

Bullets retained within the heart: diagnosis and management in three cases

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ABSTRACT Three cases of gunshot wounds of the chest are reported, in each of which a bullet was retained within the heart. Although it is rare, the surgeon should consider this possibility if the missile overlies the cardiac silhouette on the plain chest radiograph. Fluoroscopy played an important part in confirming the diagnosis. Cardiopulmonary bypass was used in all cases and provides operating circumstances that improve the prospects of success.

Despite the increasing number of casualties resulting from penetrating chest injuries, retained foreign bodies inside a cardiac chamber are very rare in civilian life. Among the few reports referring to intracardiac bullets or shell fragments,¹⁻⁹ the most interesting and important experience was published by Harken,^{1,2} based on his second world war experience. More recently, with the increasing sophistication of civilian weapons and in particular their increased calibre and muzzle velocity, a cardiac injury produced by such devices often causes extensive damage and the bullet usually passes right through the heart. Nevertheless, there is always the possibility, depending on the circumstances, that a bullet or a fragment has remained inside the heart. Three cases are described here, in each of which a bullet fired from a low velocity gun lay completely free inside a ventricular cavity after penetrating the muscular cardiac wall.

Case reports

CASE 1

A 16 year old girl was taken into hospital 40 minutes after having attempted suicide by shooting herself in the praecordium with a 22 mm gauge calibre gun. On admission she was pulseless, with the clinical signs of cardiac tamponade. A chest radiograph (fig 1) showed the bullet in the cardiac area and the lateral view showed that the bullet was "out of focus." Fluoroscopy was performed at the same time and showed movement of the bullet, indicating that it was free inside a cardiac chamber, probably the left ventricle.

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She was immediately taken to the operating theatre and the chest was opened by a median sternotomy. After the pericardium had been opened and clot removed cardiac function improved immediately. Since a bullet was known to be within the heart, cardiopulmonary bypass was instituted and the ascending aorta and the superior and inferior venae cavae were cannulated. The aorta was clamped and a cold cardioplegia solution was infused through the ascending aorta. A small perforation was identified on the right ventricular outflow tract. The right ventricle was opened through a small transverse incision and inspection showed that the bullet had also perforated the interventricular septum. The left atrium was opened and a tear in its posterior wall was exposed. The bullet was identified in and removed from the left ventricular cavity, which was inspected through the mitral valve. After the right ventricle, the left atrium and the interventricular septum had been repaired cardiopulmonary bypass was withdrawn. The patient had an uneventful recovery and was discharged from hospital on the 10th postoperative day. Twenty months later she is leading a normal life.

CASE 2

A 21 year old man was admitted to the emergency department two hours after he had been shot in the left chest with an entrance wound at the left posterior axillary line. He was in haemorrhagic shock with the signs of a left haemothorax, which was confirmed by chest radiography (fig 2a). There were no clinical signs of cardiac tamponade. His haemodynamic status was restored and stabilised after the institution of chest drainage and adequate fluid and blood replacement. After 48 hours he was well and the lungs were fully expanded, but he had a pericardial rub and there



Fig 1 Case 1: Chest radiograph showing the bullet free inside the left ventricular cavity.

were frequent ventricular dysrhythmias. A repeat chest radiograph (fig 2b) showed mediastinal enlargement, and the bullet's position had changed from that seen on the radiograph taken on admission (fig 2a). Since it was suspected that a bullet was free inside a cardiac chamber, fluoroscopy was performed and movement of the bullet was noted. The patient was taken to the operating theatre and the sternum was opened. The heart was enlarged and there was no clot in the pericardium. He was put on cardiopulmonary

bypass, with cannulation of the ascending aorta and the superior and inferior venae cavae. The aorta was clamped and the heart arrested by cold cardioplegia. A penetrating injury was identified on the back wall of the left ventricle close to the circumflex coronary artery. The left atrium was opened and inspected and the left ventricle approached through the mitral valve. With the mitral valve held wide open a 32 mm bullet was easily removed from an empty left ventricle. The left ventricle was repaired with Teflon pledgets, the

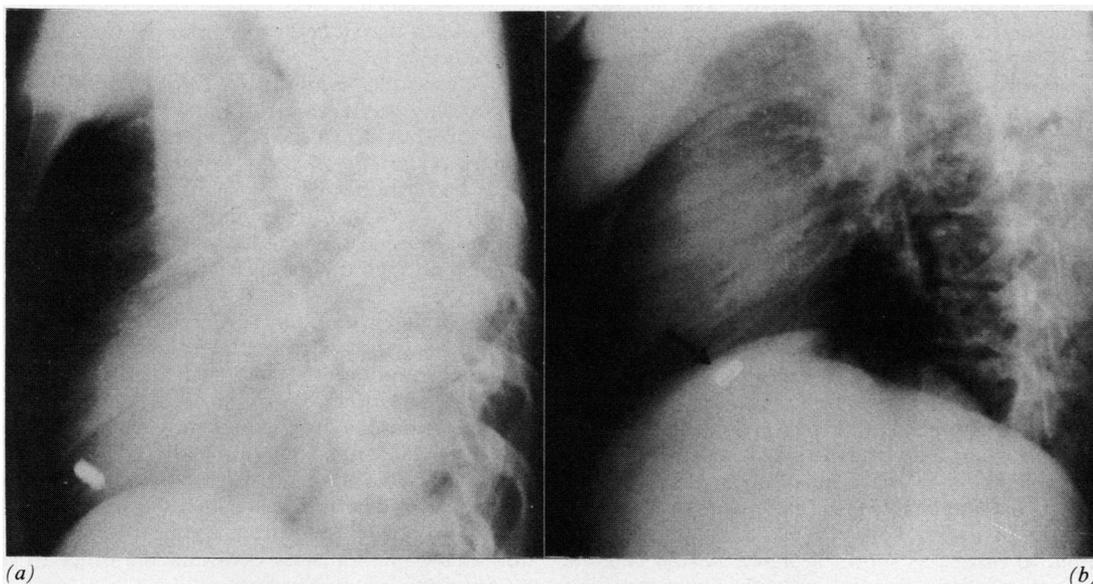


Fig 2 Case 2: Chest radiographs showing (a) bullet "out of focus" inside the left ventricular cavity, with left haemothorax still present; and (b) the changed appearances 48 hours later, when the left haemothorax had been drained and the bullet had moved into a different position.

left atrium closed and the heart weaned off cardiopulmonary bypass in the usual manner. The patient made an uneventful recovery and 10 months later is well.

CASE 3

A 15 year old boy was shot accidentally with a 22 mm pistol at the lower end of the sternum. Thirty minutes later, when he arrived at the emergency department, he was still conscious but had clinical signs of cardiac tamponade. A chest radiograph showed the bullet, which was "out of focus," to be in the cardiac area without associated haemothorax or pneumothorax. Fluoroscopy performed at the same time showed movement of the bullet, probably inside a cardiac chamber. He was taken to the operating theatre and the sternum opened, and when the pericardium had been relieved of a great quantity of clot cardiac function improved immediately. The heart was inspected and a tear, covered with clot, was identified on the anterior wall of the right ventricle, close to its diaphragmatic surface. Another perioperative radiograph confirmed that the bullet was in the heart. Cardiopulmonary bypass was instituted, with cannulation of the ascending aorta and the superior and inferior venae cavae. The aorta was clamped and the heart arrested with cold cardioplegia. The right ventricle was opened by broadening the initial tear and the bullet was removed from its cavity. The right ventricle was closed with Teflon pledgets and the heart weaned off cardiopulmonary bypass. The boy made an uneventful recovery and is well after one year.

Discussion

A wide range of penetrating cardiac injuries has been reported from both military and civilian experiences.¹⁰⁻¹⁷ Battlefield injuries are most frequently fatal; while reports of casualties in civilian life, usually with less damage, suggest that about half of these patients reach hospital alive. They usually present with cardiac tamponade, or are in haemorrhagic shock when the blood drains into a pleural cavity causing haemothorax. The details of the clinical diagnosis of cardiac injury have been described elsewhere^{5 10-12} and we wish to emphasise here that in special circumstances the suspicion of a retained cardiac foreign body should arise. In cases 1 and 3 it was not only the cardiac tamponade or the site of injury that led us to suspect that the missile was in the heart but the appearance of a missile out of focus on the chest radiograph. In case 2, as shown in figure 2a, the bullet is not as clearly defined as the rest of the film, suggesting that it was moving when the film was taken. As this patient had no clinical signs of cardiac tamponade the bullet's blurred image on the radiograph was initially

unnoticed. This particular detail, and the projection of the bullet in the cardiac area, should strongly suggest that a bullet could be free inside a cardiac cavity. The condition of these patients is usually unstable, so that a detailed cardiac investigation cannot be undertaken. Fluoroscopy becomes the main method of investigation in these circumstances; it is widely available and simple to perform, can be done quickly and can confirm whether the bullet moves with the movement of the heart. With experience it can be used to show that the bullet is free inside a cardiac chamber. When the patient is in a stable condition, as in case 2, a different position of the bullet in the cardiac area suggests the possibility of an intracardiac missile. Again, fluoroscopy can confirm the suspicion and an echocardiogram can offer additional information.

It has been difficult to define how frequently a foreign body that has penetrated the heart is in fact lying inside a chamber. Foreign bodies stated to be intracardiac in many cases referred to by Harken¹ proved after more accurate fluoroscopy, or at surgery, to be lying outside the heart. More commonly, bullets or fragments were found remaining in the muscle and sometimes protruding into a cardiac chamber. The arguments for removing them from the heart are to prevent embolisation of the foreign body or associated thrombus, to reduce the danger of bacterial endocarditis, and to prevent recurrent pleural effusions and myocardial or coronary damage.¹⁹ A more recent report from Bland and Beebe,⁷ who followed 40 patients with foreign bodies fixed in the heart over a period of 20 years, showed that effusions were present in 25% of the cases; the foreign body was successfully removed in three patients. Pneumonectomy was necessary in one patient, who had been found to have a shell fragment lodged in the left pulmonary artery 15 years earlier. All of these patients had a rather benign course during their lives, although there was tremendous psychological stress as a result of having a missile in the heart; this factor strongly affected their ability to make a complete recovery.

Less benign is the course of foreign bodies free in a cardiac chamber. Fritz and colleagues¹⁸ experimentally introduced 35 foreign bodies directly into the chambers of the heart in dogs. Only three remained within the heart, apparently caught between chordae, while all the others quickly embolised to the pulmonary or systemic circulation. Jones and Helmsworth⁵ described two patients in whom a bullet that had been lodged within the heart embolised—one to the inferior vena cava and the other to the origin of the left renal artery.

Harken¹ emphasised the use of several techniques for approaching foreign bodies and removing them from the chambers of the heart. The facilities at the

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time were far less adequate than those of today and this has probably led many surgeons to take a more expectant attitude, rather than advise urgent surgical intervention. In a recent report Zakharia¹⁴ reported his own extensive personal experience in the Lebanon war, when he operated on 285 patients with cardiac injuries, having removed four intracardiac missiles using inflow occlusion with hypothermia. Our three patients were managed by using cardiopulmonary bypass, a technique seldom required today for the management of other acute cardiac injuries. We believe that intracardiac foreign bodies can be easily dealt with by means of extracorporeal circulation; it is safer to use two caval cannulas than a single cannula in the right atrium. The bullet's exact position is not normally known before the operation, and the use of two venous cannulas permits the right atrium to be opened if necessary. The use of cold cardioplegia and moderate hypothermia (30°C) is also good practice, producing safe relaxation of the heart, which allows the surgeon to inspect the cavities and locate the foreign body. In our three cases they were easy to locate, but we imagine that they could be difficult to find. In patient No 1 cardiopulmonary bypass was necessary so that the damage to the posterior part of the left atrium could be repaired, as has been noted by others in similar circumstances.^{10 12} Without bypass, in cases two and three the bullet could probably have been removed by techniques described in earlier reports.^{1 2} On the other hand, extracorporeal circulation certainly makes it easier and safer to look for these foreign bodies, especially when their exact position within the heart has not been established pre-operatively. Under direct vision, having a certain period of safe ischaemia and a dry field gives a greater chance of success. In addition, all the necessary repairs can be performed at the same time.

Cardiac injuries encountered in civilian practice are usually far less extensive than those produced by modern military weapons. After emergency resuscitation a few victims may be found to have a foreign body lying free in a cardiac chamber, with the consequent risk of embolisation. An intracardiac bullet may be suspected from the site of the entry wound, from the position of the missile on the chest radiograph, and from the blurring of its image through movement. The intracardiac position can be confirmed by fluoroscopy and this should be followed by urgent removal. We believe that the use of cardiopulmonary bypass whenever possible should offer the best conditions for the location and removal of the bullet and for the repair of the myocardial injury while protecting the brain and myocardium from injury due to transient ischaemia.

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