Missiles in the Heart

Panagiotis N. Symbas, MD, Sue E. Vlasis-Hale, BS, Anthony L. Picone, MD, and Charles R. Hatcher, Jr, MD

Division of Cardiothoracic Surgery, Department of Surgery, Emory University School of Medicine and Grady Memorial Hospital, Atlanta, Georgia

The records of 24 patients who had a missile retained in the heart and who were treated at Grady Memorial Hospital from 1968 to 1987 were reviewed. In 22, the missile lodged in the heart after its direct injury and in the remaining 2, after the bullet injured a systemic vein. Immediately after the cardiac injury, 7 of the 22 patients were seen with cardiac tamponade (3 also had hemothorax), 11 were seen with hemothorax, 5 were asymptomatic, and 1 was in shock. Seven patients underwent emergency thoracotomy; the bullet was removed in 3, but in the remaining 4 patients, it was not located. In the other 17 patients and in the 4 in whom the bullet could not be found during emergency thoracotomy, the diagnosis was suspected from the chest roentgenograms and confirmed by cardiac fluoroscopy or angiocardiography.

Eight patients with retained bullets underwent elective operation; the bullet was removed from 7 and in 1 it was left embedded in the right ventricular septum. All 10 patients who underwent excision of the missile recovered without complication except 1 in whom pericarditis developed, and all were followed for up to 17 years. All 14 patients with a retained missile in the heart had no cardiac symptoms referable to the bullet and were followed for up to 15 years. This experience suggests that the management of patients with a bullet of .38 caliber or smaller that is retained in the heart should be individualized according to the patient's clinical course and the site of the bullet and that in select patients, bullets left in the heart are tolerated well.


Table 1. Missiles Retained in the Heart and Their Management

<table>
<thead>
<tr>
<th>Missile</th>
<th>Removed</th>
<th>Not Removed</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bullet</td>
<td>9</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Bullet fragment</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Pellets</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>10</td>
<td>14</td>
<td>24</td>
</tr>
</tbody>
</table>

The management of patients with a bullet in the heart remains controversial. To answer the questions whether or not all bullets in the heart should be removed and whether those that are not removed are tolerated over a long period, our experience at Grady Memorial Hospital was reviewed.

Material and Methods

During the 19-year period from 1968 to 1987, 24 patients with a bullet in the heart were treated at Grady Memorial Hospital. All of them were male, and age ranged from 16 to 54 years (mean age, 29 years). In 22 of the patients, the missile lodged in the heart after its direct injury. In the other 2, the bullet pierced and entered an iliac vein and subsequently migrated and became entrapped in the right ventricle. Eighteen of the retained missiles were bullets .38 caliber or smaller, one was a fragment of a bullet, and five were pellets (Table 1).

Immediately after the injury, 7 patients were seen with cardiac tamponade (3 of whom also had hemothorax), 11 were seen with hemothorax, 5 were asymptomatic, and 1 was in shock. Eight patients had concomitant intraabdominal injuries, and 2 other patients had abdominal injury resulting only in a wound of the iliac vein. The initial management consisted of observation of the 5 asymptomatic patients and tube thoracostomy in the patients with hemothorax. Seven patients underwent emergency ex-

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patients and by cardiac fluoroscopy in 5. The 4 patients who underwent emergency thoracotomy without removal of the bullet subsequently underwent angiocardiography for localization of the missile.

Seven of the 21 patients with a retained missile in the heart underwent elective operation without cardiopulmonary bypass, and the bullet was removed. One other patient was operated on with the use of cardiopulmonary bypass, but the bullet could not be removed safely because it was completely embedded high in the ventricular septum behind the tricuspid valve. In the remaining 13 patients, no attempt was made to retrieve the missile.

Therefore, 10 of the 24 patients, 9 with a bullet and 1 with a bullet fragment, had excision of the missile (see Table 1). The missiles were extracted for several reasons. In 3 patients, the missile was easily accessible at the time of emergency thoracotomy for cardiac tamponade. The bullet was removed in 3 patients because of fear of its subsequent embolization, thrombus formation with embolization, or subsequent development of bacterial endocarditis. In 2 of these patients the bullet was partially protruding into the left ventricular cavity, and in the other, the bullet was in the right inferior pulmonary vein at its junction with the left atrium. In 2 patients, 1 with a bullet adjacent to the main pulmonary artery and the other with a bullet near the ascending aorta, the missile was retrieved because of fear of subsequent erosion of these vessels. In the remaining 2 patients, both of whom had a bullet in the pericardial space, the missile was removed because of fear of subsequent pericarditis.

In 14 patients, 9 with a bullet and 5 with pellets, the missile was not removed (see Table 1). In 5 of these patients the missile was completely embedded in the right ventricular myocardium; in 3, in the left ventricular myocardium; and in 2, in the ventricular septum. In 2 other patients, the bullet was trapped in the right ventricular trabeculations following its migration from the iliac vein and in 2 more patients, the missile was in the pericardial space. These missiles were left in place because the patients did not want to be operated on, because the missile could not be safely removed, or because it was considered safe to leave the missile in place.

The 10 patients in whom the missiles were removed have been followed for 2 months to 17 years (mean follow-up, 4 years). The only complication in this group was the occurrence of postoperative pericarditis in 1 patient. The 14 patients in whom the cardiac missile was left in place have been followed from 2 months to 15 years (mean follow-up, 5 years; 4 have been followed for 10 years or more). All these patients were free from symptoms related to the missile. One patient died of alcoholic cardiomyopathy 17 months after injury (Table 2).

### Comment

With the progressive increase in the use of guns as assault weapons, the number of patients seen with a bullet in the heart is expected to rise. Bullets usually reach the heart after a penetrating wound to the heart or, rarely, to a systemic vein [1]. After injury to the heart, most missiles are either embedded in another organ or leave the thoracic cavity. Occasionally, however, at the time of the cardiac injury the bullet becomes embedded in the myocardium or falls into a cardiac chamber or the pericardial space. During the 19-year period of this study, we treated 68 patients with a gunshot wound to the heart. In 22 of them, the missile was retained in the heart.

A missile in the heart can be free in a cardiac chamber, partially embedded in the cardiac muscle and partially protruding into a cardiac chamber, or completely embedded in the myocardium. The missile can also be floating free in the pericardial space.

Bullets free in the left cardiac chambers usually embolize into a systemic artery shortly after entering the chamber [2]. Bullets free in the right cardiac chambers, particularly the right ventricle, can embolize into the pulmonary vascular bed [1] or may remain entrapped in its trabeculations indefinitely after they become encysted with fibrous tissue [3]. Sometimes, when a right-to-left shunt is present at the atrial level, a missile in the right atrium can migrate into the left atrium and embolize into the systemic arteries.

Bullets can occasionally reach the right side of the heart following an injury to a systemic vein. After entering a systemic vein, the missile usually migrates to the heart and either occasionally becomes entrapped in the right ventricular trabeculations or frequently embolizes into the pulmonary arterial bed [1]. In 2 of our 24 patients, the bullet reached and remained in the heart after an injury to an iliac vein and intravascular migration of the missile to the right ventricle.

The immediate postinjury clinical manifestations of missiles in the heart are those produced by the cardiac wound, ie, cardiac tamponade or intrathoracic bleeding. Rarely, patients with a bullet in the heart can have symptoms of valvular incompetence, communication between the aorta and the heart or pulmonary artery, and intraventricular communication or conduction defects, or they can be free from symptoms.

The subsequent manifestations of missiles in the heart are dependent on the site, shape, and size. Patients with bullets, particularly bullets with smooth edges and less than 1 to 2 cm in two of their three dimensions, embedded in the myocardium are usually free from symptoms [3-8]. Patients with bullets sitting free in a cardiac chamber or partially protruding into it can be seen with symptoms and signs of systemic or pulmonary embolization of the missile or thrombi, or they can be seen with a clinical picture of bacterial endocarditis [5, 8, 9]. Patients with bullets in the pericardial space can be asymptomatic or occasionally they have symptoms and signs of pericarditis, usually nonsuppurative [3, 10].

### Table 2. Results

<table>
<thead>
<tr>
<th>Result</th>
<th>Missiles Removed</th>
<th>Missiles Not Removed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asymptomatic</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Postoperative pericarditis</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Died of alcoholic cardiomyopathy</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>
Patients with a missile in the heart can also have neurotic manifestations of various degrees and character [8, 11]. Often they complain of palpitation, or occasionally they have a sense of impending death, not unlike that found in patients with coronary heart disease [9]. Although our patients were not asked any specific questions to uncover neurotic manifestations and no psychological testing was done, none of our patients during follow-up described to an examining physician any specific neurotic symptoms related to the retained missile. Also none of the patients in whom the bullet was not removed had any special complaints that could be attributed to the bullet. In only 1 patient did pericarditis develop after the bullet was removed.

The diagnosis of missile in the heart or pericardial space should be suspected when a metallic foreign body is seen in the cardiac silhouette in the initial roentgenogram. The diagnosis should be established first by cardiac fluoroscopy, and then the site and the degree of the bullet's embedment into the myocardium should be confirmed by echocardiography, computed tomography, or angiocardiography [12, 13].

In conclusion, our limited experience suggests that the management of patients with a bullet of .38 caliber or smaller should be individualized. Bullets easily accessible at the time of emergency thoracotomy for cardiac tamponade or bleeding should be removed. When this is not possible, the site and the degree of the embedment of the bullet in the myocardium should be confirmed by echocardiography, computed tomography, or angiocardiography before management is decided.

Missiles causing any symptoms should be removed. Bullets that are .38 caliber or smaller that are completely embedded in the myocardium appear to be well tolerated and can be left alone. Bullets partially or completely free in a left cardiac chamber should be removed to avoid systemic embolization of the bullet or clots or subsequent development of bacterial endocarditis. Bullets free in the right cardiac chambers should be allowed to embolize into the pulmonary artery where they can be retrieved without a cardiotomy. Two of our patients with a bullet trapped in the right ventricular trabeculations after migration through the systemic veins have had no problems from the bullet. Nevertheless, perhaps bullets trapped or partially protruding into a right cardiac chamber should be removed during the early postinjury period to protect the patient from the possible development of bacterial endocarditis. In an asymptomatic patient with a bullet that has been in a right cardiac chamber for a long time and in a patient with a bullet in the pericardial space, the bullet can be left alone.

Although most bullets can be found and removed at the time of an elective operation, occasionally this is not the case, as in 1 of our patients. Perhaps the use of other techniques intraoperatively to help precisely localize the bullet, such as ultrasonography [14], may be useful in these rare instances.

References