

CASE REPORT

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Blunt chest trauma-induced myocardial infarction: a case of sudden death by homicide

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Abstract

Background Blunt cardiac injuries, which are typically the result of blunt chest trauma, are not particularly significant clinically. It is vital never to underestimate blunt chest injuries, especially when they occur in the anterior thoracic area. Blunt trauma to the chest is one of the rarest causative factors of myocardial infarction (MI). Blunt cardiac injury encompasses different medical emergency conditions such as gradual damage to the myocardium leading to myocardial ischemia, injuries to the great vessels of the heart, pericardial tamponade, septum or wall ruptures, pump failure, conduction abnormalities, and atrial and ventricular fibrillations. The most common cause of blunt chest trauma is a road traffic accident (RTA), followed by a sports injury. Mostly blunt trauma chest injuries occur below the age group of 45 years.

Case presentation A 45-year-old male with a history of physical assault was brought to the emergency department by his neighbor. He was allegedly kicked by his relative over the chest during an altercation sustained blunt-force trauma to the chest and collapsed immediately. On admission, he was given cardiopulmonary resuscitation and declared dead. On autopsy, there were no signs suggestive of external injury or any shoeprints/footprints on the chest. On histopathological examination, a diffuse area of discoloration consistent with an extensive myocardial infarction was noted. Old healed infarcts were seen in the free wall of the left ventricle, left posterior papillary muscle, and left apex. The coronaries showed atheromatous plaque with lumen narrowing and focal calcification.

Conclusions It is the task of the forensic pathologist to ascertain and record evidence as to whether the myocardial infarction was caused by the alleged blunt trauma to the chest during the autopsy. This is important as it will determine the type of prosecution the accused is likely to be charged with and the extent of the punishment that he will likely receive under the Indian Penal Code.

Keywords Autopsy, Blunt chest trauma, Myocardial infarction, Homicide, Sudden death

Background

Blunt cardiac injuries, which are typically the result of blunt chest trauma, are not particularly significant clinically. It is vital never to underestimate blunt chest injuries, especially when they occur in the anterior thoracic area. An increasing number of individuals are suffering from blunt chest trauma with myocardial infarction (Modi et al. 2013). Trauma to the chest from the blunt force causes myocardial contusion, valvular disruptions, cardiac tamponade, myocardial rupture, arrhythmias, coronary artery rupture, and conduction abnormalities (Brathwaite et al. 1990; Kanchan et al. 2012). After blunt chest trauma, cardiac arrhythmias such as atrial

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and ventricular fibrillation, supraventricular tachycardia, and ventricular and supraventricular beats have been recorded. These arrhythmias develop when a steering wheel, fist or kick with a hand, or ball strikes the frontal surface of the chest or the left precordial region (Ota and Bratincsak 2015). Death from blunt chest trauma in a pre-existing instance of atherosclerosis has received little attention in the literature. In this article, we will discuss a forensic instance of blunt chest injuries sustained during a scuffle that resulted in the death of an individual due to pre-existing coronary artery disease.

Case presentation

A 45-year-old married male was brought to the emergency department by his family members with an alleged history of assault. He was allegedly kicked by his relative over the chest during an altercation and sustained injury over the chest resulting in blunt-force trauma and an immediate collapse. On admission, the carotid pulse was not palpable and the peripheries were cyanosed. Pupils were dilated and fixed. The patient was on medication and was a known case of diabetes, hypertension, and ischemic heart disease (IHD). Cardiac resuscitation was started immediately once the patient was intubated and continued for 45 min. Despite all efforts, the patient was declared dead. A board of specialist doctors performed the medicolegal autopsy because of the legal implications of the case and the suspect was taken into custody under section 302 of the Indian Penal Code (IPC), which is the section invoked for punishment for murder (Ranchhoddas and Thakore 2017).

Autopsy findings

On autopsy, there were no signs suggestive of any external injury. The clothes were also examined for the presence of shoeprints/footprints and any tears, but no such prints were visible. No notable external injuries were

present on the body while doing the postmortem examination (Fig. 1). Rigor mortis was present all over the body except fingers and toes. The post-mortem staining was present over the back of the body and was not fixed. On internal examination, there were no signs of any antemortem rib fracture (Fig. 1). On opening the pericardial cavity, no blood was found. There were no contusions on either lung. The heart weighed 448 g. The heart was examined, and four different whitish patches were identified. There was a whitish area measuring 4×3 cm, present on the anterior side of the right ventricle. Over the left ventricle's apex, there was a 3×3 cm whitish area. Over the anterior surface of the left ventricle, there was a 4.5×3 cm reddish brown area. Over the left ventricle's apex, there is a 2×1 cm whitish area (Fig. 2A). When the coronaries were examined, the left circumflex artery revealed 90% blockage 2 cm from the origin. A metallic stent (previous angioplasty) was observed in the lumen of the left anterior descending artery at a distance of 2 cm from its origin (Fig. 2B). The right coronary artery showed a thickening of the arterial wall (Fig. 2C). On cross-section examination of the coronaries, they were hard and calcified, and a gritty sensation was present. To facilitate further gross and histological evaluation, the whole dissected heart was preserved in a 10% neutral formalin-buffered solution. There was no cerebral hemorrhage or evidence of damage to the brain when the skull cap was removed. The organs of the abdomen were quite normal. Organs were preserved so that toxicological analysis could be done to rule out any possible poisoning.

Gross and histopathology examination

In the presence of experienced pathologists, the entire heart was grossly examined using the inflow and outflow method, and large samples from each cardiac chamber were obtained. A sample of each coronary was taken for histology after being dissected in 1 cm serial



Fig. 1 Photograph of the deceased showing no evidence of external injury to the chest on external and on dissection there is no evidence of muscle contusion/pericardial hemorrhage

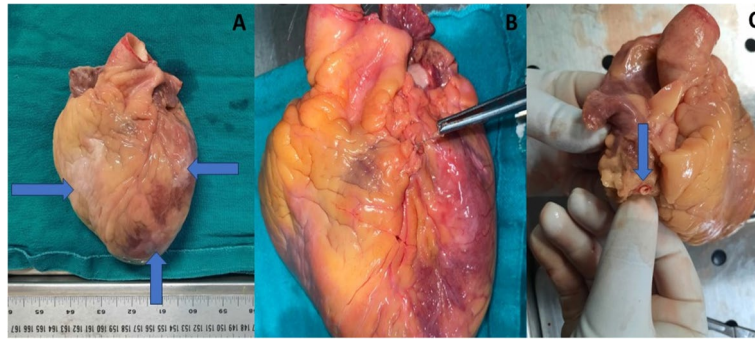


Fig. 2 Macroscopic view of the heart showing gross features. **A** Whitish patches present over the anterior surface of the heart over the right and left ventricle. **B** Metallic stent present at a distance of 2 cm from the origin in the left anterior descending artery. **C** Thickening and narrowing of the arterial lumen

sections. The left ventricular free wall left posterior papillary muscle and left apex of the formalin-fixed heart sections from the whitish patches exhibited signs of old healed infarcts of greater than 3 months (Fig. 3A, B). Atheromatous plaque with focal calcification and lumen narrowing was seen in all three major epicardial arteries (Fig. 3C, D). No acute plaque changes were noted. Bilateral atrial walls, bilateral atrioventricular valves, right ventricular wall, interventricular septum, and aorta appeared unremarkable on histology.

Toxicological analysis

The Regional Forensic Science Laboratory (RFSL) conducted toxicological studies on the samples to check for

the presence of illegal drugs, alcohol, common poisons, and other compounds having pharmacological action. All investigations yielded negative results.

Final opinion

Based on the above, the opinion regarding the cause of death was given as coronary artery disease (CAD) and its complications.

Discussion

The deceased was a married 45-year-old male who had previously been diagnosed with coronary artery disease, diabetes, and hypertension and was on medication. On the day of the occurrence, the deceased and his

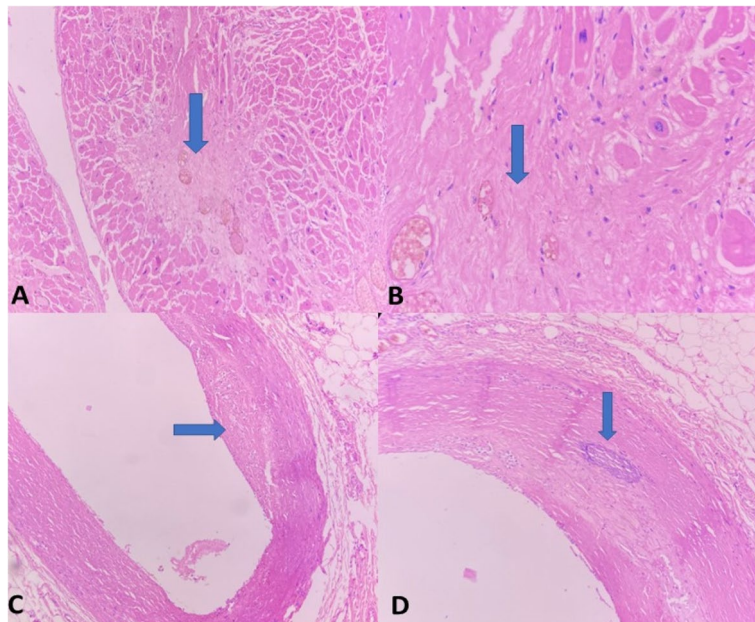


Fig. 3 **A** Section from left ventricle wall showing old healed infarct in the form of dense collagenous scar. H&E 10X. **B** Section from posterior papillary muscle showing replacement of myocardial tissue by collagenous scar. H&E 40X. **C** Section from the left anterior descending artery shows the formation of atheromatous plaque. H&E 4X. **D** Section from the right coronary artery shows an atheromatous plaque. H&E 10X

daughter's in-laws disagreed with his daughter's relationship. He sustained blunt force trauma to his chest after his daughter-in-law's family members held him down and kicked him at least three to four times during the altercation. After being brought to the emergency department unresponsive, he was subsequently declared dead. The most possible mechanism would have been the development of fatal arrhythmia which led to the sudden death of the patient called commotio cordis (Ranchhoddas and Thakore 2017; Patel et al. 2022). We were intrigued by our results and looked for related cases in the literature. However, we came across only a limited number. Commotio cordis should be differentiated from cardiac contusions in which blunt chest trauma causes structural changes (Sakka et al. 2000). A non-penetrating, low, or mild blunt impact to the chest can cause cardiac concussion or also known as Commotio cordis, an electrical event that results in a life-threatening arrhythmia and immediate death (Ranchhoddas and Thakore 2017). The position, velocity, and hardness of the impact object significantly influence the risk of developing ventricular fibrillation. A negative autopsy occurs when there is no indication of injury except for normal heart anatomy (Link 2012). Significant cardiac damage after blunt chest trauma occurs in about 5–15% of cases (Aggrawal 2017; Atalar et al. 2001).

In day-to-day life, blunt cardiac injuries are most common in traffic accidents, falls from heights, and stomping incidents. The reported incidences vary depending on the definition and diagnostic criteria and range from 3 to 71% (Singh et al. 2022; Holanda et al. 2006; McGillicuddy and Rosen 2007). With or without a flailing chest, there may be rib fractures and sternal fractures at multiple places. However, fatal blunt cardiac injury can happen without leaving any physical signs on the chest wall or damaging the bone structure. However, if the heart is compressed posteriorly against the dorsal spine, as seen in stampedes and impacts with the steering wheel, bruising, laceration, or a rupture can occur over the posterior surface of the heart. This is especially true for the right ventricle, which sustains the majority of cardiac injuries (El-Andari et al. 2021; Gonin et al. 2009). Without histological examinations, it is difficult to determine a fatal outcome in cardiac concussions or commotio cordis originating from mild or low blunt force trauma to the chest due to subtle changes in histopathology. It is critical to identify cardiac contusion/concussion in survivors of blunt trauma to the chest. In these circumstances, the use of troponin has been recommended (Koehler et al. 2004; Kaye 2002). Internal cardiac injury is possible even in cases when there are no external indications of damage to the chest wall or heart. Damage can vary from minimal epicardial bruises to severe lacerations. Nevertheless,

even in the absence of macroscopic anomalies, histological damage specifically, contraction band necrosis can be seen (Salim et al. 2001). Blunt chest trauma can cause superficial cardiac contusions which can develop into significant myocardial necrosis as a result of myocardiocyte necrosis (El-Andari et al. 2021).

The range of traumatic cardiac injuries can vary depending on the amount of force applied to the chest, the chest wall's resistance, preexisting medical history, and the exact time of force application in the cardiac cycle. The most common outcomes are post-traumatic myocardial infarction, valvular and conduction abnormalities, myocardial contusions, arrhythmias, cardiac concussion, damage to the pericardium or main blood vessels, or coronary arteries (usually the anterior descending artery) (Kanchan et al. 2012). With a 0.1 to 0.5% incidence, septal rupture is the most fatal and potentially dangerous unusual result that may develop within hours to days following a BCI (blunt cardiac injury) (Knight and Saukko 2016; Amorim et al. 1999). The common cardiac rupture sites following BCI reported in clinical investigations differ from those documented in post-mortem studies (Hermens et al. 2009). According to clinical research trials, the right atrium and the right ventricle are more frequently affected than the left atrium and left ventricle, whose rupture is almost exclusively documented after autopsy since it practically invariably results in a sudden fatality (Kato et al. 1994). Septal rupture and pericardial laceration are rare medical conditions that can result in cardiac evisceration and damage to the major blood vessels that supply the heart (Ihama et al. 2006; Tarmiz et al. 2011). Blunt chest trauma patients may not exhibit any symptoms, experience mild aftereffects, or take a long time to recover. The causal link between blunt chest trauma and heart rupture may be less obvious and more difficult to prove when a large amount of time elapsed between the two events (Gentile et al. 2021; Vougiouklakis et al. 2005; Turan et al. 2010; Dokoupil et al. 2019).

Conclusions

Determining whether or not the alleged assault appears to have caused myocardial infarction is the responsibility of the forensic pathologist. When opining about the cause of death and whether the myocardial infarction is related to the damage received in the claimed incident, forensic pathologists should proceed with extreme caution. This will significantly influence the severity of the punishment imposed on the accused. This instance shows that even in cases when there are not any clinically evident chest injuries, people with a history of coronary artery disease are susceptible to fatal severe chest trauma. Acute chest trauma prevention and increased awareness are essential to reduce the mortality rate associated with life-threatening arrhythmia.

Abbreviations

MI	Myocardial infarction
RTA	Road traffic accident
BCI	Blunt cardiac injury
IHD	Ischemic heart disease
IPC	Indian penal code
RFSL	Regional Forensic Science Laboratory

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Authors' contributions

MA, VSR, and PS performed the medicolegal autopsy and interpreted the patient data regarding the cardiac disease. KC and MR performed the histological examination of the heart and was a major contributor in writing the manuscript. All authors read and approved the final manuscript.

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Declarations

Ethics approval and consent to participate

It was ensured that personal information concerning victims and perpetrators was protected, confidential, and anonym in accordance with ethical rules and consent was obtained.

Consent for publication

Consent for publication was obtained from kin of the deceased.

Competing interests

The authors declare that they have no competing interests.

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