



Praca kazuistyczna

Case reports

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## Blunt cardiac rupture due to physical assault: An autopsy-based case series

### Pęknięcie serca na skutek urazu tępego w związku z napaścią fizyczną: analiza przypadków sekcyjnych

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#### Abstract

**Background:** The literature reports cases of ventricular rupture in blunt chest trauma following motor vehicle accidents. It rarely describes cardiac tamponade due to rupture of the heart following blunt thoracic trauma in a physical assault. There are rare cases where fatal cardiac tamponade results from a ruptured ventricle without externally visible injuries to the chest. It is also rare for the cardiac rupture to occur on the posterior side. In our case series, the first case involved a direct blow to the left side of the chest by a projectile (brick), causing rupture of the left ventricle's base with intact pericardium. In the second case, a direct blow to the left side of the chest led to rupture of the right ventricle's posterior wall.

**Case presentation:** Here, we report two autopsy-based case series of isolated right and left ventricular rupture with cardiac tamponade in blunt thoracic trauma with a specific history and background information of assault. The first case is a 35-year-old male assaulted with a brick thrown at his chest in a moving bus; he was declared dead on arrival after a one-hour journey. The second case is a 55-year-old male assaulted with double punches in his chest and declared dead on arrival at the hospital after 30 minutes. A medicolegal autopsy and thorough investigation, in both cases, revealed cardiac tamponade due to ventricular rupture with no underlying pathology.

**Conclusion:** This case series underlines the importance of systematic and complete cardiac examination in all death cases following blunt chest trauma even with minimal or no evidence of a visible injury to the chest. Rarely cardiac rupture is noticed on the posterior surface or apex of the heart. The case series illustrates a rare occurrence of cardiac rupture that requires apt investigation and certification of medicolegal causes of death to determine how the death was caused.

**Key words:** cardiac tamponade, ventricular rupture, blunt thoracic trauma, physical assault

## Streszczenie

**Wstęp:** W piśmiennictwie można odnaleźć przypadki pęknięcia komory serca na skutek tępego urazu klatki piersiowej spowodowanego wypadkiem samochodowym. Rzadko opisywana jest tamponada serca na skutek urazu tępego w związku napaścią fizyczną. Sporadyczne są przypadki, w których tamponada serca wynika z pęknięcia komory bez obecności zewnętrznych obrażeń na klatce piersiowej. Rzadko pęknięciu ulega tylna ściana serca. W naszej serii przypadków, pierwszy dotyczy bezpośredniego uderzenia w lewą stronę klatki piersiowej przez cegłę, co spowodowało pęknięcie podstawy lewej komory serca bez uszkodzenia worka osierdziowego. W drugim przypadku bezpośrednie uderzenie w lewą stronę klatki piersiowej doprowadziło do pęknięcia tylnej ściany prawej komory serca.

**Opis przypadku:** Prezentujemy dwa sekcyjne przypadki izolowanego pęknięcia prawej i lewej komory serca z tamponadą po tępych urazach klatki piersiowej, w których istniały informacje o napaści. Pierwszy przypadek to 35-letni mężczyzna napadnięty poprzez rzucenie cegłą w jadącym autobusie; zgon stwierdzono po przyjeździe po jednogodzinnej podróży. Drugi przypadek to 55-letni mężczyzna napadnięty poprzez dwa uderzenia w klatkę piersiową. Zgon stwierdzono po 30 minutach w szpitalu. Medyczo-sądowa sekcja zwłok i dochodzenie w obu przypadkach ujawniły tamponadę serca na skutek pęknięcia komory bez zmian chorobowych.

**Podsumowanie:** Powyższa seria przypadków podkreśla znaczenie systematycznego i pełnego badania serca we wszystkich przypadkach zgonów poprzedzonych tępym urazem klatki piersiowej nawet z widocznymi minimalnymi obrażeniami lub bez nich. Rzadko pęknięcie serca jest stwierdzane na jego tylnej powierzchni lub na koniuszku. Seria przypadków ilustruje rzadkie występowanie pęknięcia serca, które wymaga odpowiedniego postępowania i dokumentowania medyczo-sądowego, aby ustalić przyczynę zgonu.

**Słowa kluczowe:** tamponada serca, pęknięcie komory serca, tępy uraz klatki piersiowej, napaść fizyczna

## Introduction

Chest injuries can be closed/blunt/non-penetrating or open/penetrating. Closed chest traumas are usually associated with vehicle collisions and infrequently with non-penetrating assault cases. Cardiac tamponade is a rare complication of blunt thoracic trauma in which bleeding into the pericardial sac occurs from the surface or cavities of the heart or the intrapericardial segments of the roots of the great vessels. Rarely, fatal cardiac tamponade may be due to rupture of the heart with no externally visible signs of injury to the chest. When the heart is compressed against the thoracic spine, cardiac rupture usually occurs in the front of the right ventricle and rarely in the posterior aspect [1]. We describe two cases of cardiac tamponade caused by right and left ventricular disruption following an assault resulting

in blunt chest injury. One case involved a direct blow to the left side of the chest by a projectile (brick), causing rupture of the left ventricle's base with intact pericardium. In the second case, a direct blow to the left side of the chest led to rupture of the right ventricle's posterior wall.

## Circumstances and findings:

**Case 1:** A 35-year-old lean-built male was declared dead on arrival at a trauma center and witnesses reported that the deceased was sitting in the front seat of a bus placed in the driver's cabin. A brick struck him when some bikers pelted the bus with rocks and bricks for overtaking. He was initially treated at a primary health care center with chief complaints of chest tightness and abdominal dis-

comfort. On examination, his heart rate was 118 beats per minute and systolic blood pressure (SBP) was 68 mm Hg. There was noticeable tenderness on the left side of the chest as well as abdominal tenderness. The air entry was diminished on the left side and there were muffled heart sounds.

The Injury Severity Score (ISS) is an anatomical trauma score which is the sum of squares of abbreviated injury scores of the three worst anatomical regions. In this case it was 24 ( $2^2 + 2^2 + 4^2$ ) (ranges from 0–75, score >15 indicates a severe injury) [2, 3]. During an initial focused assessment with sonography in trauma, abdominal haemorrhage was detected. Transiently, the patient's blood pressure rose after fluid resuscitation, and he was transferred to a trauma unit of a specialty hospital within an hour, where he was declared dead on arrival. In accordance with the law of the land, a medicolegal autopsy was conducted on the body, which revealed a single abraded contusion of 20×10 cm on the left side of the chest, extending between the fourth and eighth ribs. An internal examination revealed undisplaced fractures from the fourth to eighth ribs of the left side. In addition, there was haemorrhage in the intercostal muscles, about 300cc of fluid blood in the left pleural cavity. The pericardium was intact and contained 200cc of fluid blood. The heart revealed cavity deep lacerations of the following sizes: 3×0.8 cm and 1×0.8 cm at the base of the left ventricle near the apical region, with a contusion in the surrounding cardiac tissue. Cardiac contusion of the size of 4×2.5 cm on the inferior surface of the heart involving the right ventricle and 3×2 cm on the right atrium. The weight of the heart was 265 gm. The valves, endocardium and myocardium were unremarkable on gross and histological examination. All three significant coronaries were patent. The abdomen contained 500cc of fluid blood from the lacerated spleen.

The police officials brought some bricks and stones for examination to conclude the possible weapon of offence. The brick found inside the bus was made of cement. The measurements of the brick were 19.5×5×4.5 cm, which corresponded with the dimension of the contusion found in the chest. [Figure 1E] [4]. The visit to the crime scene (the bus) did not reveal any other object or surface that could have probably produced such an injury.

**Case 2:** A 55-year-old male suddenly collapsed after getting punched twice in his chest during a scuffle with his fellow villager. He was shifted to the district hospital within half an hour and declared dead on arrival. According to his son, the deceased had no significant history of hypertension, diabetes mellitus, chronic kidney disease or hormonal disorder, etc. There was no external injury to the chest area [Figure 2A]. On opening the chest cavity, the pericardium was found intact with the appearance of a bluish hue. 100cc of fluidic and 120 gm of clotted blood were present in the pericardial sac [Figure 2B]. A laceration of the size of 2.5×0.8 cm was present on the posterior surface of the right ventricle [Figure 2C]. On dissection of the heart, clotted blood was found in the right ventricle's papillary muscles [Figure 2D]. Haemorrhage with normal myocardium of the right ventricle [Figure 2E]. The weight of the heart was 268 gm, coronaries patent, valves, endocardium and myocardium were normal on gross and histological examination. No external injury was noticed on the body or any other organ.

## Discussion

Teixiera et al. reviewed data from the United States National Trauma Data Bank and reported that 44% of blunt cardiac rupture (BCR) victims died on arrival at the emergency department or shortly thereafter. Furthermore, 45% of BCR patients who initially presented alive eventually died [5]. A study conducted by Kulshreshtha P et al. shows that 2.2% of blunt cardiac injury patients reach the hospital alive, compared to 17.4% of penetrating cardiac injuries, and many remain unrecognized [6]. Blunt chest trauma can determine a large spectrum of cardiac injuries ranging from asymptomatic cardiac contusions to life-threatening cardiac chamber rupture [7]. The type of cardiac injury is also dependent upon the intensity of force, area of impact, physical status of the victim and underlying pathology, if any. Fatal non-penetrating chest trauma is more common in vehicle accidents, whereas penetrating injuries are more common in assault-related cases [4, 8, 9]. Braithwaite CE et al report that the most common site of blunt cardiac rupture is the right atrium (41%), followed by the right ventricle (31%), the left atrium (25%) and the left ventricle (12%). Among

cases of cardiac rupture, left ventricle injuries followed by right ventricle injuries are more fatal than atrial or pulmonary artery injuries [5, 10-12]. H. Oizumi mentioned that the most common cause of death in patients with blunt cardiac trauma is cardiac tamponade as compared to haemothorax and the same was seen in both our cases [13]. In our first case, there was an abraded contusion of the chest overlying the 5<sup>th</sup> to 7<sup>th</sup> intercostal space along with abdominal tenderness, whereas in the second case, the absence of any external injury did not attract attention to the possibility of cardiac injury. Vougiouklakis et al. also reported the absence of such externally visible violent lesions in their case, in which a healthy 29-year-old-man died of the right atrial contusion after being involved in a fight [4].

The mechanism of blunt cardiac rupture by forces is empirically categorised as direct [1], indirect [2], bidirectional or compressive [3], decelerative [4], blast [5], concussive [6] and combined [7, 14]. In direct force, the transfer of kinetic energy during the impact on the chest with a sudden forceful deceleration of the heart may produce fatal results. Such an impact may produce distension, shearing, or rupture of the heart according to the “water hammer effect” [15, 16]. This effect is more pronounced when the chambers of the heart are full with closed valves during late diastole or early systole. If the heart is compressed during this period, the vulnerability of chambers to rupture increases because of the high pressure exerted on the walls by the blood inside the chambers [15-17].

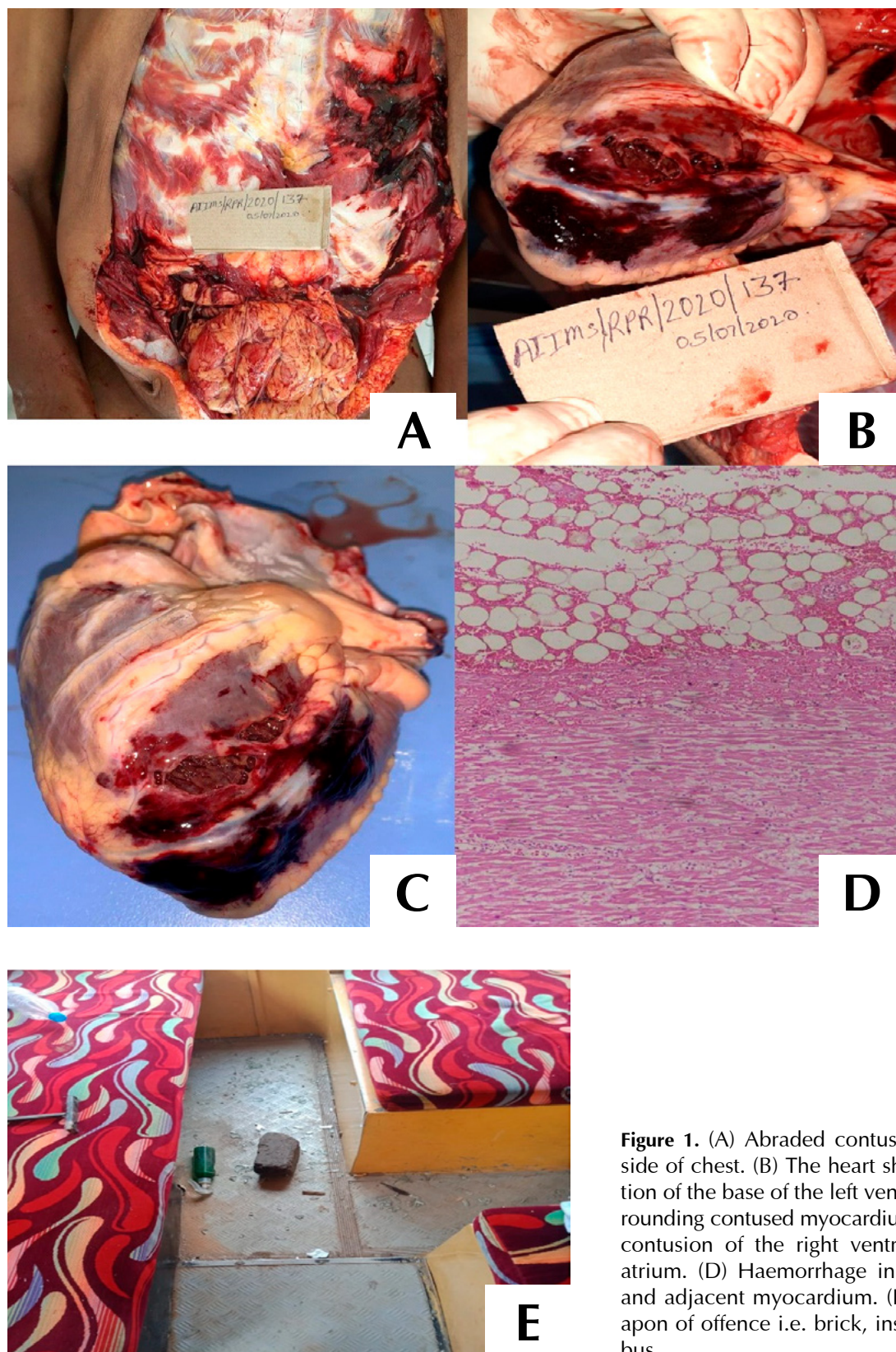
It is hypothesized that cardiac rupture in both cases is due to direct impact on the chest and most suitably, due to the water hammer effect mechanism where the force from the chest wall is transmitted to the fluidic blood-filled heart chambers, with the closed valves the force is transmitted through the fluid towards the walls, leading to the rupture. The force delivered by the brick (case 1) and two punches (case 2) was transmitted through the ribs, causing fatal rupture of the heart wall. In case 1, the intensity of the force was also increased due to the relative motion of the bus (sudden deceleration). In an

experimental model documented by Wang N et al., 6.8J energy was able to cause an extensive injury to the heart and lungs leading to the death of study animals within 30-40 minutes caused by cardiac arrhythmia and ventricular fibrillation [18]. The major portion of the anterior surface of the heart is formed by the right-sided chambers and being placed in front, they are more vulnerable to injuries produced even by trivial blunt trauma. Whereas in the second case, a series of punches in the chest led to bruising with a laceration on the posterior aspect of the right ventricle suggestive of the compression of the heart against the thoracic spine. The literature mentions that traumatic rupture of the heart usually occurs on the right side and toward its base in a healthy heart, while the left ventricle is commonly involved in a diseased heart [19]. In case 1, the rupture was in the left ventricle apical region, though the heart was healthy with no other relevant co-morbid pathology, as was confirmed on histological examination [Figure 1D]. It showed the presence of haemorrhage in epicardial fat and adjacent myocardium. The blunt impact may also cause myocardial contusions which can also lead to an outcome like myocardial infarction. In such cases of cardiac rupture after physical contact, it is of utmost importance to rule out cardiac pathology as investigative information to eliminate conditions contributing to death.

## Conclusion

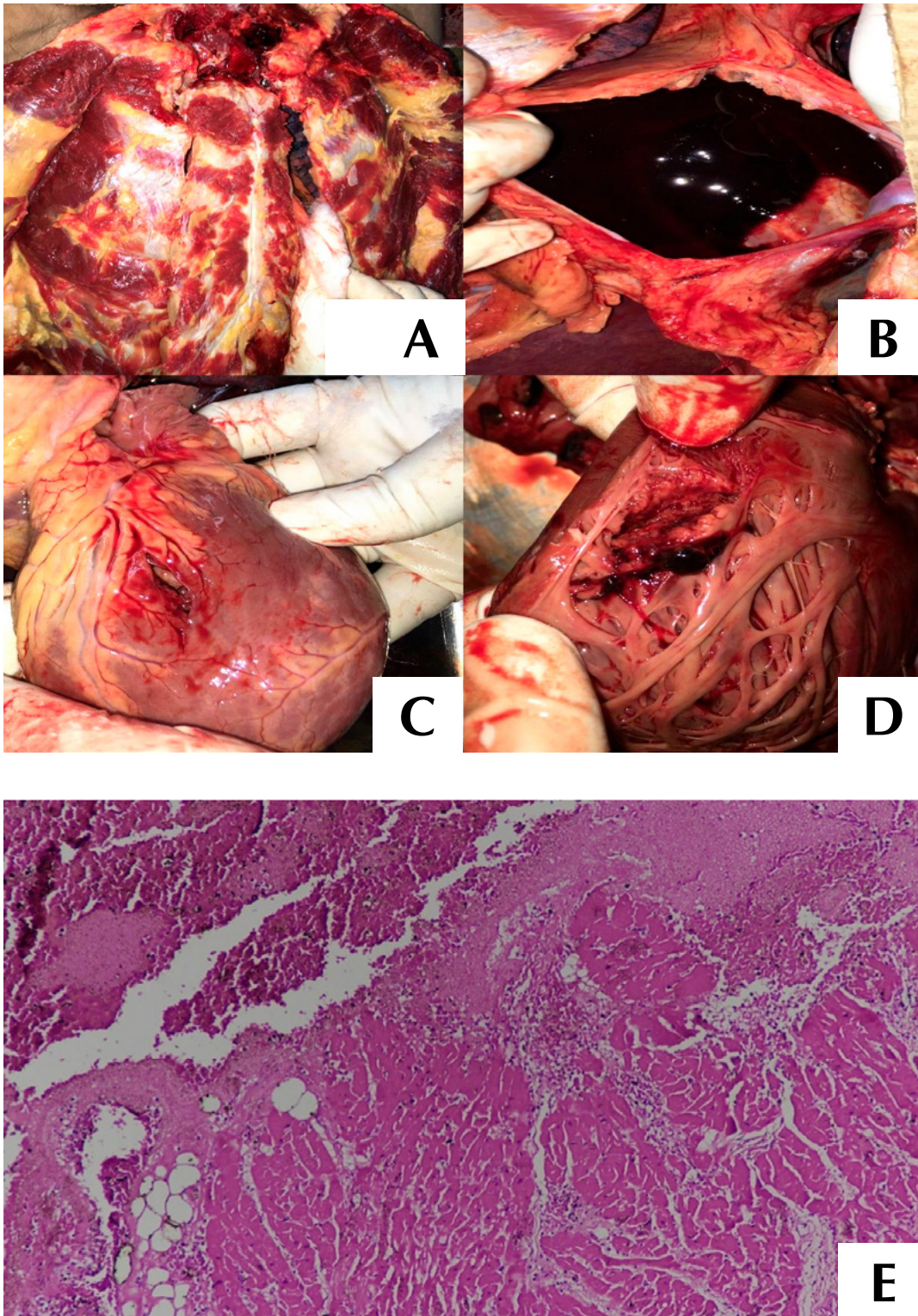
As part of a routine homicide trial, the court may give its final judgment based on several factors, including the motive, the weapons used, the type of injury, the number of injuries and damage to vital organs. With this case series, we attempt to provide investigative information in an autopsy-based cases of ventricular rupture in an apparently healthy heart with intact pericardium in fatal blunt thoracic trauma in cases of physical assault. Apt investigation and certification of the cause of death after a thorough investigation is necessary to appropriately adjudicate in such cases.





**Figure 1.** (A) Abraded contusion of the left side of chest. (B) The heart showing laceration of the base of the left ventricle with surrounding contused myocardium. (C) Cardiac contusion of the right ventricle and right atrium. (D) Haemorrhage in epicardial fat and adjacent myocardium. (E) Alleged weapon of offence i.e. brick, inside the tourist bus.





**Figure 2.** (A) No injury to the chest. (B) Haemorrhagic pericardial sac. (C) Laceration on the posterior surface of the right ventricle. (D) Clotted blood adherent to the papillary muscles of the right ventricle. (E) Showing haemorrhagic myocardium with adjacent normal myocardium.

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