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Successful treatment of massive hemothorax with class IV shock using aortography with transcatheter embolization of actively bleeding posterior left intercostal arteries after penetrating left chest trauma: A case for the hybrid OR

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ABSTRACT

Hemothorax is a common occurrence after blunt or penetrating injury to the chest. Posterior intercostal vessel hemorrhage as a cause of major intrathoracic bleeding is an infrequent source of massive bleeding. Selective angiography with trans-catheter embolization may provide a minimally invasive and efficient method of controlling bleeding refractory to surgical treatment.

PRESENTATION OF CASE: A 19 year-old male sustained a gunshot wound to his left chest with massive hemothorax and refractory hemorrhage. He was emergently taken to the operating room for thoracotomy and was found to have uncontrollable bleeding from the chest due to left posterior intercostal artery transection. The bleeding persisted despite multiple attempts with sutures, clips and various hemostatic agents. Thoracic aortography was undertaken and revealed active bleeding from the left 7th posterior intercostal artery, which was coil-embolized. The patient's hemodynamic status significantly improved and he was transferred to the intensive care unit.

DISCUSSION: Posterior intercostal bleeding is a rare cause of massive hemothorax. Bleeding from these arteries may be difficult to control due to limited exposure in that area. Transcatheter-based arterial embolization is a reliable and feasible option for arresting hemorrhage following failed attempts at hemorrhage control from thoracotomy.

CONCLUSION: Massive hemothorax from intercostal arterial bleeding is a rare complication after penetrating chest injury (Aoki et al., 2003). Selective, catheter-based embolization is a useful therapeutic option for hemorrhage control and can be expeditiously employed if a hybrid operating room is available.

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1. Introduction

Hemothorax is common after thoracic injury, whether due to blunt or penetrating trauma. The source of the bleeding varies, but is it usually secondary to disruption of the lung, pulmonary vascular hemorrhage, bronchial vessel bleeding or injury to the intercostal vessels [1–4]. Estimates of incidence of hemothorax reach approximately 300,000 cases per year in the United States [5,6]. Bleeding from intercostal vessels is an infrequent cause of massive hemothorax [7]. Most hemodynamically stable patients with blunt or penetrating hemothorax are effectively treated with

tube thoracostomy. However, patients who have persistent bleeding after chest tube placement (>1500 mL initially or 250 mL/hr for 2–4 h), generally require a thoracotomy for hemorrhage control [8]. We report on a case of massive hemothorax and shock due to penetrating trauma caused by proximal left posterior intercostal artery bleeding. After attempts to stop the bleeding via thoracotomy failed due to limited exposure, angio-embolization in the radiology suite successfully controlled the hemorrhage

2. Presentation of case

Patient is a 19-year-old male who presented to an urban level 1 trauma center after sustaining a gunshot wound to his left chest in the 4th intercostal space in the anterior axillary line as well as the right proximal thigh. He was noted to have some active bleed-

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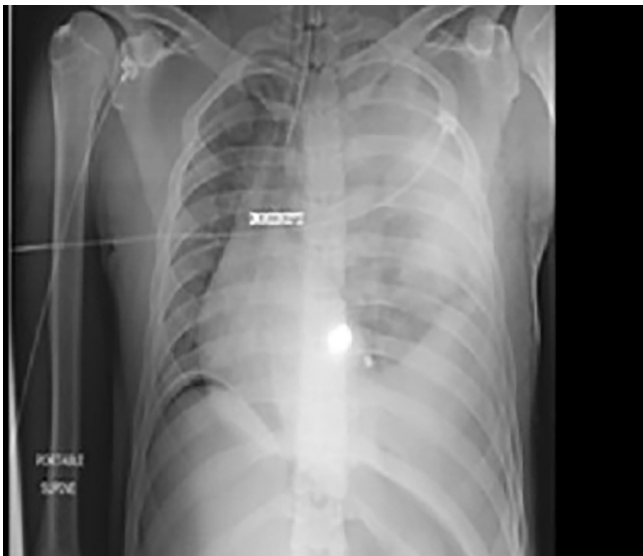


Fig. 1. The figure is a chest x-ray demonstrating a ballistic injury to the left chest with nearly complete opacification of the left hemithorax and rightward mediastinal shift consistent with a left tension hemopneumothorax as well as free intraperitoneal air visualized on both sides of the diaphragm concerning for intraabdominal injury.

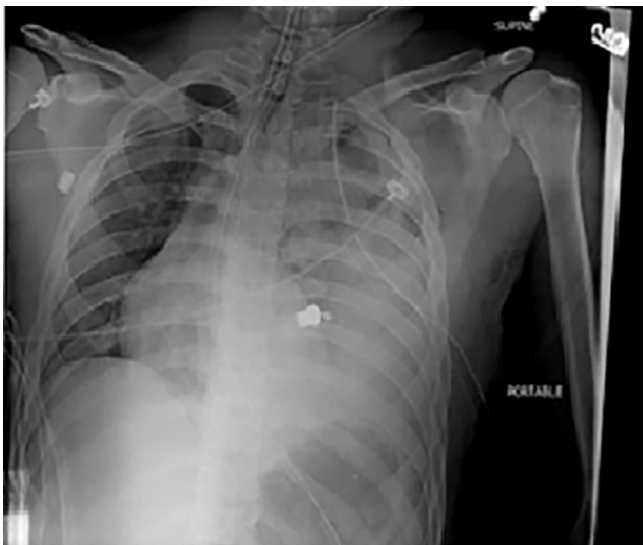


Fig. 2. This radiograph shows the interval placement of a left-sided chest tube with slight apparent decrease in rightward mediastinal shift. Ballistic injury to the left chest with nearly complete opacification of the left hemithorax and interval decrease in rightward mediastinal shift that continues to be shifted concerning the mediastinal structure, which were likely under tension.

ing from his left chest wound. His pedal pulses were normal and symmetric. He was initially relatively hemodynamically stable and Focused Assessment with Sonography for Trauma (FAST) was negative. A # 36 left chest tube was placed due to the presence of a large hemopneumothorax on chest x-ray. The tube was connected to underwater seal drainage system, with an auto-transfusion collection system in place. Eight hundred milliliters of blood were immediately collected into the drainage collecting system (Fig. 1). He progressively developed hemodynamic instability in the trauma bay and was transfused one unit of packed red blood cells (Fig. 2).

He subsequently became more hypotensive with blood pressures in the 80/40's with increased bloody drainage from the chest tube. Therefore, the massive transfusion protocol was activated and the patient was emergently taken to the operating room for antero-

lateral thoracotomy and exploration of the left chest. The patient was found to have injuries to the left hemi-diaphragm and left lung with no active parenchymal bleeding, but had ongoing significant hemorrhage from the left posterior chest wall. Multiple attempts to stop the bleeding with sutures, gelfoam, topical thrombin, surgical, and surgical clip placement were unsuccessful due to difficulty accessing the site of the bleeding that was located very posteriorly. The patient became progressively more tachycardic with heart rate in 170's and systolic blood pressures in the 70's, consistent with class IV hemorrhagic shock. His oxygenation deteriorated and he required multiple blood transfusions and vasopressor infusions. The decision was therefore made to pursue angiography with percutaneous catheter-based embolization. He was transferred to the radiology suite with resuscitation in progress. Thoracic aortography was performed and revealed active bleeding from the left 7th posterior intercostal artery about 3 cm from the aortic take-off as well as from the phrenic branch. The bleeding arterial segments were coil-embolized. In addition, the vessels immediately above and below (ICA 6 & 8) were also embolized (Fig. 3). The patient's hemodynamics significantly improved with SBP > 110 and MAPs > 70 mm Hg. The patient was transferred to the surgical ICU for ongoing resuscitation and ventilator management. He had an uneventful postoperative course and was ultimately discharged home.

3. Discussion

Intercostal bleeding from trauma is a rare cause of massive hemothorax. Hemorrhage control can be difficult and tedious especially when it originates from the posterior intercostal branches of the thoracic aorta due to the limited exposure where the ribs have the least mobility. When approaching these arterial vessels intraoperatively, hemostasis can be achieved by suture ligation. However, in patients with limited space between the posterior ribs, this can be quite challenging. The literature acknowledges the difficulty of controlling posterior intercostal bleeding [9]. Arterial embolization has been shown to be a reliable and feasible therapeutic intervention in abdominal solid organ and pelvic arterial hemorrhage [10–12]. Extension of this technique to the thorax with the use of selective thoracic aortic embolization provides a minimally invasive adjunct to surgical modalities for the treatment of refractory intrathoracic hemorrhage.

Hemostatic agents such as surgical, gauze packing, gelfoam, bone wax, and topical thrombin have been utilized in clinical practice and described in the literature, and was attempted during our case but to no avail. Miettinen et al. described a novel approach to massive intercostal bleeding in their 2012 case report [1]. They utilized a unique method of controlling active hemorrhage by crafting a hemostatic compression bolster using a surgical swab. The swab was rolled tightly and inserted over the posterior medial chest wall over the area of bleeding next to the descending thoracic aorta. Sutures were pulled through the chest wall from inside to outside to apply compression to achieve hemostasis [1].

Another option to consider is *damage control thoracotomy*. The same principles utilized in the abdomen can be applied to other areas of the body, including the neck, chest and extremities. However, packing the thoracic cavity remains controversial. Concerns do exist that following packing, the resultant increase in intrathoracic pressure may have unacceptable cardio-pulmonary consequences [6]. Phelan et al. also described the use of Fogarty catheter balloons to temporize bleeding [6]. However, the massive bleeding and profound hemodynamic instability would not have been favorable in our patient with this approach. The travel from the operating room to the radiology suite was also quite challenging in this very sick patient. Such a situation makes the case

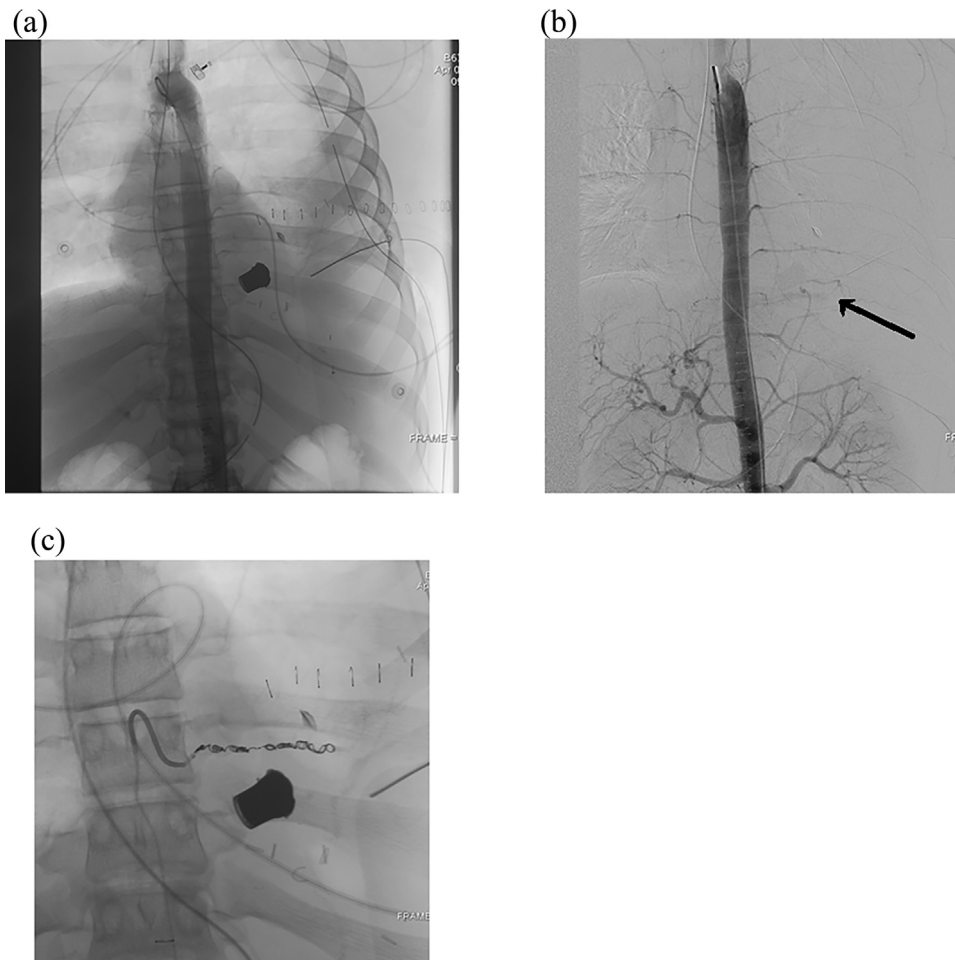


Fig. 3. A, B and C. Depicts a thoracic aortogram. The Image 3A to right demonstrates the initial diagnostic aortogram. The next Image 3B demonstrates a left 7th posterior intercostal artery injury, which was coil embolized (Fig. 3C).

for hybrid operating rooms. Hybrid operating rooms or Resuscitation with Angiography, Percutaneous Techniques and Operative Repair (RAPTOR) units provide a dedicated location for resuscitation, surgical procedures, imaging, and interventional radiology all in one place. Howell et al. demonstrated in a retrospective study of unstable trauma patients that patients who had angiographic embolization within an hour of arrival had a lower risk of mortality than those who took longer than 1 h to vascular occlusion [13]. A Japanese study by Kataoka et al., specifically looked at the outcomes of 63 individuals who were treated in a hybrid OR suite and compared the outcomes with patients treated with preoperative or postoperative angiography in the angiography suite. Mortality rates and operative durations were both found to be lower in the population treated in the hybrid OR [14]. Our patient may have avoided a risky and cumbersome trip to radiology if a hybrid OR were available and effectively utilized. The duration of exploring the chest and hemorrhage control could have been limited with an earlier determination that the bleeding would not be effectively controlled by surgical techniques.

The angiographic approach represents the technique with most documented efficacy in the control of failed surgical management of bleeding, although the data is sparse. The available literature is limited to case reports, small observational studies and is predominantly in blunt trauma. There is growing acceptance of transcatheter-based arterial embolization as an adjunct to thoracotomy where surgery fails to control the hemorrhage. Carrillo et al. also considered this as less invasive, more accurate, and reli-

able method to treat patients with these types of life-threatening injuries [2,3]. In his study and a similar report by Chemelli in 2009, the majority of their patients were successfully treated with arterial embolization with relatively low complication rates [2,3]. While trans-catheter angiography with embolization may be good option for posterior intercostal vessels bleeding, caution must be exercised to avoid embolization of the 8th to 10th intercostal arteries. This is due to the risk of paraplegia resulting from cord ischemia as a consequence of compromise to the artery of Adamkiewicz [16].

4. Conclusion

Massive hemothorax from posterior intercostal arterial bleeding is a rare complication of blunt or penetrating thoracic injury [4]. It can be arduous to treat, especially when the site of bleeding is in an area that is difficult to access, such as the posterior chest wall. Selective, catheter-based embolization techniques, while not a replacement for the need for thoracotomy, may provide a minimally invasive adjunct to surgery for control of bleeding. The availability of a hybrid operating room makes this angiographic approach a more realistic option, especially in the face of hemodynamic instability due to uncontrolled bleeding. More studies are required to confirm the applicability of this approach as a suitable option to address this difficult clinical challenge, particularly after penetrating thoracic injury.

This work has been reported in line with the SCARE criteria for case reports [15].

Conflicts of interest

The authors have no financial or other conflicts of interest related to this manuscript or topic.

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None.

Ethical approval

Approval for this project has been given by the Morehouse School of Medicine IRB committee. Ref #: [1154461–1].

Consent

Written informed consent was obtained from the patient via his father 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 upon request*.

Authors contribution

Carolyn Moore, MD – Contributed to the study concept or design, data collection, data analysis and interpretation, and writing of the paper.

Golda Kwayisi, MD – Contributed to the study concept or design, data collection, data analysis and interpretation, and writing of the paper.

Omar K. Danner, MD – Contributed to the study concept or design, data collection, data analysis and interpretation, and writing of the paper.

Prince Esiobu, MD – Contributed to the study concept, writing and editing of the paper.

K. Aviva Bashan-Gilzenrat – Contributed to the data analysis and interpretation, editing and writing of the paper.

Ray Matthews, MD – Contributed to the data analysis and interpretation, editing and writing of the paper.

Jonathan Nguyen, DO – Contributed to the data analysis and interpretation, editing and writing of the paper.

Nathan Moriary, MD – Contributed to the background research, data analysis and collection of radiographic studies, editing and writing of the paper.

Michael Liggon, MD – Contributed to the background research, data analysis and collection of radiographic studies, editing and writing of the paper.

Kahdi Udobi MD – Contributed to the data analysis and interpretation, editing, restructuring of the study concept of the paper.

Assad Taha, MD – Contributed to the data analysis and interpretation, editing, reconfiguration of the study concept and writing of the paper.

Ed W. Childs, MD – Contributed to the data interpretation, senior advisement, and editing of the paper.

Registration of research studies

Research registry 3271.

Guarantor

Omar K. Danner, MD.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.ijscr.2018.04.023>.

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