosis of internal mammary artery injury caused by blunt trauma, *Clin. Radiol.* 56 (2001) 120–123.
- [10] C.J. Whigham Jr., R.G. Fisher, C.J. Goodman, C.A. Dodds, C.C. Trinh, Traumatic injury of the internal mammary artery: embolization versus surgical and nonoperative management, *Emerg. Radiol.* 9 (2002) 201–207.