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CASE REPORT

Injury to a cardiopulmonary resuscitation provider by sternal wire

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Abstract

Background: Median sternotomy is a common surgical procedure during cardiac and pulmonary surgeries. There are many reports of patient injury associated with wire breakage. However, there are only a few reports of healthcare worker injuries by sternal wire.

Case Presentation: A patient in his 70s, having a history of thoracic aorta replacement, collapsed suddenly and paramedics started mechanical chest compression. On hospital arrival, the emergency department nurse attempted to initiate manual chest compression but was injured by a sternal wire protrusion on the patient's chest. The emergency physician placed gauze on the sternal wire and continued manual chest compression, but the patient died.

Conclusion: To prevent this injury, cardiopulmonary resuscitation (CPR) providers should consciously check the patient's chest. If they observe wire exposure, they should immediately place a gauze, pad or consider performing mechanical chest compression. Safety measures such as the installing rubber pads in the AED should be considered.

KEYWORDS
bone wire, cardiopulmonary resuscitation, heart massage, sternotomy, wound stab

INTRODUCTION

Median sternotomy is a common surgical procedure performed during cardiac and pulmonary surgeries. Most cardiac surgeons continue to use sternal wire cerclage for sternotomy closure due to the low rate of sternal wound complications and the low cost of wires.[1] Wires have the potential to move during handling and pressurization.[2] Many reports of patient injury are associated with wire breakage or deviation, due to which the wire penetrates the anterior mediastinum or aorta.[3,4] However, only a few reports of healthcare worker injuries caused by sternal wire movement. Here, we report a case where a sternal wire injured a CPR provider involved in manual chest compression.

CASE REPORT

A man in his 70s suddenly collapsed after breakfast. His family called emergency medical services immediately, but his initial rhythm was pulseless electrical activity when paramedics arrived. His medical history included acute aortic dissection with ascending artificial aortic replacement (underwent surgery in his 60s), hypertension, cerebral infarction, and hyperuricemia. Paramedics provided basic life support through mechanical chest compression. However, despite continuous CPR, he did not recover on arrival at the hospital. He was intubated orally by an emergency department physician. Mechanical chest compression was temporarily interrupted to obtain chest radiographs. The emergency department nurse immediately attempted to initiate manual chest compression, but felt a sharp pain in his hand. He noticed that his gloves were punctured, and his palm was bleeding. On careful observation of the patient's chest, we identified a median sternal incision scar and epidermal peeling with a sharp cut end of a sternal wire approximately 3 mm (0.12 inch) protruding into the chest hair (Figure 1A,B).

The emergency physician carried out manual chest compression after placing gauze on the sternal wire protrusion.

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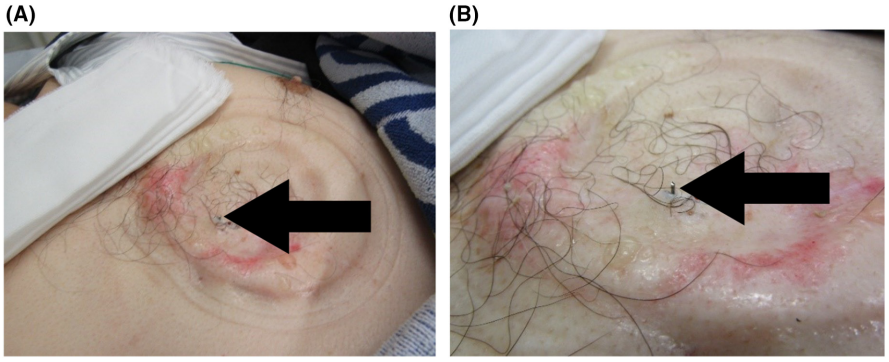

FIGURE 1 (A, B) Median sternal incision scar and epidermal peeling with a sharp cut end of a sternal approximately 3 mm (0.12 inch) protruding into the chest hair(arrow).

We diagnosed aortic rapture as the cause of the cardiopulmonary arrest (CPA), because the radiographs showed a massive haemothorax (Figure 2). The injured nurse immediately washed the wound with tap water and visited the infection control department for follow-up. Fortunately, the wound did not lead to infection and healed without complications.

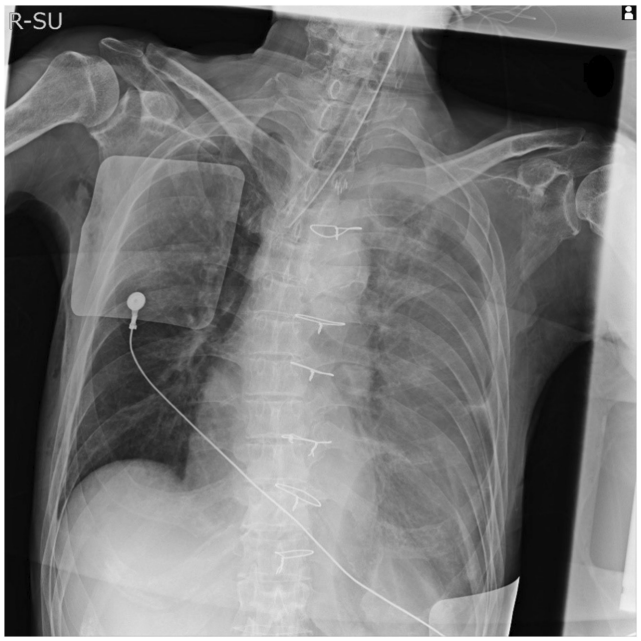

FIGURE 2 The chest radiographs show decreased permeability in the left lung and sternal wires.

DISCUSSION

Median sternotomy is the standard surgical approach for most procedures that require adequate exposure of the heart and other mediastinal structures. Multiple techniques have been proposed to reinforce the precarious sternum after median sternotomy. However, the original and best-known approach is the weaving wire closure, popularized by Robiscek et al. in 1977.[5] Although this method has been used for a long time, the probability of sternal wire fracture after surgery is not low. In clinical practice, if surgeons notice a wire sticking out of a patient's chest during a routine checkup, they cut the sharp end of the wire using pliers. However, because sternal wire fractures or unraveling wire sutures are usually clinically silent, damage to patients has been reported, including embolization of the pulmonary arteries or migration to the anterior mediastinum owing to wire breakage or deviation.[3,4]

Based on a MEDLINE via PubMed search, only three published cases appeared pertinent to the present case. The first was of a 41-year-old man with a history of coronary bypass graft surgery and mitral valve replacement. The patient underwent CPA, and CPR was performed in the cardiac care unit. A sternal wire injured a nurse who performed the chest compressions.[6] The second case was that of a 72-year-old woman who had undergone cardiac surgery 20 years ago and presented with dyspnoea and experienced arrest. A sternal wire injured the paramedic during manual chest compressions.[7] The third case was a percutaneous injury to the hands of a physician performing chest compressions in a 76-year-old patient who experienced an out-of-hospital cardiac arrest.[8]

All these cases indicate two reasons as to why the sternal wire caused injury to CPR providers. The first is the thickness of the tissue under the skin of the chest. All four patients were elderly and skinny; the foreign body under the flat tissue easily escape. In Asia, especially Southeast Asia, elderly and emaciated people may have flat tissue beneath the skin.[9] In this case reviewed retrospectively, computed tomography scans taken 1 year before the collapse day (11 years after surgery). The thickness of the tissue under the chest skin decreased (Figure 3A,B).

The second is the sternal wire itself. Structural changes in the sternal wire (or screws) or postoperative dehiscence or instability can cause wire breakage or deviation. Some reports insist that coughing leads to sternal wire breakage because coughing generates a pressure that differs substantially from ambient pressure.[10]

Combined with the stimulation during mechanical or manual chest compressions, these factors can lead to sternal wire breakage or exposure. In the present case, we performed mechanical chest compressions (before arrival at the hospital) and manual chest compressions (in the emergency department). Mechanical chest compression can cause sternal fractures, instability of the sternal wire, and peeling of

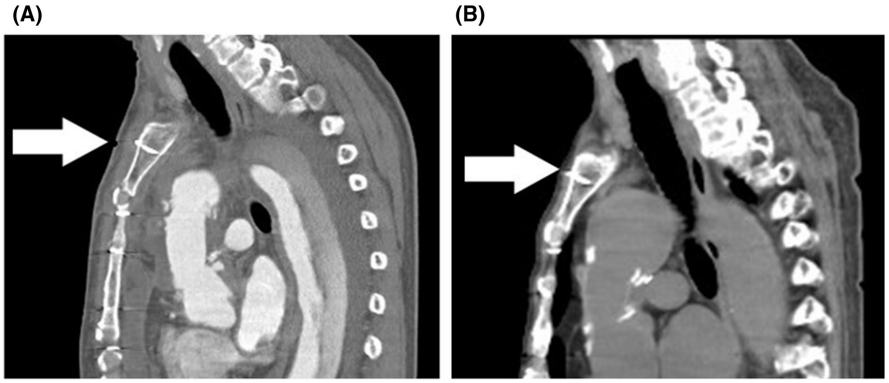

FIGURE 3 (A, B) Computed tomography scans taken 1 year before the collapse day (11 years after surgery). The thickness of the tissue under the chest skin decreased (arrow).

the patient's chest skin. Therefore, mechanical chest compression can lead to increased exposure of the sternal wire.

To prevent injuries due to exposed sternal wires, CPR providers should consciously check the median sternum and consider sternal wire exposure when the patient has an incision scar. If they observe sternal wire exposure, they should immediately place a gauze, pad, or rubber plate before manual chest compression, or consider performing mechanical chest compression. Mechanical chest compression may prevent injury to CPR providers since the rubber part of the machine used for chest compression can cover the entire portion of the exposed sternal wire.

If mechanical chest compression is initiated, it may be better to continue and check the patient's sternum. It often differs from the usual psychological situation for chest compression providers, especially for bystander citizens, and complete prevention is difficult with only attention. Safety measures such as installing rubber pads in the automated external defibrillator should be considered.

The case reported here might just be the tip of the iceberg, and many more such incidences may exist. Therefore, academic societies and other stakeholders should strive to raise awareness of the potential risk. Such initiatives and appropriate preventive measures are necessary to avoid injury to people performing the procedure.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest associated with this manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

Approval of the research protocol: N/A.
Informed Consent: Written informed consent was obtained from the patient's family for publication of this case report and accompanying images.
Registry and the Registration No. of the study/trial: N/A.
Animal studies: N/A.

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REFERENCES

1. Allen KB, Thourani VH, Naka Y, Grubb KJ, Grehan J, Patel N, et al. Randomized, multicenter trial comparing sternotomy closure with rigid plate fixation to wire cerclage. J Thorac Cardiovasc Surg. 2017;153(4):888–96.
2. Brocki BC, Thorup CB, Andreasen JJ. Precautions related to midline sternotomy in cardiac surgery: a review of mechanical stress factors leading to sternal complications. Eur J Cardiovasc Nurs. 2010;9(2):77–84.
3. Mokhtar AT, Baghaffar A, Ramer SA, Fraser JD. Migrated fractured sternal wire in proximity to the main pulmonary artery: case report and review. J Card Surg. 2020;35(3):692–5.
4. Imanaka K, Asakura T, Yamabi H. When a snapped sternal wire stabbed the aorta. Eur J Cardiothorac Surg. 2008;34(4):904.
5. Chlosta WF, Elefteriades JA. Simplified method of reinforced sternal closure. Ann Thorac Surg. 1995;60(5):1428–9.
6. Steinhoff JP, Pattavina C, Renzi R. Puncture wound during CPR from sternotomy wires: case report and discussion of periresuscitation infection risks. Heart Lung. 2001;30(2):159–60.
7. Morita S, Amino M, Aoki H, Inokuchi S. Chest compressions in "patients who have undergone cardiac surgery". Intern Med. 2014;53(6):635–6.
8. Vicario-Merino A, Gómez-Robledo ME, Cardós-Alonso C. Clinician wire puncture injury to the hand from chest compressions on a patient with a median sternotomy: a case report. J Emerg Nurs. 2022;48(3):253–6.
9. Prevalence of Underweight Among Adults. BMI <18 (age-standardized estimate) (%). https://www.who.int/data/gho/data/indicators/indicator-details/GHO/prevalence-of-underweight-among-adults-bmi-18-(age-standardized-estimate)-(–) (Accessed 6 October 2022).
10. Casha AR, Manché A, Gatt R, Duca E, Gauci M, Schembri-Wismayer P, et al. Mechanism of sternotomy dehiscence. Interact Cardiovasc Thorac Surg. 2014;19(4):617–21.

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