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Case report

Should an emergency physician be a “surgeon” in a rural area? A case of blunt cardiac rupture successfully treated by an emergency physician

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Abstract

Objective: Blunt cardiac rupture is a life-threatening injury that requires surgical repair by cardiovascular or trauma surgeons. We report a case of blunt cardiac rupture in a rural area in which emergency physicians performed emergency department thoracotomy and surgical repair to save the patient’s life.

Patient and Methods: This case involved an 18-year-old female who was injured in a traffic accident and underwent emergency thoracotomy and surgical repair.

Results: The patient’s left thorax was deformed, and sonographic assessment revealed pericardial effusion. She experienced cardiopulmonary arrest 13 min after hospital arrival. An emergency physician performed an emergency department thoracotomy. The clots were removed from the surface of the left ventricle, followed by wound compression to control bleeding from the ruptured left ventricular wall. After the recovery of spontaneous circulation, the emergency physician sutured the ruptured heart. The patient survived with good neurological function.

Conclusion: In rural areas, blunt cardiac rupture may require emergency department thoracotomy and cardiac repair by emergency physicians. The establishment of educational systems that include continuous education on trauma surgical procedures and consensus guidelines is needed to assist rural emergency physicians in performing surgical procedures.

Key words: clinical competence, health care systems, physician’s role, rural hospital, traumatic cardiac rupture

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Introduction

Injuries cause 4.4 million deaths worldwide each year, constituting nearly 8% of all deaths. Among people aged 5–29 years, three of the top five causes of death are injury-related. Injuries impose a massive burden on national economies in terms of lost productivity and the increased need for enhanced law enforcement[1].

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The establishment of a regional trauma care system is essential to reduce the mortality of injured patients[2]. This is a tiered system in which medical institutions are categorized according to their ability to provide trauma care[3]. This system needs to be well organized at all levels, from prehospital to interfacility. Although trauma systems are being built, the mortality rate of patients with severe trauma in rural areas remains higher than that in urban areas[4]. In Japan, a regional trauma care system has been built to provide timely and appropriate treatment to each victim in an appropriate medical facility[5]. However, the mortality rate of severe trauma cases, such as traumatic brain injury, was higher in rural areas than in urban areas[6]. This difference in mortality rates indicates that trauma systems are disadvantageous for patients with trauma in rural areas.

Blunt cardiac rupture (BCR) is a rare injury. Most patients with BCR lose their lives before hospital arrival and 89% die in the emergency room despite showing signs of life upon hospital arrival[7]. The treatment for patients with

BCR includes emergency department thoracotomy (EDT), relief from cardiac tamponade, and surgical repair[8]. Because rapid diagnosis and treatment are essential for BCR presenting with cardiac arrest or an unstable hemodynamic status, patients with BCR in rural areas with limited cardiac surgical capacity may not survive.

In this report, we present a case of BCR in a rural area without a cardiac surgeon.

Case Report

An 18-year-old female was injured along with four other individuals during a motor vehicle collision. The helicopter emergency medical service (HEMS) could not be used because it was a rainy night; therefore, a physician-staffed emergency vehicle was dispatched from the Miyakonojo Medical Association Hospital. Her Glasgow Coma Scale (GCS) score was E1V1M3, and her heart rate (HR) was 137 bpm. Blood pressure (BP) and oxygen saturation (SpO_2) could not be measured. Examination revealed no other trauma except a left chest deformity and no jugular vein distension. Two peripheral venous routes were established, and oral tracheal intubation was performed. The patient was in serious condition. Our hospital was close to the scene and there were four other injured patients; therefore, all patients were transported to our hospital. Upon arrival at our hospital, the emergency physician, neurosurgeon, pediatrician, and internal medicine physician were prepared. Surgeons were unavailable and required one hour to arrive.

The patient's vital signs were as follows: GCS score, E1V1M3; HR, 143 bpm; BP, 40/25 mmHg; and SpO_2, 99%. A focused assessment with sonography for trauma revealed pericardial effusion. Thirteen minutes after arrival, the patient experienced bradycardia (HR, 40 bpm), and her common carotid artery was not palpable; therefore, she was diagnosed with cardiac arrest due to cardiac tamponade (Table 1).

The emergency physician performed EDT through a left anterolateral thoracic incision. The pericardium was opened and clots were observed in the left ventricular apical region. After clot removal, the myocardium showed a contusion with pulsatile bleeding from the ruptured area (Figure 1). Hemostasis using a skin stapler failed; therefore, digital compression of the ruptured region was performed. Eight units of packed red blood cells and four units of fresh frozen plasma were administered. Return to spontaneous circulation occurred 8 min after cardiac arrest. Computed tomography performed after temporary hemostasis and stabilization of vital signs revealed left ventricular rupture, multiple left rib fractures, hemopneumothorax, and pulmonary contusion (Figure 2). The ruptured heart was sutured using a 3-0 nylon thread, a chest drain was inserted, and the chest was closed.

The patient received intensive care, including targeted temperature management. The patient showed no abnormal findings on electrocardiography or echocardiography after

Table 1 Laboratory findings on admission

	Normal range	On admission
White blood cell ($\times10^9$/L)	3.30–8.60	11.40
Hemoglobin (mmol/L)	116.00–148.00	96.00
Platelet ($\times10^9$/L)	15.8–34.8	26.6
Activated partial thromboplastin time (sec)	24.0–34.0	25.5
Prothrombin time-international normalized ratio	0.85–1.15	1.03
Fibrinogen (g/L)	2.00–4.00	2.43
Fibrin degradation products (mg/L)	<5.0	79.1
D-dimer (nmol/L)	<5.48	206.45
Blood urea nitrogen (mol/L)	2.86–7.14	4.53
Creatinine (μmol/L)	35.08–60.24	50.33
Total bilirubin (μmol/L)	6.84–25.66	5.13
Aspartate aminotransferase (μkat/L)	0.22–0.50	1.55
Alanine aminotransferase (μkat/L)	0.12–0.38	1.07
Lactate dehydrogenase (μkat/L)	2.07–3.71	3.82
Creatinine kinase (μkat/L)	0.68–2.56	0.99
C-reactive protein (mg/L)	0.00–1.40	3.80
Blood gas analysis (venous)		
pH	7.35–7.45	7.103
pCO_2 (kPa)	4.66–5.99	3.92
HCO_3- (mmol/L)	21.8–26.2	8.8
Base Excess (mmol/L)	−2.0–2.0	−19.5
Lactate (mmol/L)	0–2	18

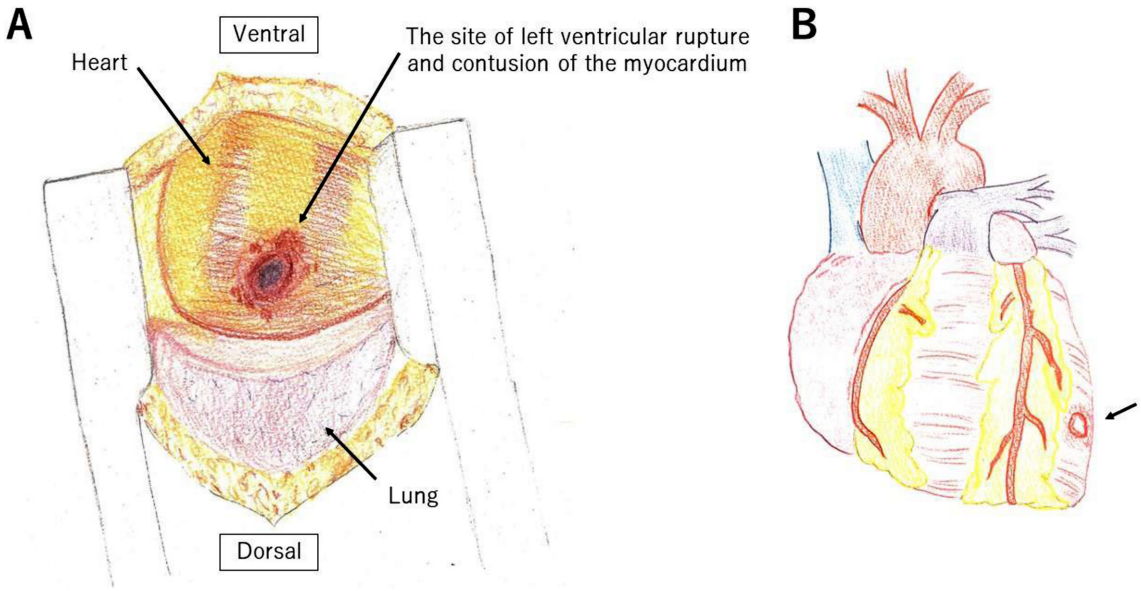

Figure 1 View of the surgical field during emergency department thoracotomy (A) and overall view of the ruptured heart (B). (A) After a clot on the surface of the left ventricle was removed, the cardiac rupture with myocardial contusion became visible. (B) The site of the cardiac rupture was located at the apex of the left ventricle (black arrow).

Figure 2 Computed tomography findings after emergency department thoracotomy performed by emergency physician.
Computed tomography findings after emergency department thoracotomy by emergency physician show left ventricular rupture (white arrowhead), left hemopneumothorax, left pulmonary contusion, and multiple left rib fractures. White arrows indicate skin staplers.

cardiac rupture repair. A tracheostomy was performed on day 16, and the patient was weaned off the ventilator on day 18. Oral intake was initiated on day 42. Due to hypoxic encephalopathy, the patient still had visual loss and attention disorders; however, she was discharged on day 134. One year and six months after the injury, the patient was an outpatient and remained healthy.

Discussion

This case involved cardiac arrest due to BCR in Miyakonojo, which has no cardiovascular surgeons and is 30 km from the trauma center (Figure 3). The emergency physician performed a surgical repair of the BCR and saved the patient's life.

EDT should be performed for blunt trauma with cardiopulmonary resuscitation for less than 10 min, persistent severe hypotension due to cardiac tamponade, hemorrhage, or air embolism[8]. This patient underwent EDT for cardiac arrest due to BCR, which relieved the cardiac tamponade, allowed temporary digital compression hemostasis for cardiac rupture, and facilitated final suturing of the heart, thereby saving her life. Although EDT is less effective for blunt trauma compared with penetrating trauma, this case demonstrates the effectiveness of prompt EDT, even for blunt trauma.

A ruptured heart is generally treated by a cardiovascular or trauma surgeon. In this case, emergency physicians performed EDT and repaired the cardiac wound because the patient's critical status precluded transport to the trauma center. The mortality rate of patients experiencing motor vehicle accidents in rural areas are higher[9]. Although the HEMS can transport critically injured patients from rural areas, its operation is limited by weather conditions. Moreover, severely ill patients who cannot tolerate transportation should be treated in rural hospitals.

Establishing a centralized trauma system, in which potentially fatal severe trauma cases are gathered at a desig-

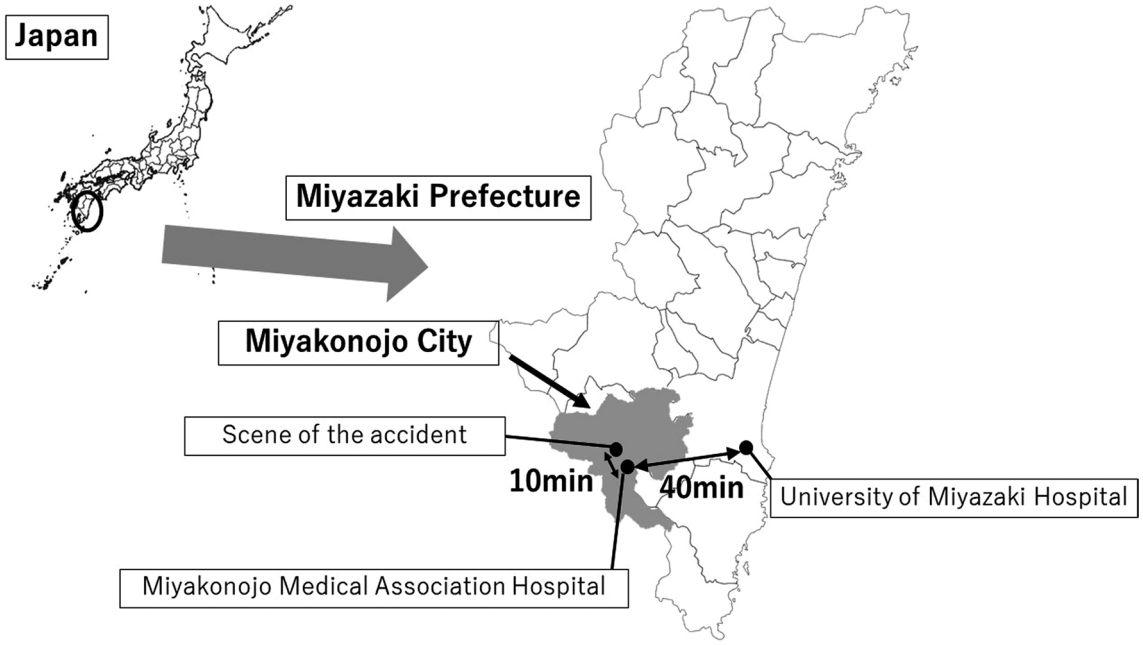

Figure 3 A map of Miyakonojo City.
Map showing Miyakonojo City, Miyazaki Prefecture, southwest Japan. Miyakonojo Medical Association Hospital is located 30 km from the University of Miyazaki Hospital, which is the only trauma center and base hospital for a helicopter emergency medical system in Miyazaki Prefecture.

nated trauma center, would be beneficial for providing and maintaining high-quality trauma care. In this case, trauma bypass of the patient directly from the scene to the University of Miyazaki Hospital, where trauma and cardiovascular surgeons are available, or a request for a physician-staffed emergency vehicle from the University of Miyazaki Hospital, may have been an option. However, these options were difficult because the cause of the near cardiac arrest was unknown at the scene to be a blunt cardiac injury, the cardiac arrest occurred early after arrival at the hospital, and the case was a multiple victim accident. Transporting the cardiac surgeon to the patient is also an option in this case; however, this would take longer preparation time and would be affected by weather and darkness. To gain more time to allow for these options, extracorporeal cardiopulmonary resuscitation (ECPR) for blunt cardiac rupture might be an option to achieve definitive surgery at the designated trauma center[10]. However, ECPR for blunt cardiac rupture is uncommon and requires expert opinion. The present case highlights the fact that a centralized trauma system does not benefit extremely emergent cases in rural areas.

In such cases, emergency physicians in rural areas are required to treat critically injured patients, posing a major challenge. In Japan, general surgery is included in the curriculum for fellowships in emergency medicine[11]; however, such training is insufficient for treating critically injured patients. The emergency physician who treated the patient in this case had limited experience with trauma surgical techniques, such as a few EDT cases and trauma surgery training using cadavers. Surgical training[12] including the use of cadaveric models, may be an effective way for emergency physicians to maintain surgical skills[13]. To enhance the quality of the trauma surgical skills of emergency physicians, educational systems need to be improved, mandating EDT training in their curriculum. In addition, there should be backup guidelines that share an understanding of when emergency physicians should perform less frequent but critical procedures to save patients' lives. These system backups would encourage rural emergency physicians who encounter a critically injured patient who cannot tolerate transport to a trauma center to perform advanced surgical procedures, even if they are "physicians".

Conclusions

Here, we present a case of successful BCR treatment in a rural area. Although establishing a centralized regional emergency system is important, transportation to advanced medical facilities may not be possible for patients experiencing BCR in rural areas. Therefore, expanding the competencies of emergency physicians in rural areas may be necessary to reduce mortality from critical trauma. To achieve this, emergency physicians in rural areas may require further training in trauma surgical procedures, including

EDTs, supported by well-established educational systems and consensus guidelines.

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