

## CASE REPORT

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## Non-lethal penetrating cardiac injury from a crossbow bolt

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**Abstract** Crossbow injuries to the thorax are nowadays uncommon. The type of arrowhead used determines not only the form of entrance wound but often the outcome of these injuries. We report the case of a 38-year-old man who attempted to commit suicide by firing a bolt from a sport crossbow into his heart. Although the bolt penetrated the mediastinum causing a deep intraseptal myocardial lesion and the pre-operative diagnostic procedure delayed the necessary operation, the patient survived.

**Key words** Penetrating cardiac injury · Emergency thoracotomy · Suicide · Crossbow wounds

## Introduction

The crossbow, a derivative of the longbow and a predecessor of the rifle, was most popular in the Middle Ages when it revolutionized warfare. It was dreaded because of its ability to penetrate a suit of armour at close range [8]. Since the invention of efficient firearms the crossbow has become an unusual weapon. Today it is becoming more popular for sports and hunting [2, 13].

Arrow wounds are not often seen in forensic practice and have been described in only a few cases. Crossbow injuries are most often suicidal [1, 2, 4, 10, 11] or accidental [3, 14, 15] and a few homicides have been reported [4, 13].

In injuries due to uncommon weapons, the forensic pathologist is often asked to confirm or to exclude a suicide [9] and to estimate the potential danger of these weapons [8].

This rare case is reported to offer a reminder of simple general rules of emergency medicine and to highlight the legal conditions that currently allow the sale of potentially lethal weapons.

## Case report

An unemployed, divorced 38-year-old man attempted to commit suicide by firing a crossbow bolt through his chest into the heart following domestic arguments with his former wife (8:30 p.m.). The bolt pierced his leather jacket and entered the chest wall 4 cm below the left nipple (Fig. 1 A, B) in a craniolateral to inferiomedial direction. The woman alerted the rescue services (8:43 p.m.) and about 6 min later an emergency physician arrived. The patient was slightly intoxicated and found to be conscious and co-operative, with no severe respiratory distress, hemodynamically stable (BP 160/125, HR 80/min) and without any pain.

The heel of the bolt projected approximately 10 cm from the left parasternal entry point and moved in time to the heart beat. Both lungs were aerated and no other injuries were found. After venous access was secured and portable electrocardiography was performed, the patient was transported to a city hospital without a department of thoracic surgery (arrival time: 9:15 p.m.). Chest radiography showed that the bolt tip projected to the base of the heart. Pericardial tamponade, pneumothorax and pleural effusion were excluded. The CT scan showed a crossbow bolt penetrating anteriorly through the mediastinum. The tip of the bolt was positioned intramyocardially in the left ventricle (Fig. 2). The patient who was still conscious in a stable condition, and in no pain, was transferred by helicopter to the University hospital 2 h after admission (departure 11.05 p.m.) where he was taken immediately to the operating theatre via the emergency room. Surgery began at 11:30 p.m. 3 h after injury and 10 min after arrival the heart-lung machine was in stand-by mode. First a circumcision of the skin surrounding the bolt was performed to allow free movement of the shaft. Median sternotomy was then carried out without opening the pleura. After longitudinal pericardiotomy only a small quantity of blood was found confirming the absence of ventricle perforation. The pencil-like tip of the bolt lodged within approximately 1.5 mm of the left anterior descending artery (LAD) and penetrated the interventricular septum to a depth of 1 cm. The bolt was removed carefully and found to be a field-tipped bolt. Wound repair was performed using two U-sutures and a pericardial patch pledget. Cardiorrhaphy sutures traversed below the LAD and deep into the myocardium away from the injury to prevent stenosis of the LAD.

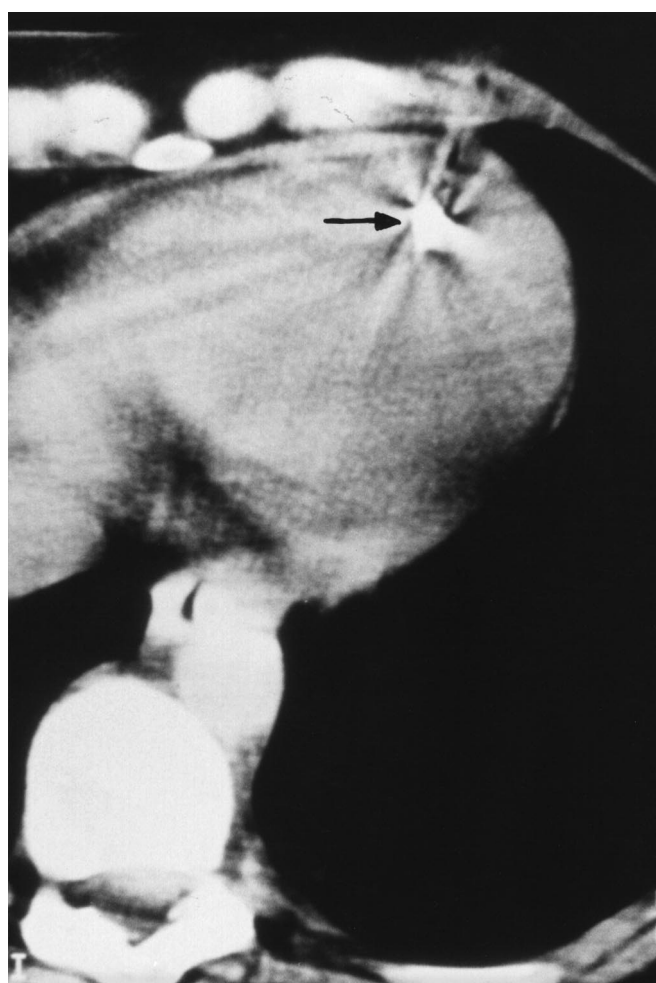
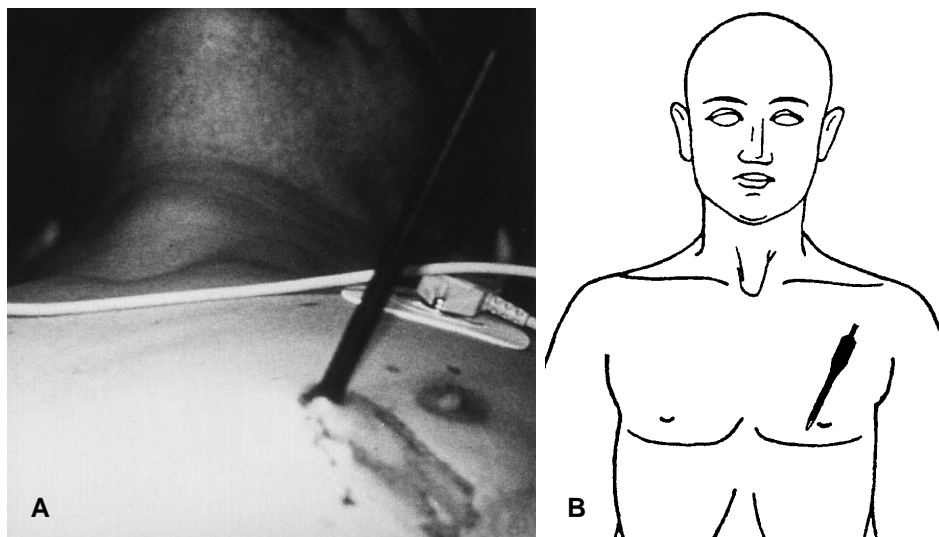
The entire post-operative course was uneventful.

Because of the rareness of such an injury, the forensic pathologist was asked to determine whether it is in fact possible to attempt suicide with this weapon.

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**Fig. 1** **A** The crossbow bolt penetrating the thorax 4 cm below the left nipple in a cranio-lateral to inferiomedial direction and **B** schematic drawing showing the location

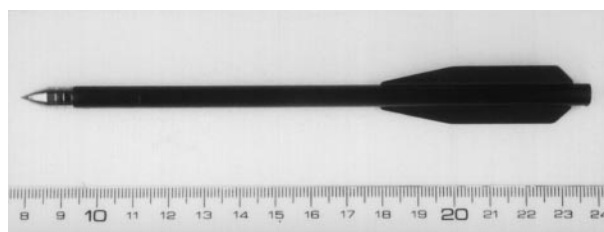


**Fig. 2** Thoracic CT image through the heart revealing the tip of the bolt (see arrow) located intramyocardially

The attempted suicide was made using a pistol crossbow manufactured by Barnett International Inc. (England) with a rated draw weight of 34 kg an accuracy for 20 m and a rated bolt velocity of about 45 m/s. The pistol crossbow has a maximum effective range



**Fig. 3** Model of a pistol crossbow manufactured by Barnett International Inc. (England)



**Fig. 4** Crossbow bolt with field tip arrowhead used in this case

of about 50 m and produces 9 J of energy (Fig. 3). The crossbow is loaded in a ready-to-fire position similar to the air rifle principle. One bolt is located inside the guide rail of the barrel. The bolt used for this suicide attempt had black plastic fletchings, a metal shaft 0.6 cm in width, a length of 15.5 cm, a conical silver coloured point and a weight of 9 g. (Fig. 4)

## Discussion

The type of arrowhead dictated the injury pattern and was decisive for the outcome of this case.

The arrowhead may be one of two general designs – the pencil-like bolt tip described here, or the hunting broadhead tip consisting of multiple razor-edged vanes. Broadhead tips produce characteristic wounds reflecting the geometry of the tip. These distinctive triangular skin wounds made by a broadhead tip leave little confusion concerning the cause of injury. Wounds from an arrow with a field – tipped bolt, in contrast, are nearly indistinguishable from a wound caused by a gunshot according to some authors [4, 12].

For these cases there may be a need to differentiate an arrow from a gunshot entrance wound, e.g. in the absence of an identifiable projectile at the scene of crime. Randall and Newby [12] found experimentally the following characteristics:

1. Gunshot wounds usually had a circular defect whereas arrow wounds were more likely to be slit-like or elliptical.
2. Archery wounds had very inconspicuous abrasion rings as compared to the often prominent abrasion rings of gunshot wounds.
3. Gunshot wounds had macroscopic, wipe-off material and chemically identifiable wipe-off residue by the spot test [12].

According to Hain [4] low velocity field tip wounds usually lack the cavitation of gunshot wounds.

The hunting broadhead tip causes triangular skin wounds and seems to be more dangerous because of its deep incising wounds. In the survived cases of crossbow injuries reported and in our case, bolts with conical tips were used [3, 10, 14, 15]. The pencil-like bolt tip has no razor effect and thus causes no incising injury so that even in cases with injuries of the brain stem, the spinal cord, the aorta or the heart, the patient survived [10, 14, 15].

In our case the bolt of a pistol crossbow penetrated the chest through the fifth intercostal space and remained in the myocardial septum without perforation of the ventricle. The leather jacket and soft tissue reduced the energy of the bolt. During the initial medical examination the patient underwent detailed and time-consuming examination procedures consisting of chest radiography and computer-aided thoracic scanning, although the hospital had no department of thoracic surgery or cardiopulmonary bypass facility. This unnecessary diagnostic procedure could have led to the death of the patient if the injury had been slightly different.

It should be generally accepted that rapid transport of thoracic injury victims to emergency facilities experienced in thoracic trauma is vital [3, 16, 17]. The pulsating bolt and the stable hemodynamic situation of the patient indicated that a heart chamber was not opened. In the case reported an experienced surgeon should have been able to assess the situation correctly without technical examination and without further delay [5]. Mullan et al. [10] described a similar but more serious suicide attempt with a crossbow bolt passing through the sternum, the right ventricle, the interventricular septum, the left ventricle and the descending thoracic aorta.

Suicides and suicide attempts by firearms seem to be typical of males [7]. Among all suicidal and accidental

crossbow injuries reported in literature there is a clear majority of males [2, 10, 11, 15]. Most of the suicides or attempts were done with one shot and there is only one report in literature of a crossbow suicide using multiple arrows [11].

This case supports the investigation of Karger et al. [6] who disprove a criterion still in use in forensic practice that the clothing is often removed before a suicide.

Although crossbows are accurate and deadly weapons, they are sold freely. Missliwetz and Wieser [8] showed experimentally that the missile energy of crossbows and pistol crossbows exceed the limit of 7.5 J prescribed in the German gun-control laws for freely-sold weapons and that even bolts of pistol crossbows penetrated the cranium. Nevertheless, no gun licence is needed to own or use a crossbow. Purchasers only have to prove their age by presenting an identity card to the dealer. This access to sports weapons in Germany should be more restricted.

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