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

Article Type: Case Report

Keywords: cardiac conduction system injury; blunt chest trauma; cardiac contusion; car accident; forensic pathological diagnosis

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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 subendocardial 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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We would like to submit you this case report “*Death of a 23-year-old man from cardiac conduction system injury through a blunt chest impact after a car accident*” in order to an eventual publication on your journal.

Awaiting your kind reply,

S. Zerbo

With regards

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

S. Zerbo, E. Maresi, F. Portelli, C. Sortino, E. Ventura Spagnolo, P. Procaccianti, A. Argo.

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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 subendocardial 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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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 vertebrae, 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 injury such a (us) 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

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4 disruption of (to) the conduction system: sino-atrial nodal disturbances, atrio-
5 ventricular junctional dysfunction, intraventricular conduction defects (e.g. bundle
6 branch blocks) or ventricular fibrillation, although most cases of minor cardiac
7 contusion may follow a benign course [3].
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10 In 1930, George Schlomka was the first to describe the factors that can lead to
11 arrhythmia after a moderate precordial impact. He believed that the force, location
12 and type of object causing the impact determined the type of injury and the
13 subsequent risk of arrhythmia.
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16 The threshold speed of impact to cause ventricular fibrillation is between 25 and 30
17 mph, therefore a relatively little force but a vulnerable period of the cardiac cycle.
18 When the speed is over 50 mph, however, the likelihood of ventricular fibrillation
19 actually decreases, although the possibility of myocardial contusion becomes greater
20 [4].
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28 29 **Case report**

30 The case regards a 23-year-old man who died in a car accident. He was sitting in the
31 back without a seat belt. He was 172 cm tall and weighed 90 kg. The *external*
32 *examination* of the body revealed: on the right side of the thoracic region a linear
33 contusion measuring 5 cm x 1 cm; in the middle sternum region a small circular
34 skin contusion measuring 1.2 cm x 1 cm; In the left scapular region a rectangular
35 skin abrasion-contusion lesion measuring 12 cm x 6 cm; few bruises on the upper
36 and lower limbs.
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39 The *section of the body* revealed: On the anterior chest wall it was possible to
40 observe hemorrhagic infiltration between the intercostal muscles corresponding to
41 the lesions seen on the body surface, without any fractures of the ribs and sternum.
42 The posterior chest wall presented hemorrhagic infiltration between the intercostal
43 muscles of the first to the ninth rib on the left side. The spine did not show any
44 fractures. A hemorrhagic infiltration was observed between the seventh and the
45 ninth dorsal vertebra.
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4 A contusion was observed on the middle lobe of the right lung, corresponding to the
5 linear contusion observed on the right side of the thoracic region on the boby surface.
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7 The lungs showed subpleural petechiae.
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9 The heart weighed 410 g; on the posterior surface of the right atrium, punctiform
10 ecchymosis were observed, specifically between the superior and inferior vein caval
11 connection and the wall of the right atrium (fig.1). Analogous ecchymosis were
12 observed on the obtuse margin and small confluent petechiae on the interatrial
13 septum near the atrio-ventricular junction.
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16 The blood alcohol and toxicological screening were negative.
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22 **Histological findings**

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25 Routine Hematoxylin-Eosin (HE) was performed on all tissue specimens.
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27 The histological examination of the cardiac conduction system showed: petechial
28 hemorrhagic infiltration in the subepicardial adipose tissue and between myocardial
29 fibers at the level of the sinoatrial node with evidence of fibrillolysis(fig. 2-3); in the
30 atrioventricular conduction tissue, plurifocal petechial hemorrhagic infiltration of the
31 interatrial septum involving the myelinic fibers in the contest of adipose tissue (fig.
32 4). Isolated foci of myofibrillolysis were observed in the right ventricle.
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38 These findings were consistent with a cardiac contusion.
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44 **Discussion**

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46 Blunt cardiac trauma can lead to various cardiac injuries, including cardiac contusion
47 with an incidence rate between 5% and 50% depending on the series [5-6]. The most
48 common situation leading to myocardial contusion is traffic accidents [7-8]
49 Traumatic circumstances may involve sport activities, accidents or aggressions [5].
50 Cardiac contusions are usually due to acute heart elastic compression between the
51 sternum and the spine secondary to an increased intrathoracic pressure. Other
52 potentially involved mechanisms are: (a) direct injury from a fractured sternum, (b)
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4 “water hammer effect” – an abrupt increase in blood pressure within the cardiac
5 chambers after chest/abdominal compression/crushing which can lead to heart
6 distension, shearing or rupture [5]. The severity of the lesion depends on the impact
7 velocity and chest compression.
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10 Cardiac tissue is inherently excitable, and the key elements of the conduction system
11 are directly situated posteriorly to the sternum [7].
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14 Children and adolescents are at a greater risk than adults, due to increased chest
15 wall compliance, which facilitates energy transmission to the myocardium. Some
16 authors postulate that adolescents also may be more vulnerable because
17 neuromuscular immaturity, combined with a false sense of security afforded by
18 protective gear, leaves them less able to avoid injury [7].
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21 Lethal cardiac contusions are very rare. In most cases not only a single blunt chest
22 trauma but also multiple injuries such as major fractures or ruptured viscera are
23 reported and the fatal outcome is generally caused by these latter injuries.
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26 In our case report the blunt cardiac injury, occurred after a frontal car collision,
27 resulted from a direct kick impact to the precordial area without causing any
28 fractures of the ribs, sternum and spine, but resulting in a significant contusion to the
29 heart conduction system.
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32 Indeed the heart gross examination and the histological findings were consistent with
33 a cardiac contusion. No coronary artery diseases and no epicardial coronary artery
34 traumas were observed. In our case, as the energy of the forces was not dissipated by
35 the fracturing of sternum or ribs, almost the whole amount of kinetic energy was
36 transmitted to the heart. At autopsy, although the chest trauma was anterior, the
37 macroscopic heart contusion was observed in the posterior wall of the heart. This
38 could have been the result of the impact of the heart against the spine.
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41 Concerning the mechanism of death, although the cardiac injury, including the
42 contusion of the myocardium itself was not so extensive, we considered that an
43 arrhythmia induced by the cardiac conduction system injury, was the cause of death.
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46 This report suggests that when the autopsy findings and toxicological examinations
47 are inconclusive, the histological examination of the cardiac conduction system is
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4 helpful for identifying a possible cardiac conduction system injury so improving the
5 quality of forensic pathological diagnosis.
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Illustrations

Fig. 1: on the posterior surface of the right atrium, punctiform ecchymosis were observed, specifically between the superior and inferior vein caval connection and the wall of the right atrium

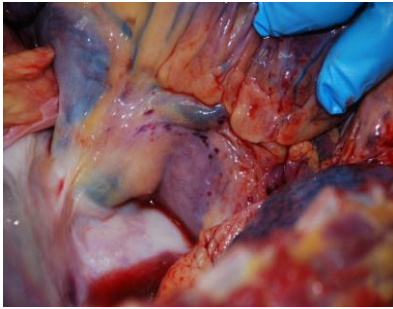
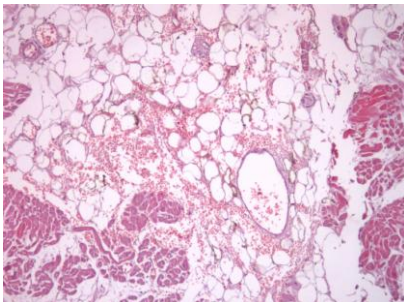
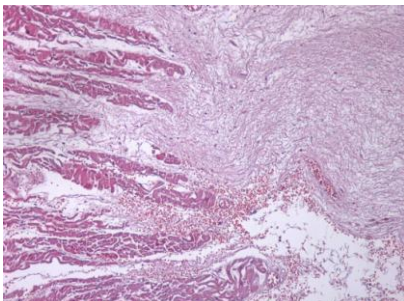


Fig 2-3 petechial hemorrhagic infiltration in the subepicardial adipose tissue and between myocardial fibers at the level of the sinoatrial node with evidence of fibrinolysis in the in the right ventricle.

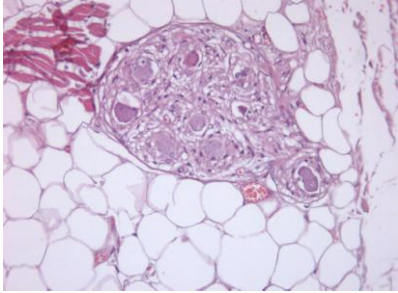


E-E 25x



E-E 25x

Fig 4 in the atrioventricular conduction tissue, plurifocal petechial hemorrhagic infiltration of the interatrial septum involving the myelinic fibers in the contest of adipose tissue



EE 40x

Caption to Illustrations

Fig. 1: on the posterior surface of the right atrium, punctiform ecchymosis were observed, specifically between the superior and inferior vein caval connection and the wall of the right atrium

Fig. 2 - 3: Histological examination showed a petechial hemorrhagic infiltration in the subepicardial adipose tissue and between myocardial fibers at the level of the sinoatrial node with evidence of fibrillolysis in the in the right ventricle (EE X25).

Fig. 4: in the atrioventricular conduction tissue plurifocal petechial hemorrhagic infiltration of the interatrial septum involving the myelinic fibers in the contest of adipose tissue (E E x 40).