CASE REPORT

A Case Report of Blunt Aortic Trauma in a Difficult Anatomic Location with Emergent Intraoperating Room Extracorporeal Membrane Oxygenation

Maya Rapoport[1], Noa D Rose[2], Majd K Ibrahim[3], Ronit Bar-Haim[4], Yoram Klein[5], Rijini Nugzar[6], Arie Sorosky[7], Dmitry Yakubovitch[8], Adam L Goldstein[9]

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Abstract

Aim and background: To describe the challenges of a multitrauma patient with severe blunt chest trauma, including thoracic aortic injury, and the need for emergent extracorporeal membrane oxygenation (ECMO) in the operating room.

Case description: A young man was involved in a high-speed motorcycle accident with his chest reportedly hitting the curb. In the trauma bay, he was unstable, with a positive abdominal focused assessment with sonography for trauma (FAST), and a chest X-ray (CXR) with a widened mediastinum. He underwent emergent damage control abdominal surgery, followed by a total body computed tomography (CT), and definitive endovascular repair of a proximal descending thoracic aortic injury with carotid-carotid-left subclavian bypass graft. During the first 36 hours, he received ultramassive blood product transfusion and emergent venovenous (VV) ECMO placement in the operating room. Despite his survival, he suffered from partial paralysis and infection of the vascular bypass graft.

Conclusion: Thoracic aortic injury in the multitrauma patient remains a challenge. The use of ECMO in the acute setting has life-saving potential. Multidisciplinary teams optimize the outcome of these difficult patients.

Clinical significance: Here, we show examples of a supine trauma bay CXR that was sensitive for aortic injury, the complexity of blunt thoracic aortic trauma definitive care, and utilization of emergent ECMO.

Keywords: Blunt thoracic aortic injury, Case report, Extracorporeal membrane oxygenation, Widened mediastinum.

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Introduction

Among nonpenetrating traumatic injuries, blunt thoracic aortic injury (BTAI) is the second most common cause of mortality, second to intracranial hemorrhage.[1] Chest X-ray (CXR) can screen for widened mediastinum, which may be a sign of aortic rupture or mediastinal hematoma.[2] Although routinely used in severe trauma, mediastinal abnormalities on CXR are not sensitive and cannot serve as the sole screening criteria for BTAI. The use of computed tomography (CT) should be considered depending on CXR findings and mechanisms of injury in order to accurately diagnose BTAI.[3] If the patient is not stable, then the timing of CT depends on how the patient responds to damage control management. Once the BTAI is diagnosed, the timing and optimal repair in young patients remain in question. This is especially related to the precise anatomical location of the injury, the extent of the injury, and concurrent injuries. Here, we share a multitrauma case involving emergent extracorporeal membrane oxygenation (ECMO) and proximal descending thoracic aortic injury in a young male.

Case Description

A 20-year-old male was found at the scene after a high-velocity motorcycle accident. The victim had a decreased level of consciousness and was suffering from abdominal to chest pain. After scoop-and-run to our trauma center, the patient arrived at our trauma bay with no external signs of bleeding, a patent airway, tachypnea what abrasions and contusions to anterior chest/torso, cool and clammy with weak and rapid central pulses, abdominal and chest tenderness,

[1,2]Department of General Surgery, Tel Aviv University School of Medicine, Tel Aviv, Israel

[3]Department of Surgery, Wolfson Medical Center, Holon, Israel

[4]Department of Surgery, Trauma Unit, Wolfson Medical Center, Holon, Israel

[5]Department of Trauma, Acute Care, & Critical Surgery, Sheba Medical Center, Ramat Gan, Israel

[6]Department of Anesthesiology, Wolfson Medical Center, Holon, Israel

[7]Department of Intensive Care, Wolfson Medical Center, Holon, Israel

[8]Department of Vascular Surgery, Wolfson Medical Center, Holon, Israel

[9]Department of General Surgery, Trauma Surgery Unit, Wolfson Medical Center, Holon, Israel

Corresponding Author: Adam L Goldstein, Department of General Surgery, Trauma Surgery Unit, Wolfson Medical Center, Holon, Israel, e-mail: adamg.barefoot@gmail.com

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conscious with a Glasgow Coma Scale (GCS) of 13 (M6V4E3), moving all extremities, and without other major deformities upon exposure.

Adjuvants to the primary survey showed an initial systolic blood pressure of 90, a heart rate of 150, and saturation on room air of 96%. A supine CXR showed a widened mediastinum (Fig. 1), without hemothorax or pneumothorax, and a normal diaphragmatic contour. Pelvic X-ray was without traumatic findings, and focused assessment with sonography for trauma (FAST) was positive for fluid in the peritoneal cavity, without a pericardial effusion. Base excess was –7.

Two units of O+ uncrossed packed red blood cells (pRBCs) were given, and a massive transfusion protocol (MTP) was initiated. The patient remained conscious, a following blood pressure after the two units of pRBC showed a blood pressure of 85/60, and the pulse remained elevated at 145. A second FAST ultrasound still did not show a pericardial effusion. Due to the patient not responding to resuscitation, it was decided to proceed directly to the operating room.

The first procedure was a trauma laparotomy. Approximately, 1 L of blood was in the abdominal cavity. The left lateral liver was obliterated (segments 2 and 3), and there was injury and bleeding from the spleen. There was no retroperitoneal hematoma, diaphragmatic injury, or other intraperitoneal injuries. The patient underwent resection of segments 2 and 3 of the liver, splenectomy, abdominal packing, and temporary abdominal closure with a Barker Vac.

During this time, the patient was receiving thromboelastography (TEG)—driven MTP and had received over 60 units of blood products. He was beginning to become hypothermic and acidotic and continued to remain unstable with the need for inotropes together with blood products. Before being able to leave the operating room, his temporary abdominal closure was saturated with blood, and we therefore reexplored his abdomen where we found bleeding from the cut edge of the liver, which was controlled by clips and sutures, and bleeding from short gastric vessels in the left upper quadrant. Once surgical bleeding was controlled, his abdomen was repacked and temporarily closed.

A follow-up CXR was performed in the operating room (129 minutes after his initial trauma bay X-ray) (Fig. 2). Due to the patient remaining unstable, and increased whitening of the lung field, bilateral chest tubes were placed. The right side drained 500 cc of blood, and the left side 1500 cc of blood. Despite the amount of blood from the left side, it was decided not to open the chest at this time because of the chance an aortic rupture might be the source of the bleeding and contained/semicontained injury would therefore be completely released. Also, because the initial CXR was without major pathology in the left chest, we had a low suspicion of acute lung injury as the source of bleeding. After the bilateral chest tubes, he slightly stabilized and we felt comfortable to proceed to CT scan.

The CT scan showed a grade III/IV aortic injury at the proximal descending aorta, millimeters from the left subclavian artery (Figs 3A and B). During the CT scan the left chest tube continued

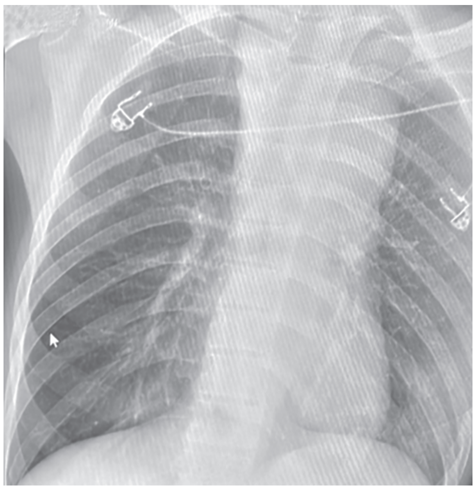


Fig. 1: Supine CXR from trauma bay

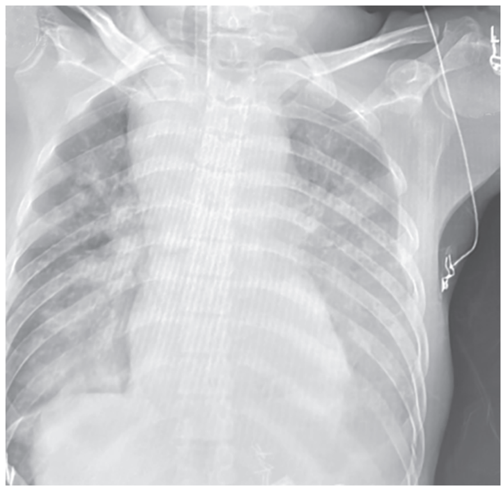
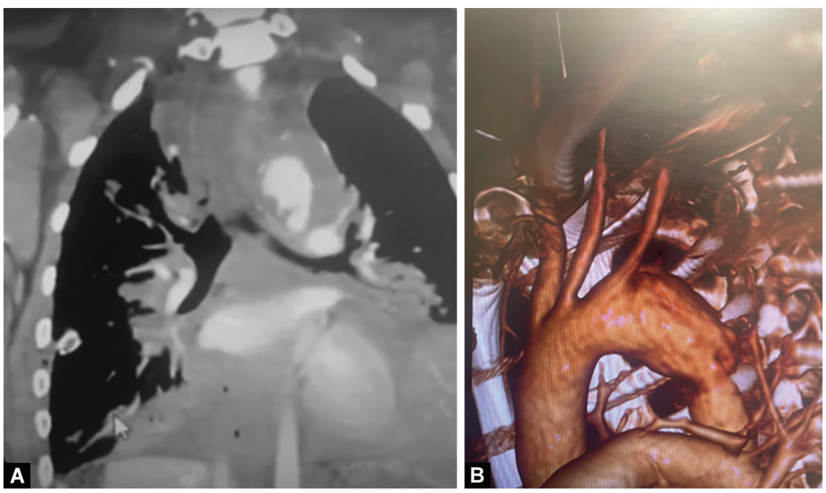


Fig. 2: Follow-up CXR in operating room



Figs 3A and B: Computed tomography (CT) and 3D rendition of the aortic injury to have a significant amount of blood loss, and the CT scan also showed a remaining blush in the left upper quadrant (LUQ) of the abdomen. The patient returned to the operating room, where the left chest was opened, hemostasis was obtained from the intercostal arteries in proximity to rib fractures (there were multiple bilateral rib fractures), and the abdomen was reopened and repacked with adequate hemorrhage control.

It was decided to further stabilize the patient in the intensive care (ICU), and proceed with definite repair of the aorta the following day. An endovascular approach was decided upon, yet for adequate endovascular coverage, the stent would have to cover the left femoral (LF) carotid and subclavian. Therefore, a right carotid-left carotid-left subclavian artery bypass with a synthetic graft was done, followed by thoracic endovascular aortic repair (TEVAR). Upon transferring the patient to the operating room table, he underwent cardiac arrest in which the chest was reopened, a clamp placed on the aorta, and cardiac compressions initiated after the pericardium was opened. The patient soon returned to sinus rhythm, yet remained significantly hypoxic. It was decided to place the patient on emergent venovenous (VV) ECMO before proceeding with the surgery. The patient was successfully cannulated, and we proceeded with the planned surgery (Figs 4 and 5). The chest remained with packing and a temporary closure.

Postoperatively, the patient remained on ECMO for 4 days, had renal failure which was treated with continuous renal replacement therapy for a duration of 30 days, and pneumonia which was treated with a course of antibiotics. He underwent a tracheostomy at hospital-day 14. His caloric intake was met with both enteric and parenteral nutrition. He was maintained on dual antiplatelet therapy (aspirin and plavix) for his grafts, together with low-molecular-weight Heparin for deep vein thrombosis prophylaxis. On day 10 after the TEVAR, a CT angiography showed no endoleak and all the grafts were patent. Between the 1st and 2nd week after his accident, he lost all motor and sensory functions inferior to the umbilicus. A magnetic resonance imaging (MRI) showed an infarcted region of the thoracic spine, suspected secondary to low flow state during his prolonged period of shock and multiorgan failure. The patient was eventually decannulated, receiving all nutrition per os (PO), neurologically fully intact, then began to suffer from high-peaking fevers with multiple possible blood cultures consistent with upper gastrointestinal tract flora. Transthoracic and transesophageal echos were negative for cardiac/valvular vegetations, and a follow-up CT showed no collections, endoleaks, or source of infection. The patient was transferred to a tertiary center in order to undergo a positron emission tomography (PET) CT scan to search for a source of infection. The PET CT showed uptake at the location of the left carotid-graft anastomosis. It was decided by a multidisciplinary team to undergo an occlusion test of the left carotid. This was performed which did not show any neurological sequelae from occlusion. The following day the entire graft was removed. During the surgery, there were very few adhesions of the graft to the surrounding soft tissue (over 6 weeks since the initial placement) which was a sign that the body also did not incorporate the graft well, secondary to infection. The patient tolerated the surgery well, was extubated in the postoperative ward, and returned to baseline neurologic function. He was then transferred to a neurological rehabilitation center.

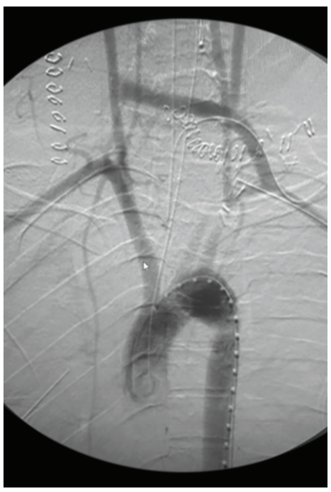


Fig. 4: Right carotid-left carotid-LF subclavian bypass followed by TEVAR

Discussion

There are many unique and challenging aspects of this case that we can learn from. Beginning with the initial CXR in the trauma bay. Despite common practice, the sensitivity and utility of CXR in the trauma bay are unclear. In the unstable patient, the CXR remains an important adjuvant in order to rule out life-threatening hemopneumothorax in the patient who is too unstable to proceed to CT. There is a recent trend to bypass supine CXR in the stable blunt trauma patient who will proceed to CT, due to the low sensitivity and poor screening ability.[4,5] A widened mediastinum has been found to be nonspecific and inaccurate for diagnosing traumatic aortic injuries, with reports of a positive predictive value of <1%.[6] Our patient was extremely thin, therefore possibly increasing the sensitivity and level of suspicion of aortic pathology, together with the known mechanism. Nevertheless, the priority was to stabilize him, before a definitive diagnosis of aortic injury, because that was not going to be his immediate cause of death.

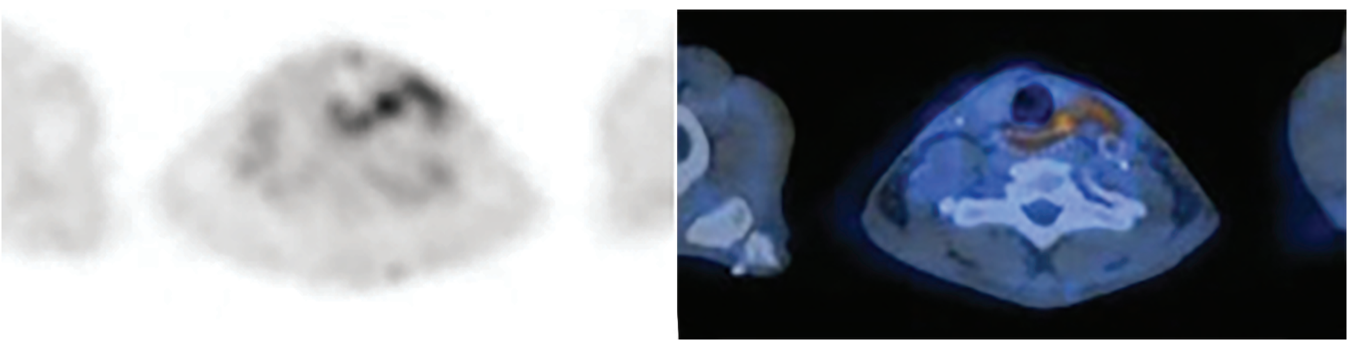


Fig. 5: Positron emission tomography (PET) CT showing the active infection at the site of the LF carotid graft anastomosis

Recent literature has identified broad indications for ECMO use in trauma (venous-venous or arterial-venous), which include inability to adequate gas exchange, extensive injury with damage control management, and the need for circulatory support due to collapse.[7] The emergent use of ECMO in the operating room remains a rare and extreme scenario. Extracorporeal membrane oxygenation centers must be prepared for a rapid team deployment and cannulation of the patient to this life-saving treatment at all hours. Upon collapse of the patient, it must be determined if the deterioration is due primarily to respiratory failure (with the need for VV ECMO) or a primarily circulatory collapse with or without respiratory failure [requiring venoarterial (VA) ECMO].[8] The majority of ECMO utilization in trauma patients to date is VV ECMO, secondary to severe acute respiratory distress syndrome, which materializes due to a multitude of factors in the severely injured patient.[7,9] For specific trauma patients after severe blunt cardiac injury or penetrating cardiac injury, VA ECMO is used early to attenuate cardiovascular collapse by maintaining adequate perfusion and oxygenation. Case studies have been published regarding the use of VA ECMO for cardiogenic collapse due to severe aortic injury,[10] therefore, it is also important to recognize the primary root of the collapse and make use of the most appropriate use of ECMO.

Our patient had numerous possible factors that influenced his collapse. First, was that he was 16 hours after initial injury and over a hundred blood products had been given (ultramassive transfusion).[11] This ultramassive would almost certainly cause transfusion-induced acute lung injury, especially since a huge amount of products were used within the first 24 hours.[12] Secondly, he had high kinematic blunt chest trauma. There were no objective signs of blunt cardiac injury (initial electrocardiogram was with sinus tachycardia, and troponin was not elevated), but he did have multiple bilateral rib fractures, a thoracotomy, and significant bilateral lung contusions, which severely affected the mechanics of his chest wall and gas exchange. Our patient was also in severe shock, resulting in the progression of multiorgan failure in which the lungs are most often the first organ to fail.[13] In the operating room, it was unable to oxygenate the patient. Despite being on a high dose of inotropes, it was felt that the primary organ failure that could not be maintained by standard methods (mechanical ventilation) was his respiratory system. Therefore, it was decided to emergently cannulate him and begin VV ECMO instead of VA ECMO.[10,14]

In regard to the repair of our patient's aortic injury, there were a few possible options. Despite the proven advantages of endovascular aortic repair, in younger patients, there remains more controversy and possible long-term adverse sequelae.[15] An open approach in experienced aortic centers is always a possibility, yet most studies have shown in severe blunt polytrauma patients that an open approach has higher mortality, morbidity, and complications when compared to endovascular treatment.[16] We felt that for the best outcome, the bypass graft was necessary in order to maintain optimal cerebral and limb flow. Another option was to partially cover the left subclavian (zone 3 deployment), or even fully covering the left subclavian and partially covering the left common carotid (zone 2 deployment) with a left carotid-subclavian transposition graft. This has been shown to be tolerated with acceptable outcomes, although in the trauma community, there is still debate (and word of cation) regarding endovascular coverage of the left subclavian artery because of neurological adverse events.[17]

Conclusion

Blunt thoracic injury in a severely injured multitrauma patient is a challenge for any center. The use of emergent ECMO, and the decision of timing and approach for the aortic repair, all require a multidisciplinary team to achieve the best outcome in these patients.

Clinical Significance

- Chest X-ray (CXR) is not an adequate screening tool for blunt aortic injury.
- Extracorporeal membrane oxygenation (ECMO) is an important treatment for the most severely injured patients, and institutions receiving trauma must be prepared to utilize ECMO urgently.
- When utilizing ECMO in the polytrauma patient, it is important to understand if the collapse is secondary to respiratory collapse, cardiovascular collapse, or a combination, in order to choose between VV and VA ECMO.
- Blunt thoracic aortic injury (BTAI) in young patients remains a complex and difficult injury to successfully treat.

References

1. Mouawad NJ, Paulisin J, Hofmeister S, et al. Blunt thoracic aortic injury - concepts and management. J Cardiothorac Surg 2020;15(1):62. DOI: 10.1186/s13019-020-01101-6
2. Attar S, Ayella RJ, McLaughlin JS. The widened mediastinum in trauma. Ann Thorac Surg 1972;13(5):435–449. DOI: 10.1016/S0003-4975(10)65155-7
3. Gutierrez A, Inaba K, Siboni S, et al. The utility of chest X-ray as a screening tool for blunt thoracic aortic injury. Injury 2016 47(1):32–36. DOI: 10.1016/j.injury.2015.08.003
4. Lopes JA, Frankel HL, Bokhari SJ, et al. The trauma bay chest radiograph in stable blunt-trauma patients: do we really need it? Am Surg 2006;72(1):31–34. PMID: 16494179.
5. Dillon DG, Rodriguez RM. Screening performance of the chest X-ray in adult blunt trauma evaluation: Is it effective and what does it miss? Am J Emerg Med 2021;49:310–314. DOI: 10.1016/j.ajem.2021.06.034
6. Vasileiou G, Qian S, Al-Ghamdi H, et al. Blunt trauma: what is behind the widened mediastinum on chest X-ray (CXR)? J Surg Res 2019;243:23–26. DOI: 10.1016/j.jss.2019.04.079
7. Lee A, Romano K, Tansley G, et al. Extracorporeal life support in trauma: indications and techniques. J Trauma Acute Care Surg 2024;96(1):145–155. DOI: 10.1097/TA.0000000000004043
8. MacKay EJ, Cannon JW. Extracorporeal membrane oxygenation in the unstable trauma patient. Endovascular Resuscitation and Trauma Management: Bleeding and Haemodynamic Control. 2020.
9. Ehrlich H, Bisbee C, Ali A, et al. Extracorporeal membrane oxygenation utilization in blunt and penetrating traumatic injuries: a systematic review. Am Surg 2022;88(11):2670–2677. DOI: 10.1177/00031348211011112
10. Wada D, Hayakawa K, Kanayama S, et al. A case of blunt thoracic aortic injury requiring ECMO for acute malperfusion before TEVAR. Scand J Trauma Resusc Emerg Med. 2017;25(1):110. DOI: 10.1186/s13049-017-0456-z
11. Matthay ZA, Hellmann ZJ, Callcut RA, et al. Outcomes after ultramassive transfusion in the modern era: an Eastern Association for the Surgery of Trauma multicenter study. J Trauma Acute Care Surg 2021;91(1):24–33. DOI: 10.1097/TA.0000000000003121
12. Holena DN, Netzer G, Localio R, et al. The association of early transfusion with acute lung injury in patients with severe injury. J Trauma Acute Care Surg 2012;73(4):825–831. DOI: 10.1097/TA.0b013e318256de3

13. Mizock BA. The multiple organ dysfunction syndrome. Dis Mon 2009;55(8):476–526. DOI: 10.1016/j.disamonth.2009.04.002
14. Kelly B, Carton E. Extended indications for extracorporeal membrane oxygenation in the operating room. J Intensive Care Med 2020;35(1):24–33. DOI: 10.1177/0885066619842537
15. Youssef A, Kalaja I, Alkomi U, et al. Aortic stiffness and related complications after endovascular repair of blunt thoracic aortic injury in young patients. Vasa 2020;49(4):295–300. DOI: 10.1024/0301-1526/a000858
16. Manoly I, El Tahan M, Al Shuaibi M, et al. TEVAR versus open repair of blunt traumatic descending aortic injury in polytraumatic patients involved in motor vehicle accidents. Cardiothorac Surg 2021;29:1–6. DOI: 10.1186/s43057-021-00040-9
17. Chung J, Kasirajan K, Veeraswamy RK, et al. Left subclavian artery coverage during thoracic endovascular aortic repair and risk of perioperative stroke or death. J Vasc Surg 2011;54(4):979–984. DOI: 10.1016/j.jvs.2011.03.270