



CASE REPORT

Death of a 23-year-old man from cardiac conduction system injury through a blunt chest impact after a car accident



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Abstract Cardiac contusion, usually caused by blunt chest trauma, has been recognized with increased frequency over the past decades. Traffic accidents are the most frequent causes of cardiac contusion resulting from a direct blow to the chest. Myocardial contusion is difficult to diagnose; the clinical presentation varies greatly, ranging from a lack of symptoms to cardiogenic shock and arrhythmia. Although death is rare, cardiac contusion can be fatal.

The authors report a case of death due to a cardiac conduction system injury from a blunt chest impact following a car accident. The autopsy showed no external signs of thoracic trauma, no evident rib or sternum fractures. A small sub-endocardial hemorrhage was found in the region of the atrioventricular node. Histological examination revealed an injury of the atrioventricular node and His' bundle. The cause of the death was attributed to the arrhythmia induced by contusion of the cardiac conduction system.

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1. Introduction

Blunt cardiac injury is a common visceral injury in blunt chest traumas, formerly known as “myocardial contusion”.¹ The causative force is typically applied to the anterior precordium.² Due to its position between the sternum and the thoracic ver-

tebrae, the heart is exposed to any sudden impact on the sternum and to compression forces applied to the chest. High energy blunt traumas (injury severity scores – ISS) can lead to different types of cardiac injuries, such as valve or myocardial contusions and cardiac rupture. These lesions are usually associated with a high mortality rate either by hemorrhagic or arrhythmic complications. The only possibility of sudden death from a relatively minor contusion is following the disruption of the conduction system: sino-atrial nodal disturbances, atrio-ventricular junctional dysfunction,

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intra-ventricular conduction defects (e.g., bundle branch blocks) or ventricular fibrillation, although most cases of minor cardiac contusion may follow a benign course.³

In 1930, George Schlomka was the first to describe the factors that can lead to arrhythmia after a moderate pre-cordial impact. He believed that the force, location and type of object causing the impact determined the type of injury and the subsequent risk of arrhythmia.

The threshold speed of impact to cause ventricular fibrillation is between 25 and 30 mph, therefore a relatively little force, but a vulnerable period of the cardiac cycle. When the speed is over 50 mph, however, the likelihood of ventricular fibrillation actually decreases, although the possibility of myocardial contusion becomes greater.⁴

2. Case report

The case regards a 23-year-old man who died in a car accident. He was sitting in the back without a seat belt. He was 172 cm tall and weighed 90 kg. The *external examination* of the body revealed: on the right side of the thoracic region a linear contusion measuring 5 cm × 1 cm; in the middle sternum region a small circular skin contusion measuring 1.2 cm × 1 cm; in the left scapular region a rectangular skin abrasion–contusion lesion measuring 12 cm × 6 cm; a few bruises on the upper and lower limbs.

The *section of the body* revealed: on the anterior chest wall it was possible to observe hemorrhagic infiltration between the intercostal muscles corresponding to the lesions seen on the body surface, without any fracture of the ribs and sternum. The posterior chest wall presented hemorrhagic infiltration between the intercostal muscles of the first to the ninth rib on the left side. The spine did not show any fractures. A hemorrhagic infiltration was observed between the seventh and the ninth dorsal vertebra.

A contusion was observed on the middle lobe of the right lung, corresponding to the linear contusion observed on the right side of the thoracic region on the body surface. The lungs showed sub-pleural petechiae.

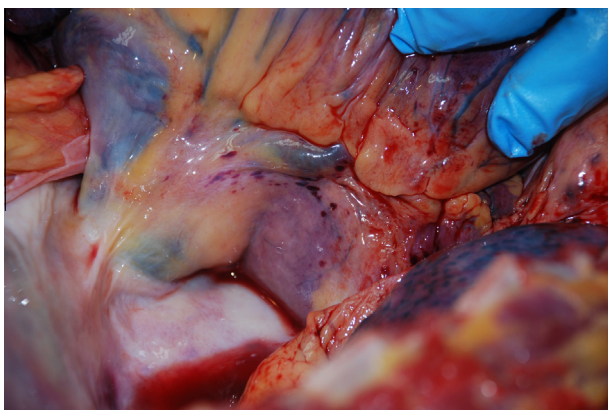
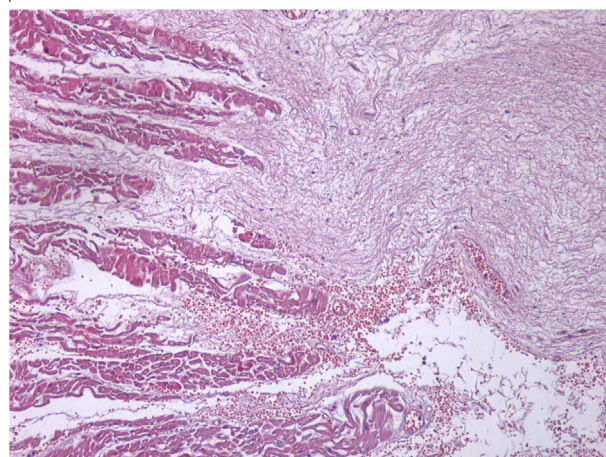
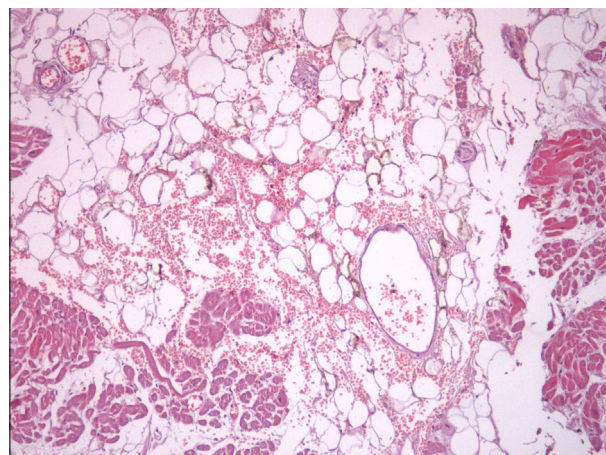


Figure 1 On the posterior surface of the right atrium, punctiform ecchymosis was observed, specifically between the superior and inferior vena cava connections and the wall of the right atrium.



Figures 2-3 Histological examination showed a petechial hemorrhagic infiltration in the sub-epicardial adipose tissue and between myocardial fibers at the level of the sino-atrial node with the evidence of fibrinolysis in the right ventricle (EE ×25).

The heart weighed 410 g; on the posterior surface of the right atrium, punctiform ecchymosis was observed, specifically between the superior and inferior vena cava connection and the wall of the right atrium (Figure 1). Analogous ecchymosis was observed on the obtuse margin and small confluent petechiae on the inter-atrial septum near the atrioventricular junction.

The blood alcohol and toxicological screenings were negative.

3. Histological findings

Routine hematoxylin-eosin (HE) was performed on all tissue specimens.

The histological examination of the cardiac conduction system showed: petechial hemorrhagic infiltration in the sub-epicardial adipose tissue and between the myocardial fibers at the level of the sino-atrial node with the evidence of fibrinolysis (Figures 2 and 3); in the atrioventricular conduction tissue, plurifocal petechial hemorrhagic infiltration of the inter-atrial septum involving the myelinic fibers in the context of adipose tissue (Figures 4). Isolated foci of myofibrinolysis were observed in the right ventricle.

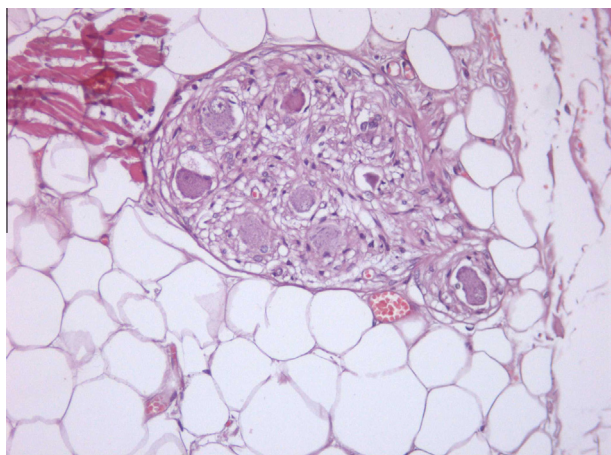


Figure 4 In the atrioventricular conduction tissue, plurifocal petechial hemorrhagic infiltration of the inter-atrial septum involving the myelinic fibers in the context of adipose tissue (EE $\times 40$).

These findings were consistent with a cardiac contusion.

4. Discussion

Blunt cardiac trauma can lead to various cardiac injuries, including cardiac contusion with an incidence rate between 5% and 50% depending on the series.^{5,6} The most common situations leading to myocardial contusion is traffic accidents.^{7,8} Traumatic circumstances may involve sport activities, accidents or aggressions.⁵ Cardiac contusions are usually due to acute heart elastic compression between the sternum and the spine secondary to an increased intrathoracic pressure. Other potentially involved mechanisms are: (a) direct injury from a fractured sternum; and (b) “water hammer effect” – an abrupt increase in blood pressure within the cardiac chambers after chest/abdominal compression/crushing which can lead to heart distension, shearing or rupture.⁵ The severity of the lesion depends on the impact velocity and the chest compression.

Cardiac tissue is inherently excitable, and the key elements of the conduction system are directly situated posteriorly to the sternum.⁷

Children and adolescents are at a greater risk than adults due to increased chest wall compliance, which facilitates energy transmission to the myocardium. Some authors postulate that adolescents also may be more vulnerable because neuromuscular immaturity, combined with a false sense of security afforded by protective gear, leaves them less able to avoid injury.⁷

Lethal cardiac contusions are very rare. In most cases not only a single blunt chest trauma, but also multiple injuries such as major fractures or ruptured viscera are reported and the fatal outcome is generally caused by these latter injuries.

In this case report the blunt cardiac injury that occurred after a frontal car collision resulted from a direct kick impact to the pre-cordial area without causing any fractures of the ribs, sternum or spine, but resulting in a significant contusion to the heart conduction system.

Indeed, the heart gross examination and the histological findings were consistent with a cardiac contusion. No coronary artery diseases and no epicardial coronary artery traumas were observed. In this case, as the energy of the forces was not dissipated by the fracturing of the sternum or ribs, almost the whole amount of kinetic energy was transmitted to the heart. At autopsy, although the chest trauma was anterior, the macroscopic heart contusion was observed in the posterior wall of the heart. This could have been the result of the impact of the heart against the spine.

Concerning the mechanism of death, although the cardiac injury, including the contusion of the myocardium itself was not so extensive, it was considered that an arrhythmia induced by the cardiac conduction system injury was the cause of death.

This report suggests that when the autopsy findings and toxicological examinations are inconclusive, the histological examination of the cardiac conduction system is helpful for identifying a possible cardiac conduction system injury, thereby improving the quality of forensic pathological diagnosis.

Funding

None.

Conflict of interest

None declared.

Ethical approval

Necessary ethical approval was obtained from the institute ethics committee.

References

1. Madea B, Argo A. Certification of death: external postmortem examination. In: Madea B, editor. *Handbook of forensic medicine*. Chichester, West Sussex: UK; 2014. p. 57–74.
2. Dermengiu D, Ceaușu M, Rusu M, Căpățînă C, Hostiuc S, Curcâ GC. Medical legal implications of cardiac contusion – case report. *Rom J Leg Med* 2010;**2**:83–94.
3. Zhu B, Fujita MQ, Quan L, Ishida K, Oritani S, Fukita K, et al. A sudden death due to cardiac conduction system injury from a blunt chest impact. *Legal Med* 1999;**1**:266–9.
4. Curcâ GC, Ceaușu M, Dermengiu D, Popov P. Delayed sudden death determined by right atrial contusion – case report and literature review. *Rom J Leg Med* 2008;**16**(4):253–60.
5. Gonin J, De la Grandmaison GL, Durigon M, Paraire F. Cardiac contusion and hemopericardium in the absence of external thoracic trauma. Case report and review of the literature. *Am J Forensic Med Pathol* 2009;**30**:373–5.
6. Holanda MS, Dominguez MJ, Lopez-Espadas F, et al. Cardiac contusion following blunt chest trauma. *Eur J Emerg Med* 2006;**13**:373–6.
7. Deady B, Innes G. Sudden death of a young hockey player: case report of commotion cordis. *J Emerg Med* 1999;**17**(3):459–62.
8. Hossack KF, Moreno CA, Vanway CW, Burdick DC. Frequency of cardiac contusion in non-penetrating chest injury. *Am J Cardiol* 1988;**61**(4):391–4.