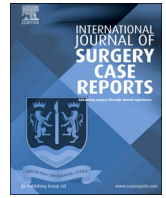


Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

International Journal of Surgery Case Reports

journal homepage: www.casereports.com

Bullet embolization to the heart: A rare and confounding penetrating cardiac injury case report

Despoina Daskalaki^a, Hazim Hakmi^a, Adam Stright^a, Brian Mitzman^b, Evan R. Mair^c, D'Andrea K. Joseph^a, Gerard A. Baltazar^{a,*}

^a NYU Langone Health, Department of Surgery, United States

^b NYU Langone Health, Department of Cardiothoracic Surgery, United States

^c NYU Langone Health, Department of Radiology, United States

ARTICLE INFO

Article history:

Received 14 May 2020

Received in revised form 21 June 2020

Accepted 21 June 2020

Available online 25 June 2020

Keywords:

Trauma

Cardiac

Gunshot wound

ABSTRACT

Gunshot wounds to the cardiac region usually result in devastating injuries. However, if bullets embolize into the myocardium without significant damage to the organ, optimal evaluation and management remains unclear. We present the case of a hemodynamically stable gunshot wound patient who presented with a bullet to the heart. Sternotomy revealed that the bullet had embolized through the superior vena cava and embedded into the apex of the right ventricle. The patient was managed without retrieval of the bullet and continues to be well despite a retained intracardiac bullet. We discuss cases of bullet embolization to the heart and the emergence of minimally-invasive approaches for management.

© 2020 The Authors. Published by Elsevier Ltd on behalf of IJS Publishing Group Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Gunshot wounds (GSWs) to the cardiac region usually result in devastating injuries with a high mortality rate [1]. Survival from cardiac injury may be predicted from the presence of cardiac tamponade, physiologic status on presentation, injury to one or more cardiac chambers, and the need for resuscitative thoracotomy [2]. In rare cases, bullets may penetrate the pericardium but not directly damage the heart [3,4]. Even less commonly, bullets may travel with the blood into the heart and injure the endocardium [5–9]. The management of a hemodynamically unstable patient with cardiac GSW is universally operative [10]. However, management of a hemodynamically stable patient after a GSW to the cardiac area with no clear signs of penetrating cardiac injury, may proceed without initial operation [11].

We present the case of a hemodynamically stable young male who suffered a GSW to the right chest. Computed Tomography (CT) scan performed because of his stability, demonstrated a bullet in close proximity to the heart. Sternotomy revealed bullet embolization through the superior vena cava (SVC) to the right ventricle that then embedded in the apical endocardium, obviating safe retrieval. We discuss the literature on bullet embolization to the heart and options of observation, endovascular and open surgical management.



Fig. 1. Entry site of bullet (black-outlined arrow).

2. Presentation of case

A 37-year-old male with no significant medical history presented to a level 1 trauma center as a level 1 trauma activation after suffering a single GSW to the right anterior chest just lateral to the midclavicular line at approximately the level of the fourth thoracic vertebra (Fig. 1). On presentation, his only complaint was pain localized to the GSW. All vital signs were stable. A chest x-ray and focused abdominal sonogram for trauma were emergently

* Corresponding author at: NYU Langone Health, NYU Winthrop Hospital, 222 Station Plaza North, Suite 300, Mineola, NY 11501, United States.

E-mail address: Gerard.Baltazar@nyulangone.org (G.A. Baltazar).

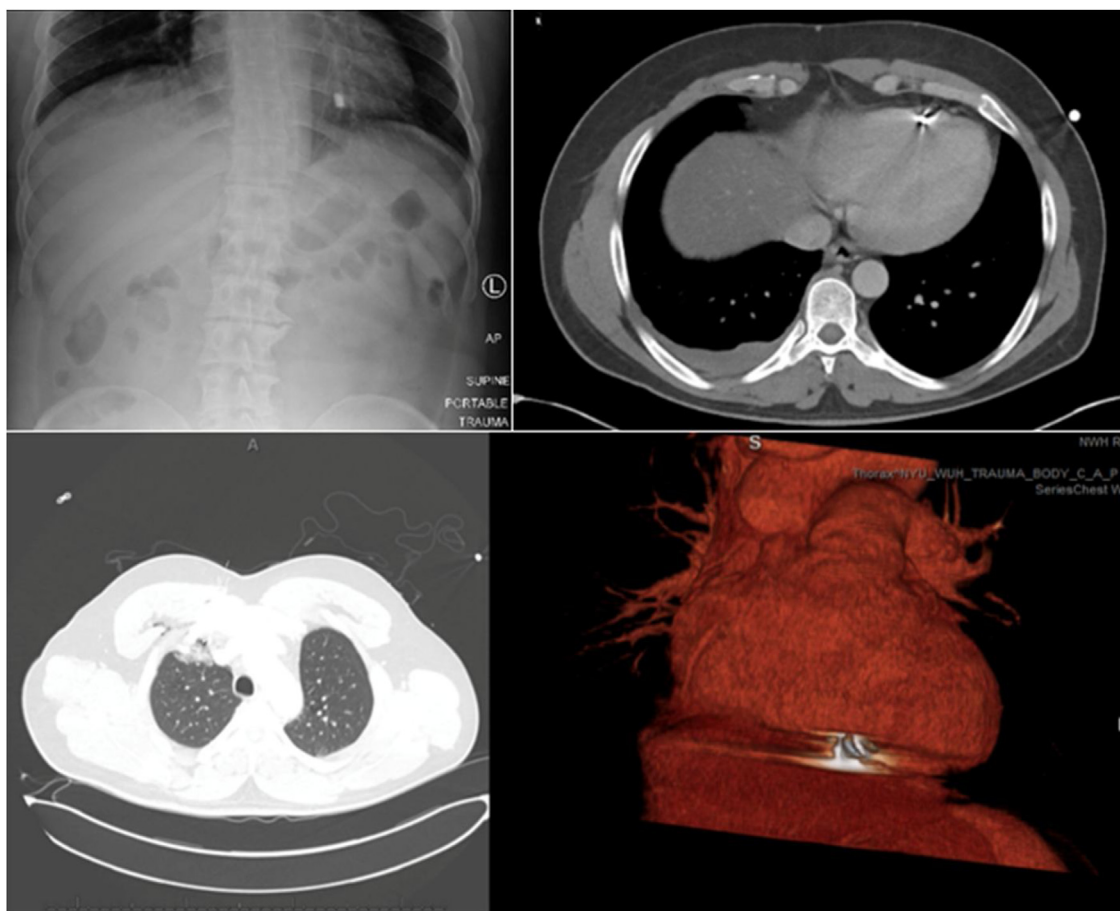


Fig. 2. Preoperative radiographic studies attempting to localize bullet. 2a. Chest x-ray showing hyperdensity (bullet) sitting to left of midline. 2b. Axial CT with bullet anterior to intra-ventricular septum. 2c. Axial CT with bullet track through anterior chest wall, and lung parenchymal contusion in region of the SVC. 2d. 3D reconstruction of bullet between inferior border of heart and diaphragm.

performed. Imaging revealed no pneumothorax, hemothorax, pericardial effusion, or intra-abdominal free fluid. The patient was taken for a CT scan which showed a focused area of parenchymal lung injury in the right anterior upper lobe with an adjacent first rib fracture.

The bullet was noted to be anterior to the apex of the heart in the pericardial fat (Fig. 2). Laboratory values were within the normal limits, including a hemoglobin of 14.7 g/dL, base deficit of 1 mEq/L and troponins <0.1 ng/mL. An electrocardiogram demonstrated normal sinus rhythm with heart rate of 79 beats per minute.

A transthoracic echocardiogram was unable to clarify whether the bullet was outside or within the pericardial sac, and a three-dimensional reconstruction of the initial CT scan was performed. Interpretation by a dedicated thoracic radiologist was that the bullet was not within the pericardium. The presence of an upper mediastinal hematoma raised moderate suspicion that the bullet had migrated inside the pericardial sac from its entry site in the anterior mediastinum. Due to concern for future cardiac irritation and endocardial erosion, the decision was made for exploration performed by thoracic and cardiac surgeons.

A subxiphoid pericardial window did not reveal a bloody pericardial effusion or the presence of a bullet. This was converted to a sternotomy because of a high index of suspicion, and this also did not reveal the bullet in the pericardial sac or in either pleural space. There were no outward signs of myocardial injury. We identified a moderately-sized hematoma in the right hilum, surrounding the SVC, without active bleeding. Fluoroscopy confirmed the location of the bullet to be midline and in the region

of the heart. We lifted the apex of the heart, and the bullet was palpated in the right ventricular myocardium just lateral to the septum. A simple ventriculotomy failed to allow access to the bullet. The bullet had embedded through the endocardium into the deep myocardium, and retrieval would have likely necessitated cardiopulmonary bypass with extensive cardiac dissection.

The decision was made to leave the bullet in place, and the ventriculotomy was repaired and the chest closed. The patient had an uneventful recovery. At 3-month follow up, the bullet had not changed position on chest x-ray.

3. Discussion

We present the case of a healthy, hemodynamically stable young male, who suffered bullet embolization through the SVC into the endocardium of the right ventricle (Fig. 3). The rarity of his case combined with benign presentation and inconclusive imaging created challenges with regard to choice of treatment modality. Few cases of bullets or bullet fragments embolizing to the right heart exist in the literature, and most are isolated case reports or case series [5–9]. Thus, definitive guidelines for evaluation and management have yet to be developed.

In 2018, Yoon et al. performed a systematic review of 54 articles, reporting 62 patients with thoracic bullet emboli [11]. The authors found that 64.7% of bullet emboli that enter the venous system migrate into the right heart with most such emboli being caught in the chordopapillary apparatus or ventricular trabeculae. In line

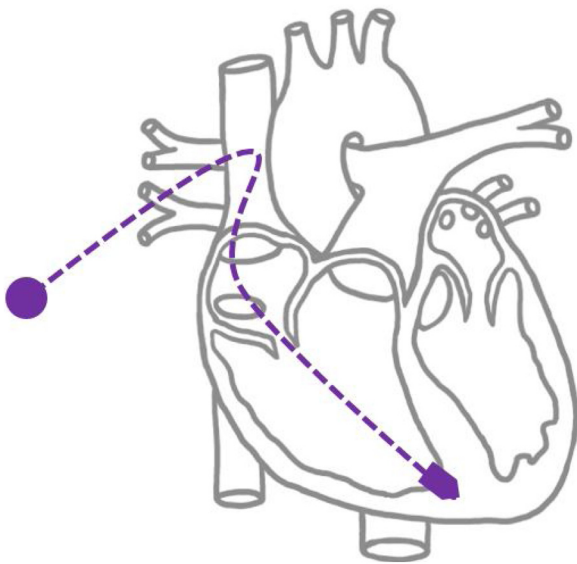


Fig. 3. Bullet entry (circle), embolization track through superior vena cava (dashed line), and final site of embedding in right para-septal ventricular myocardium (bullet).

with our case, Yoon et al. found that nearly 90% of such cases are asymptomatic on initial presentation [11].

The workup of patients with GSWs to the chest begins with Advanced Trauma Life Support protocols and guidelines. Patients who remain stable may undergo adjunct imaging to help determine the specific location of the bullet as a guide for management.

Suspicion for bullet emboli should occur in the setting of radiographic evidence of a missile and ongoing hemodynamic stability. Imaging options include X-ray, Computed Tomography, and transthoracic and/or transesophageal echocardiography. Hashimi et al. found transesophageal echocardiography superior to transthoracic echocardiography for the localization and characterization of intracardiac bullet fragments [12]. Indeed, localization is essential for the surgeon contemplating observation versus operative intervention [13].

In addition to observation and open operative retrieval, endovascular extraction of intracardiac missiles has emerged as a viable option. In Yoon et al.'s review, endovascular retrieval was successful in 53% of attempts. Of the endovascular attempts that failed, 28.6% were successfully observed, and 71.4% underwent open retrieval [11]. Thus, despite clinical earnest to retrieve intracardiac bullets, observation in the asymptomatic patient may be a satisfactory approach particularly if the bullet appears to be small caliber or firmly lodged and immobile [11,13]. To leave the bullet and observe or to remove the bullet invasively is not an easy decision, and discussion should occur between the patient and treatment team. Embolization of intracardiac bullets into the distal pulmonary artery branches is unlikely to have a significant impact based on available literature on fractured IVC filter fragments leading to benign pulmonary artery embolization [14].

This case report has been reported in line with the SCARE 2018 criteria [15].

4. Conclusion

Our review of the literature and current experience suggests that the initial management of hemodynamically stable patients with suspected intracardiac bullet emboli can be non-operative. Non-operative management should include intensive care observation along with transesophageal echocardiography to better-localize the bullet. Considering endovascular approaches with preparation

for possible open operative intervention is a valid alternative that carries a higher risk of morbidity and mortality, in comparison to non-operative management [12,13]. Intracardiac bullets can be left in place, with no significant impact.

Declaration of Competing Interest

None.

Funding

None.

Ethical approval

This is a case report, thus exempted from IRB approval.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

Despoina Daskalaki: Writing original draft.
 Hazim Hakmi: Writing original draft.
 Adam Stright: Review and editing.
 Brian Mitzman: Review and editing.
 Evan R. Mair: Reviewing.
 D'Andrea K. Joseph: Supervision, review and editing.
 Gerard A. Baltazar: Writing original draft, supervision, review and editing.

Registration of research studies

Case report does not need to be registered.

Guarantor

D'Andrea K. Joseph.
 Gerard A. Baltazar.

Provenance and peer review

Not commissioned, externally peer reviewed.

References

- [1] A.L. Tang, K. Inaba, B.C. Branco, M. Oliver, Postdischarge complications after penetrating cardiac injury: a survivable injury with a high postdischarge complication rate, *Arch Surg.* 146 (September (9)) (2011) 1061–1066, <http://dx.doi.org/10.1001/archsurg.2011.226>.
- [2] J.G. Tyburski, L. Astra, R.F. Wilson, C. Dente, Factors affecting prognosis with penetrating wounds of the heart, *J. Trauma* 48 (April (4)) (2000) 587–590, <http://dx.doi.org/10.1097/00005373-200004000-00002>, discussion 590–591.
- [3] J.H. Choi, J.S. Uhm, S.E. Lee, K.H. Chun, H.J. Lee, Constrictive pericarditis long after a gunshot wound, *Korean Circ. J.* 45 (July (4)) (2015) 333–336, <http://dx.doi.org/10.4070/kcj.2015.45.4.333>, Epub 2015 Jul 24.
- [4] M.W. Khalil, T. Khan, S. Gower, M. Loubani, Removal of a bullet in the pericardial cavity by video-assisted thoracoscopic surgery, *Interact. Cardiovasc. Thorac. Surg.* 15 (August (2)) (2012) 297–298, <http://dx.doi.org/10.1093/icvts/ivs079>, Epub 2012 May 17.
- [5] H. Sarmast, A. Takriti, Tricuspid valve incompetency due to the grenade chip embolization to the heart, *Open J. Cardiovasc. Surg.* 5 (June (11)) (2019), <http://dx.doi.org/10.1177/1179065219853587.eCollection2019>, 1179065219853587.

- [6] A. Mojtahedi, S. Contractor, P.S. Kiszka, Endovascular approach for management of bullet embolization to the heart, *Vasc. Endovascular Surg.* 52 (May (4)) (2018) 295–298.
- [7] I.F.H. Elsis, A. Kidambi, A shot to the heart: a rare case of cardiac embolization, *Echo Res. Pract.* 5 (March (1)) (2018) K19–K21, <http://dx.doi.org/10.1530/ERP-17-0073>, Epub 2018 Feb 12.
- [8] S. Bakan, B. Korkmazer, A. Baş, O. Şimşek, Embolism of a pellet after shotgun injury: from liver to right ventricle, *Ulus. Travma Acil Cerrahi Derg.* 22 (July (4)) (2016) 395–398, <http://dx.doi.org/10.5505/tjtes.2015.32470>.
- [9] V. Bors, S. Aubert, E. Flecher, N. Bonnet, Bullet embolization from the left brachiocephalic vein to the right ventricle, *J. Card. Surg.* 23 (March–April (2)) (2008) 176–177, <http://dx.doi.org/10.1111/j.1540-8191.2007.00515.x>.
- [10] American College of Surgeons, *ATLS: Advanced Trauma Life Support - Student Course Manual*, 10th ed., American College of Surgeons, 2018.
- [11] O.J.F. Van Waes, J.A. Halm, D.I. Van Imhoff, P.H. Navsaria, Selective nonoperative management of penetrating thoracic injury, *Eur. J. Emerg. Med.* 25 (February (1)) (2018) 32–38, <http://dx.doi.org/10.1097/MEJ.0000000000000401>.
- [12] M.L. Kaljusto, N.O. Skaga, J. Pillgram-Larsen, T. Tønnessen, Survival predictor for penetrating cardiac injury; a 10-year consecutive cohort from a scandinavian trauma center, *Scand. J. Trauma Resusc. Emerg. Med.* 23 (June (41)) (2015), <http://dx.doi.org/10.1186/s13049-015-0125-z>.
- [13] C.S. Restrepo, F.R. Gutierrez, J.A. Marmol-Velez, D. Ocazonez, Imaging patients with cardiac trauma, *Radiographics* 32 (May–Jun (3)) (2012) 633–649, <http://dx.doi.org/10.1148/rg.323115123>.
- [14] S.O. Trerotola, S.W. Stavropoulos, Management of fractured inferior vena cava filters: outcomes by fragment location, *Radiology* 284 (September (3)) (2017) 887–896, <http://dx.doi.org/10.1148/radiol.2017162005>, Epub 2017 Apr 19.
- [15] R.A. Agha, M.R. Borrelli, R. Farwana, K. Koshy, A. Fowler, D.P. Orgill, For the SCARE Group, The SCARE 2018 statement: updating consensus surgical Case Report (SCARE) guidelines, *Int. J. Surg.* 60 (2018) 132–136.

Open Access

This article is published Open Access at [sciencedirect.com](https://www.sciencedirect.com). It is distributed under the [IJSCR Supplemental terms and conditions](#), which permits unrestricted non commercial use, distribution, and reproduction in any medium, provided the original authors and source are credited.