

EDITORIAL COMMENT

Gunshot-Related Cardiac Trauma

A Multidisciplinary Approach Using Multimodality Imaging*



Santhi Adigopula, MD,^a Lalitha C. Medepalli, MD^b

The Centers for Disease Control and Prevention estimates that close to 40,000 firearm injury-related deaths were reported in the United States in 2018 (1). These injuries could have resulted from intentional self-injury or unintentional injury due to accidental firing, firearm homicide, or an assault injury from a firearm. Although rare, cardiac firearm injuries are associated with high mortality due to associated vascular injury to the aorta, vena cavae, and pulmonary vessels (2). Because most of the current literature on gunshot-related cardiac injuries was acquired during world wars and regional conflicts, the data are limited (3).

Cardiac gunshot wounds to the thoracic cavity can occur through either a direct penetrating injury or blunt trauma. The clinical presentation of these injuries can range from asymptomatic to life-threatening; hence, prompt recognition is crucial because of the following: 1) direct coronary vessel injury can occur and potentially result in ST-segment elevation myocardial infarction; 2) cardiac contusion can possibly result in conduction system abnormalities, heart blocks, and arrhythmias; 3) cardiac structural damage can result in conceivable valvular or sub-valvular injury, fistulas, aneurysms, or ventricular free-wall rupture; 4) pericardial injuries may occur and include pericardial laceration, effusion, and

hemopericardium; and 5) pellets can be deposited in the intracardiac chambers, which have the risk of distal embolization.

Penetrating cardiac trauma remains a serious, socially linked disease. Several factors can influence the extent of trauma, including the entry and exit of bullet wounds, the trajectory of the bullet, and the structural anatomy of the heart. Cardiac injuries may result in single or multiple chamber involvement. Due to its more anterior position within the thoracic cavity, the right ventricle is more commonly affected, followed by the left ventricle, right atrium, and left atrium.

The management of patients with cardiac gunshot injuries is based on the patient's hemodynamic status. Patients with hemodynamic instability are explored urgently, whereas those with stable hemodynamic parameters can be considered to receive conservative management on a case-by-case approach (4). Understanding the pathophysiology and mechanism of the gunshot-related wound with prompt intervention is important to prevent future complications.

Asymptomatic dislodgement of the bullet should be observed carefully over time if the patient is stable, because operating on these patients can sometimes be risky due to associated damage to the surrounding structures. However, the decision must be individualized after determining the extent of injury using multiple imaging modalities. There are few relative indications in which removal of lodged bullets in asymptomatic patients is recommended, such as in patients who need cardiac magnetic resonance (CMR) imaging (5).

In this issue of *JACC: Case Reports*, Jain et al. (6) highlighted a case of a 38-year-old man with a bullet lodged intrapericardially with no damage to the intracardiac chambers. His clinical findings and electrocardiographic abnormalities suggested the

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From the ^aDivision of Cardiology, Department of Medicine, The Heart Center of Northeast Georgia Medical Center, Gainesville, Georgia, USA; and ^bNoninvasive Cardiology, Northside Hospital Cardiovascular Institute, Northside Hospital, Atlanta, Georgia, USA.

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possibility of pericardial involvement, but there was minimal elevation in troponin I levels, which suggested no major myocardial involvement. Non-gated contrast-enhanced computerized tomography (CECT) of the thorax was the initial imaging approach to investigate the etiology; however, it was limited by beam artifact. Therefore, the investigators used multimodality imaging with transthoracic echocardiography and a transesophageal echocardiography to locate the bullet. The patient successfully underwent surgical exploration with a good outcome (6).

Shah et al. (7) described a case of a 29-year-old man who presented with multiple gunshot wounds. Due to vascular trauma and multiple fractures, the patient underwent immediate surgical exploration. He was noted to have ST-segment elevation on telemetry during the peri-operative period. Based on echo findings and a multidisciplinary team approach, conservative management was decided on initially. Because the patient became hemodynamically unstable within the course of a few hours, it was commendable that the investigators used serial bedside portable imaging to make the appropriate diagnosis of pericardial effusion and tamponade. The team also reinitiated a multidisciplinary team approach that involved trauma surgery, cardiothoracic surgery, and cardiology service teams. This led to prompt recognition of tamponade in a unique complex circumstance with an emergent intervention and repair of the epicardial laceration over the right ventricle. Had the injury not been recognized in a timely manner, the outcome could have been detrimental.

Also, in this issue of JACC: Case Reports, Donuru et al. (8) highlighted a case from a pediatric population with remote history (approximately 5 years ago) of gunshot injuries. Chest x-ray abnormality in this patient prompted further evaluation. Echocardiography, together with advanced imaging techniques and CMR imaging, were used to identify a left ventricular apical aneurysm. Other imaging tools, including exercise stress testing and a 24-h Holter monitor, were used to allow for risk stratification and clinical management of this patient. Intervention was subsequently decided against, and the patient was followed closely.

In summary, bedside echocardiography is an excellent noninvasive imaging modality to evaluate for pericardial effusion and tamponade and to

assess for left ventricular regional wall motion abnormalities, hemodynamically significant valvular abnormalities, stress cardiomyopathy, foreign body in the cardiac chambers, and wall rupture. Advanced imaging modalities including CECT and CMR can identify pseudo and true aneurysms, location of the bullet wound, extent, thrombus, and delayed hyper-enhancement. A multidisciplinary approach involving cardiologists, trauma, and cardiothoracic surgeons is crucial to recognize and to treat the trauma related to the penetrating injury to the cardiovascular system, thereby preventing morbidity and mortality. All 3 cases were unique by themselves in demonstrating consistent, continuous, and coordinated care using multiple yet different imaging modalities to achieve positive outcomes.

These case reports highlight the need for increased awareness and vigilant monitoring of post-acute cardiac trauma patients with a penetrating wound or in patients with a remote history of cardiac trauma who needs follow-up over time. Early detection can lead to earlier diagnosis of potentially life-threatening complications, resulting in reduced morbidity and mortality. Multimodality imaging techniques including CECT and cardiac MRI were used, and these, combined with emerging bedside technologies including 3-dimensional echocardiography and contrast-enhanced ultrasound imaging, will be of great value in the future in triaging patients early on to direct and coordinate care.

Gunshot-related cardiac trauma is challenging for patients, physicians, and families. It is important to decide on a team approach with patient and family involvement to achieve a successful outcome and establish long-term follow-up. In addition, it is important to recognize that a subset of patients with cardiac trauma may develop post-traumatic stress disorder. Appropriate counseling should be also be offered to these patients (9).

AUTHOR DISCLOSURES

Both authors have reported that they have no relationships relevant to the contents of this paper to disclose.

ADDRESS FOR CORRESPONDENCE: Dr. Santhi Adigopula, The Heart Center of Northeast Georgia Medical Center, 200 S. Enota Drive NE, Suite 100, Gainesville, Georgia 30501, USA. E-mail: adigopula.santhi@gmail.com.

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