

Journal of Forensic Medicine & Toxicology

Vol. 43, No. 3, July–September 2026

Fatal Cardiac Rupture Due to Blunt Trauma to the Chest – An Autopsy Based Forensic Case Series

Amit Patil¹, Metta Yaswanth Reddy^{2*}, Toshali D Wankhade³, Rahul Bhaira⁴, Dinil D Nangelil⁵¹Professor and Head of Department, Department of Forensic Medicine and Toxicology, AIIMS Patna, Patna.²Junior Resident (Academic), Department of Forensic Medicine and Toxicology, AIIMS Patna, Patna.³Associate Professor, Department of Forensic Medicine and Toxicology, AIIMS Patna, Patna.⁴Senior Resident (Non-academic), Department of Forensic Medicine and Toxicology, AIIMS Bathinda, Bathinda.⁵Junior Resident (Academic), Department of Forensic Medicine and Toxicology, AIIMS Patna, Patna.

* Corresponding author. E-mail: dryashreddyfmt@gmail.com

<https://doi.org/10.48165/jfmt.2026.43.03.19>

ARTICLE INFO

Article history

Received: 16.04.2026

Revised: 17.06.2026

Accepted: 29.06.2026

Keywords

Autopsy

Blunt chest trauma

Rib fracture

Sternum

Cardiac rupture

Forensic pathology

Fatal

ABSTRACT

The heart is a well-protected vital organ within the thoracic cage yet it remains highly vulnerable to severe blunt force trauma such as road traffic collisions, falls and crush incidents which can lead to a spectrum of structural cardiac injuries. Cardiac rupture is the most severe and overwhelmingly fatal consequence of these injuries, often resulting in death before any medical intervention.

This autopsy-based forensic case series examines three distinct cases of fatal cardiac rupture caused by blunt force trauma to the chest. The victims, all adult males (aged 33 to 36), sustained their injuries through different mechanisms: a high-velocity fall from a height onto steel rods, a crushing incident between a reversing vehicle and a wall, and a pedestrian-motor vehicle collision. Autopsies across all three cases revealed a classic and consistent pattern of severe thoracic damage. Findings included extensive bilateral rib fractures, sternal fractures, and associated pulmonary contusions or lacerations. The traumatic cardiac ruptures primarily involved the right atrium and right ventricle. The forensic injury analysis indicates that these ruptures were caused by the direct transmission of massive kinetic force, which violently compressed the heart between the sternum and the vertebral column. The fatality of blunt chest trauma is directly proportional to the magnitude of the kinetic force delivered and the resulting structural compromise of the thoracic rib cage. This series highlights the importance of recognizing the classic forensic triad of rib/sternal fractures, lung damage and cardiac rupture during autopsy.

INTRODUCTION

The cardiac structure is fairly protected within the thoracic cage, located in the centre of the chest, with the sternum in front, the vertebral column in the back, and the lungs on both sides. Nevertheless, it is still vulnerable to penetrating and blunt trauma to the chest that may cause a significant morbid or fatal injury to it.

Penetrating injury is mostly due to stab wounds, while blunt injuries to the heart are mostly seen

in RTAs, falls from height, and in stamping assault cases.^{1,2} It is said that 64% of all blunt chest injuries (BCIs) occur as a result of falls from a height, blasts, high-risk sports, assaults, and road traffic collisions.^{3,4,5} Blunt cardiac injuries seen in road traffic collisions are mostly associated with motor vehicle accidents (51%), followed by pedestrian collisions with motor vehicles (35%), and motorcycle accidents (9%).^{6,7}

As per the American Association for Surgery of Trauma, the spectrum of structural blunt cardiac injury includes myocardial contusion; pericardial disruption; coronary artery injury; valvular, papillary or septal

injury; and blunt rupture of cardiac chambers.⁸

Several mechanisms for blunt cardiac trauma have been hypothesized like: direct transmission of force to the heart; compression between the sternum and vertebral column; concussion; blast injury; penetration from broken ribs or sternal fragments; acceleration or deceleration of the heart and great vessels; and the “hydraulic ram” or “water hammer” effect, where sudden compression of abdominal and/or extremity veins forcibly distends the cardiac chambers.^{9,10} Highlighting these ‘mechanisms involve force transmission between the sternum and spine’ can deepen forensic understanding and reinforce the importance of injury analysis.

In this autopsy-based case series, we discuss three forensic cases of fatal cardiac rupture and their mechanism due to blunt force trauma to the chest. Emphasising the ‘autopsy-based’ nature of this case series aims to foster trust and confidence in forensic findings among professionals and students alike.

CASE SERIES

Case 1

The deceased was a 36-year-old male, a construction worker working on the railway bridge construction site. There was an alleged history of a fall from height at the construction site over the rubble, which consisted of steel TMT rods used in construction. He was brought to the hospital in a gasping stage but was declared dead on arrival.

At autopsy, the external examination revealed multiple imprint abrasions resembling those of the TMT iron rods, predominantly over the back of the neck, chest and abdomen. There was a single laceration of the scalp with an underlying scalp haematoma. On internal examination, the ribs of both sides were fractured. The right side ribs 3-8 were fractured anteriorly in the mid-clavicular region with extravasation of blood in the surrounding muscles and tissues. The left side 3-5 ribs were fractured anteriorly in the mid-clavicular line. Also, 2-8 ribs were fractured anteriorly in the anterior axillary line. Both lungs showed lacerations on their anterior surface corresponding with displaced and undisplaced fractures of the ribs. There was an undisplaced transverse fracture of the 3rd part of the body of the sternum. The pericardium was torn anteriorly with a transmural cardiac laceration of size 06cmx02 cm cardiac cavity deep obliquely involving the anterior surface of the right ventricle (Fig 1). All

other structural parts of the heart were intact with no evidence of any injury. Approximately 1500 ml of blood and blood clots were found in both pleural cavities.

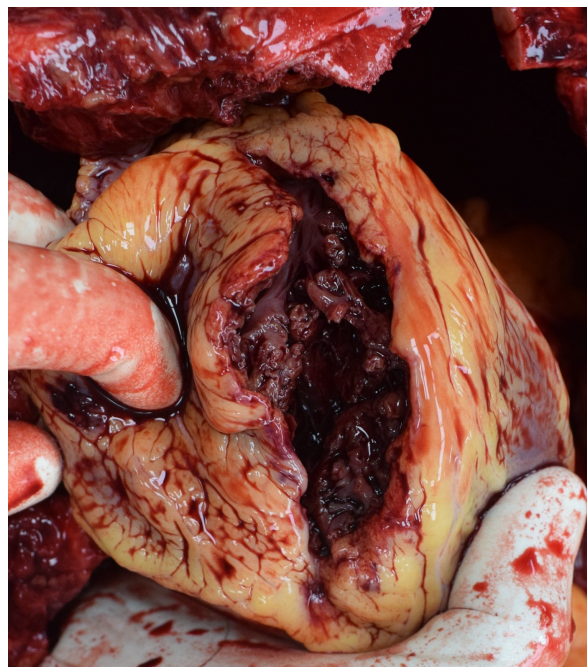


Figure 1: Oblique laceration of the right ventricle

The cause of death was determined to be haemorrhagic shock, based on the extensive traumatic fractures, internal organ lacerations, and the volume of blood loss, providing a clear forensic basis for the fatal outcome.

Case 2

In this case, the deceased was a male, 35 years of age, with an alleged history of being crushed by a motor vehicle. He was compressed between a reversing pickup vehicle anteriorly and a stationary wall at the back. He was brought for treatment to the hospital but was declared dead on arrival.

At autopsy, the deceased was of average build. There was a single contusion in the right supra-clavicular region. Postmortem radiological image revealed fracture of the right clavicle along with rib fractures.

Internal examination revealed a fracture of the right clavicle in the mid-shaft region. Undisplaced fracture of the right side 1-4th ribs and 2-5th ribs in its mid-clavicular and anterior axillary line, respectively, with extravasation of blood in the surrounding muscles and tissues. The left side 1-6 ribs were fractured at two places, anteriorly in the mid-clavicular line and posteriorly in the paravertebral region. There was a displaced fracture of the right side 1 and 2 ribs at their posterior part in the paravertebral gutter near their

insertion with the thoracic vertebrae. A contusion of the right lung was present on its mediastinal surface. The pericardium was torn anteriorly. The right atrium showed a contusion of size 09mm x 07mm on right ventricular surface and a transmural laceration on its anterior surface of size 04cm X 1.5cm x cardiac cavity deep, just above the right atrioventricular junction (Fig 2-3). The chest cavity had two (02) litres of blood with blood clots.

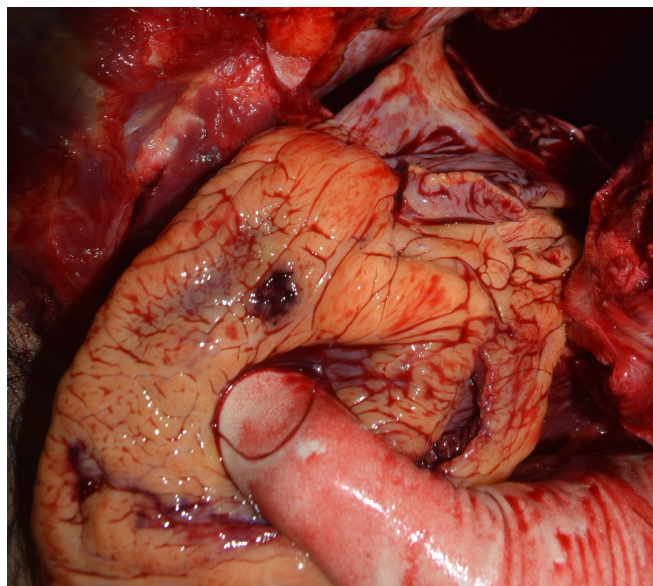


Figure 2: Cardiac contusion of size 09mm x 07mm on the right ventricle

The cause of death was haemorrhagic shock as a result of multiple traumatic fractures and laceration of the heart due to blunt force impact to the chest.

Case 3

In this case, the deceased was a male of 33 years of age who was a daily wage worker and was found dead on the side of a road by the local police with an alleged history of motor vehicle collisions.

External examination of the deceased body revealed multiple grazes all over the anterior part of the chest, face, left elbow and right knee joint consistent with getting dragged on a rough surface. Two imprint abrasions were seen over the right forearm and the right side of the abdomen, consistent with motorcycle tyre marks. Internally, the right side 2-5 ribs were fractured in the anterior axillary line, and the left 4th rib fracture on the mid-clavicular line. The sternum was also an oblique fracture of the 2nd and 3rd parts of the body. There was rupture of the right atrium of size 06cm x 01cm x cardiac cavity deep along with 150 ml of blood in the pericardial cavity (Fig 4). Also, the liver was shattered with around 1500 ml of blood in the peritoneal cavity. Death was due to haemorrhage and

shock with rupture of the heart and liver as a result of blunt force trauma to the chest and abdomen.

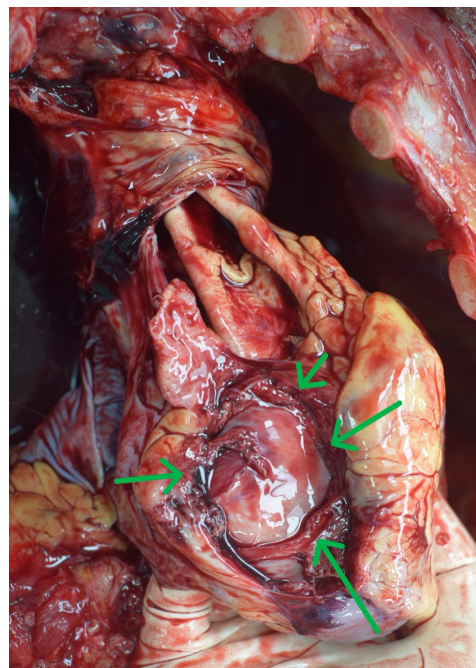


Figure 4: Rupture of right atrium

DISCUSSION

Thoracic trauma, either due to penetrating or blunt-force, can lead to a wide spectrum of injuries ranging from soft tissue injuries to fatal intrathoracic organ injuries. It is noted that in less than 10% of trauma patients, the diagnosis of blunt cardiac trauma is made, where the severity ranges from clinically insignificant cardiac contusions to fatal multiple cardiac chamber rupture.¹¹

Cardiac rupture is considered the most serious form of blunt cardiac injury/trauma, usually with a fatal outcome. Most of the victims die at the scene of the accident or during transportation.^{1,12} The commonest sites of traumatic cardiac rupture in diminishing order are the right atrium, right ventricle, left ventricle, left atrium, ventricular septum and valves associated with pericardial contusions and endocardial tears.¹³

Road traffic accidents involving motor vehicle or motorcycle collisions, along with pedestrians being hit, are the most common causes of cardiac lacerations by blunt force, followed by crushing and falls.^{14,15} Though mostly cardiac lacerations are immediately fatal, delayed death due to fatal complications of cardiac contusions with forensic implications is also reported.¹⁶

In the present case series, all the victims sustained direct blunt chest trauma either due to a fall or due to motor vehicle collisions with direct transmission

of force to the heart that resulted in its rupture. The most common mechanism for cardiac rupture following blunt trauma is a direct blow to the chest with transmission of a kinetic force that compresses the heart between the sternum and the spine.¹⁷

The classic pattern of injuries seen in these cases is bilateral multiple rib fractures (either displaced or undisplaced), contusions and lacerations to the lungs and cardiac rupture, indicating compression of the thoracic rib cage and internal structures. The extensive damage to these thoracic structures implies application of greater force to the chest, and the energy of that force is not only dispersed by fracturing the ribs or sternum but also through the lungs and heart.

Chest compression between two hard surfaces or objects delivers a somewhat crushing force to the thoracic rib cage, either due to a vehicle run-over or compression of the chest by primary impact with the vehicle. Even in high-velocity falls from height, direct blunt force to the chest may lead to cardiac rupture. The incidence of blunt cardiac injury following falls is reported to be between 5% and 50%.¹⁸ The severity of the injuries is directly proportional to the amount of force delivered. In all three cases discussed above, a maximum blunt force was delivered to the anterior and posterior parts of the chest, which resulted in the classical pattern of injuries to the ribs, lungs and the heart. Cardiac injury due to a blunt mechanism is mostly due to the heart being pinched into the bony thorax.¹⁰

In the present case series all three cases shows grade V cardiac rupture as per American Association for Surgery of Trauma.⁸ The cases were due to motor vehicle collisions and a fall from height. The classic injury pattern of rib fractures, sternum fractures, lung contusions, and cardiac ruptures indicates a heavy direct force delivery to the chest, which was fatal.

CONCLUSION

In conclusion, fatality in blunt chest trauma depends on the amount of kinetic force delivered and the structural involvement of the thoracic organs, including ribs and the sternum. In the present case series discussion, all the deceased victims sustained a fatal blunt force chest trauma that resulted in direct transmission of force to the heart, causing its rupture. Death in all these cases was immediate or instantaneous owing to the acute blood loss, fractures and lacerations to vital thoracic organs.

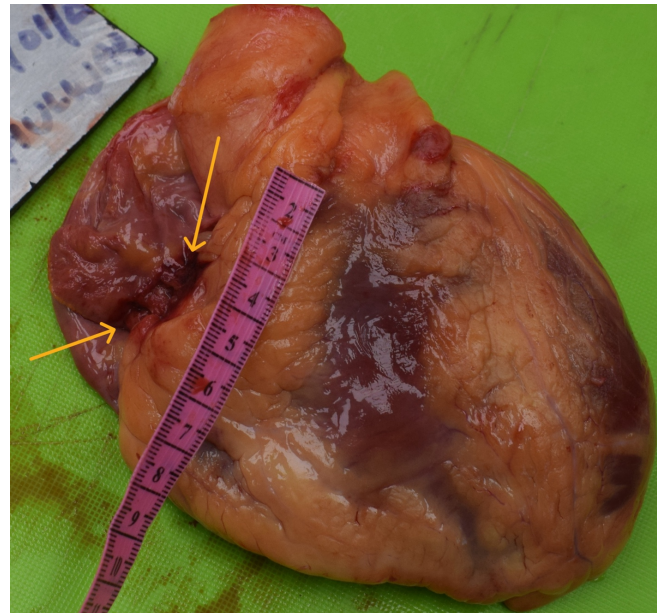


Figure 3: Traumatic laceration of the right atrium

CONFLICT OF INTEREST

There is none to declare

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