

# Air Gun Ballistic Projectile Lodged in the Interventricular Septum of an Asymptomatic Dog



Philip R. Fox, DVM, Ann E. Hohenhaus, DVM, and Rima J. Kharbush, DVM, *New York, New York*

## INTRODUCTION

Gunshot wounds are a common cause of morbidity, disability, and often fatality in the United States.<sup>1,2</sup> Penetrating cardiac wounds are the most lethal form of cardiothoracic trauma.<sup>3</sup> Gunshot injury is also a source of trauma to companion animals, and in one study, 22% of gunshot wounds involved the thorax.<sup>4</sup> Nonpowder firearm injuries from air guns, including BB and pellet guns, are an overlooked but important cause of serious, preventable injury, especially in children.<sup>5-7</sup> Nonfatal gunshot wounds leading to projectile lodgment within the myocardium are rarely reported.

## CASE PRESENTATION

An asymptomatic, 14-month-old, mix-breed, female dog weighing 20.5 kg was presented for routine veterinary examination. It had been orphaned and rescued in Texas, tested positive for *Dirofilaria immitis* (heartworm disease), and was medically managed according to American Heartworm Society guidelines.<sup>8</sup> A soft, systolic heart murmur was detected, and a point-of-care cardiac ultrasound examination was performed. A metal-density foreign body was identified within the basal interventricular septum. One month later, the dog was referred to a veterinary cardiology specialist. At physical examination the dog appeared to be healthy. Overt chest wall injury or superficial wounds were not detected. Thoracic radiographs were taken, and two metallic projectiles were seen, one adjacent to the right, 13th costovertebral junction and the second summated over the heart, with no other findings (Figure 1).

A comprehensive two-dimensional echocardiographic examination revealed a metallic projectile embedded within the basilar interventricular septum below the insertion of the mitral and tricuspid valve leaflets (Videos 1 and 2).

The width of this interventricular segment measured at end-diastole was 9.1 mm. The projectile lodged within this segment measured 5.8 mm in diameter. No associated flow disturbance, septal defect, pericardial or pleural effusion, arrhythmia during simultaneous electrocardiographic recording, or hemodynamic compromise was detected. The echocardiographic examination was otherwise unremarkable. Epithelialization around the embedded projectile

was presumed to account for lack of shunting around the projectile. When the projectile's echocardiographic position and orientation relative to the basal interventricular septum were compared with similar characteristics from initial point-of-care images, these relationships were subjectively judged to be unchanged. Because the ferromagnetic features of the projectiles could not be confirmed, magnetic resonance imaging was not performed out of concern for secondary dislocation. Computed tomography was not performed, because of anticipated metal density-induced artifact. Overall, given the absence of clinical symptoms or cardiac complications, conservative management was elected. Serial echocardiography to monitor for bullet migration or development of related new acquired cardiovascular injuries was recommended.

## DISCUSSION

In this asymptomatic dog, detection of a metallic projectile embedded in the interventricular septum was unanticipated. Forensic details pertaining to weapon, external and terminal ballistics, distance from muzzle to victim, and time course between the gunshot wound and the date of veterinary examination were unknown. However, the physical features of the metallic projectiles were consistent with ballistic, pointed-shaped, metallic pellets fired by nonpowder air guns (also referred to as air rifles, pellet guns, and BB guns). These weapons use compressed air or other gasses to pneumatically propel metallic projectiles and are manufactured to shoot missiles of various calibers. Caliber .177 and .22 lead or lead-based alloy pellets are most common.<sup>9</sup> The projectile's diameter measured from the right parasternal four-chamber echocardiographic view in the present case was proportional to a .22 caliber gun. Modern pellets fired by air guns resemble an hourglass shape, known as a "diablo design," and are further classified on the basis of the shape of the projectile head.<sup>10</sup> Pointed-shaped pellets are marketed for optimal tissue penetration. The metallic projectiles found in this dog conformed to this design. One pellet was within soft tissue adjacent to the spine of the dog, and one pellet was embedded in the interventricular septum. In a case report of a 2-year-old child shot with a similar projectile fired from an air rifle, the projectile was also reported to be lodged within the interventricular septum.<sup>11</sup> Because air guns do not use explosives to expel projectiles, in the United States, they are not classified by the Bureau of Alcohol, Tobacco, Firearms, and Explosives as firearms.<sup>12</sup> Ownership laws and restrictions regulating nonpowder guns vary from state to state.<sup>13</sup> Other countries such as Canada apply different metrics, where regulations are influenced by ballistic details that incorporate muzzle velocity and/or muzzle energy.<sup>14</sup> Nevertheless, whether air guns are subsonic, high velocity, or designated as firearms or not, their missiles are capable of penetrating vital organs and can result in substantial morbidity, as well as life-threatening and fatal injuries.<sup>11,15-17</sup>

In the case presented here, we presumed that a direct, penetrating gunshot wound to the heart was plausible to explain the projectile's

From the Department of Cardiology and Caspary Research Institute (P.R.F.), The Cancer Institute (A.E.H.), and the Department of Cardiology (R.K.), The Animal Medical Center, New York, New York.

Keywords: Cardiac, Gunshot, Interventricular septum, Air gun, Canine

Conflicts of interest: The authors reported no actual or potential conflicts of interest relative to this document.

Copyright 2020 by the American Society of Echocardiography. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

2468-6441

<https://doi.org/10.1016/j.case.2020.08.011>

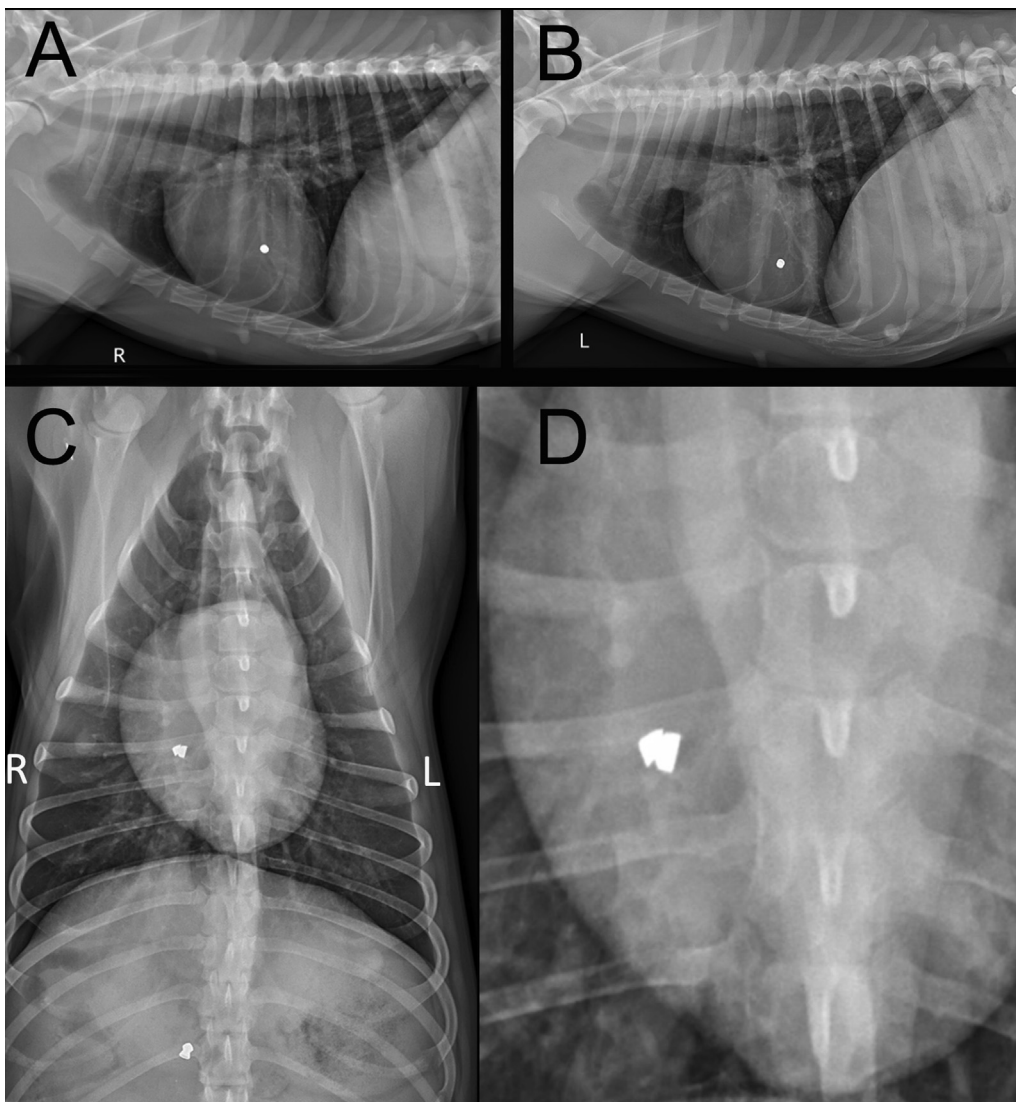
**VIDEO HIGHLIGHTS**

**Video 1:** Transthoracic two-dimensional echocardiogram. Right parasternal long-axis four-chamber cardiac view shows a homogeneous, hyperechoic projectile embedded in the basal interventricular septum. There was no associated septal defect or pericardial or pleural effusion. Reverberation artifact is seen beneath the metallic projectile.

**Video 2:** Transthoracic two-dimensional echocardiogram. Short-axis cardiac view shows a homogeneous, hyperechoic projectile embedded in the basal interventricular septum. There was no associated septal defect or pericardial or pleural effusion. Reverberation artifact is seen beneath the metallic projectile.

View the video content online at [www.cvcasejournal.com](http://www.cvcasejournal.com).

being completely embedded within the approximately 9-mm-thick basal interventricular septum. As such, the ballistic projectile would have had to contain sufficient velocity and energy, relative to the distance between the patient and weapon, to perforate skin, muscle, lung, pericardium, and heart. At the time of examination there was no evidence of pericardial or pleural effusion. Such findings also were reported in a young child who sustained a penetrating cardiac injury from a similar ballistic projectile that was fired from an air gun.<sup>11</sup> However, we could not exclude the alternative possibility that the heart was the final destination for the ballistic projectile, following a wound to the systemic venous system that embolized to the right heart. Although rare, bullet embolization is a potential complication of penetrating gunshot wounds when metallic ballistic projectiles gain access to the vascular compartment, and projectiles embedded within the myocardium have been reported. A case in point is that of a 28-year-old man who sustained a gunshot wound to the right abdomen and 2 months later was found with a ballistic projectile partially embedded in the trabeculated right ventricle. This final cardiac destination was attributed to bullet migration along



**Figure 1** Thoracic radiographic views from a 14-month-old, mix-breed, female dog. **(A)** Right lateral, **(B)** left lateral, **(C)** ventrodorsal, and **(D)** magnified view from **(C)**. A small, pointed-tip, metallic-density, ballistic projectile summates over the cardiac silhouette in all views. In **(B)** and **(C)**, a second metallic projectile is seen adjacent, and to the right, of the 13th costovertebral junction. L, Left; R, right.

the vena cava.<sup>18</sup> Factors associated with embolization of ballistic projectiles include vascular access from wounds, direct propulsion, vascular erosion, projectile size and shape, body position, gravity, muscular and respiratory motion, and other causes.<sup>18-21</sup> Ballistic projectiles entering the venous system with cardiac embolization commonly migrate to the right heart, especially the right ventricle,<sup>22</sup> with the pulmonary artery, lung, and other final destinations reported less frequently.

Because this dog displayed no clinical signs or complications on physical examination, radiography, and echocardiography, we elected a conservative approach, as has been advocated in the human literature.<sup>23,24</sup> This included serial echocardiography, as projectile-related erosion, migration, and other complications can develop months following cardiac trauma.<sup>23</sup>

## CONCLUSION

This case contributes to the literature demonstrating that air guns are capable of inflicting serious cardiac injury. A ballistic metallic projectile lodged within the interventricular septum of this dog was plausibly the result of direct cardiac penetration. However, we could not exclude the possibility of a gunshot wound that caused vascular injury, with subsequent projectile migration and embolization to the right heart as the final destination. At the time of medical examination, this dog was asymptomatic and without apparent complications. Conservative management was selected with sequential echocardiography intended to monitor for projectile migration or late-developing complications.

## SUPPLEMENTARY DATA

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.case.2020.08.011>.

## REFERENCES

1. Vyrostek SB, Annest JL, Ryan GW. Surveillance for fatal and nonfatal injuries—United States 2001. *MMWR Surveill Summ* 2004;53:1-57.
2. Centers for Disease Control and Prevention. WISQARS™—Web-Based Injury Statistics Query and Reporting System. Available at: <https://www.cdc.gov/injury/wisqars/>. Accessed June 12, 2020.
3. Abbas S, Riaz MN, Zameer M, Khan AA, Ahmad W. Cardiac trauma with gunshot injuries. *J Coll Physicians Surg Pak* 2004;14:41-2.
4. Olsen LE, Streeter EM, DeCook RR. Review of gunshot injuries in cats and dogs and utility of a triage scoring system to predict short-term outcome: 37 cases (2003–2008). *J Am Vet Med Assoc* 2014;245:923-9.
5. Kumar R, Kumar R, Mallory GW, Jacob JT, Daniels DJ, Wetjen NM, et al. Penetrating head injuries in children due to BB and pellet guns: a poorly recognized public health risk. *J Neurosurg Pediatr* 2016;17:215-21.
6. Jones M, Kistangari S, Smith GA. Nonpowder firearm injuries to children treated in emergency departments. *Pediatrics* 2019;144:e20192739.
7. Centers for Disease Control and Prevention. BB and pellet gun-related injuries—United States, June 1992–May 1994. Available at: <https://www.cdc.gov/mmwr/preview/mmwrhtml/00039773.htm>. Accessed June 12, 2020.
8. American Heartworm Society. Current canine guidelines for the prevention, diagnosis, and management of heartworm (*Dirofilaria immitis*) infection in dogs (revised 2018). Available at: <https://www.heartwormsociety.org/images/pdf/2018-AHS-Canine-Guidelines.pdf>. Accessed June 14, 2020.
9. Air Gun Planet. Choose the right airgun caliber for maximum results!. Available at: <https://airgunplanet.com/choose-the-right-airgun-caliber-for-maximum-results/>. Accessed September 12, 2020.
10. Beeman RD. Airgun projectiles. Available at: [http://www.beemans.net/airgun\\_projectiles.htm](http://www.beemans.net/airgun_projectiles.htm). Accessed June 12, 2020.
11. Sidhu M, Singh HP, Chopra AK, Kapila D, Goel P, Anand M. Cardiac gunshot injury: child with stable presentation and asymptomatic short-term follow-up. *Echocardiography* 2010;27:208-9.
12. Bureau of Alcohol, Tobacco, Firearms and Explosives. Firearms questions & answers. Available at: <https://www.atf.gov/questions-and-answers/firearms-qas>. Accessed June 12, 2020.
13. Giffords Law Center. Non-powder & toy guns. Available at: <https://lawcenter.giffords.org/gun-laws/state-law/50-state-summaries/non-powder-guns-state-by-state/>. Accessed June 14, 2020.
14. Royal Canadian Mounted Police. Specific types of firearms: air guns. Available at: <https://www.rcmp-grc.ca/en/firearms/specific-types-firearms#ag>. Accessed June 12, 2020.
15. Aslan S, Uzkeser M, Katirci Y, Cakir Z, Bilir O, Bilge F, et al. Air guns: toys or weapons? *Am J Forensic Med Pathol* 2006;27:260-2.
16. Hyak JM, Todd H, Rubalcava D, Vogel AM, Fallon S, Naik-Mathuria B. Barely benign: the dangers of BB and other nonpowder guns. *J Pediatr Surg* 2020;55:1604-9.
17. DeCou JM, Abrams RS, Miller RS, Touloukian RJ, Gauderer MW. Life-threatening air rifle injuries to the heart in three boys. *J Pediatr Surg* 2000;35:785-7.
18. Charniot JC, Leprince P, Cluzel P, Demondion P. Percutaneous transjugular extraction of venous bullet embolism to the right ventricle. *Ann Thorac Surg* 2018;106:e281-3.
19. Colquhoun IW, Jamieson MPG, Pollock JCS. Venous bullet embolism—a complication of airgun pellet injuries. *Scott Med J* 1991;36:16-7.
20. Bining HJS, Artho GP, Vuong PD, Evans DC, Powell T. Venous bullet embolism to the right ventricle. *Br J Radiol* 2007;80:e296-298.
21. Michelassi F, Pietrabissa A, Ferrari M, Mosca F, Vargish T, Moosa HH. Bullet emboli to the systemic and venous circulation. *Surgery* 1990;106:239-45.
22. Yoon B, Grasso S, Hofmann LJ. Management of bullet emboli to the heart and great vessels. *Mil Med* 2018;183:e307-13.
23. Kumar S, Moorthy N, Kapoor A, Sinha N. Gunshot wounds: causing myocardial infarction, delayed ventricular septal defect, and congestive heart failure. *Tex Heart Inst J* 2012;39:129-32.
24. Symbas PN, Picone AL, Hatcher CR, Vlasis-Hale SE. Cardiac missiles. A review of the literature and personal experience. *Ann Surg* 1990;211:639-47.