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A Rare Case of Aortic Arch Penetrating Stab Wound Masked and Occluded by Mediastinal Hematoma: A Case Report and Literature Review

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ABSTRACT

Background:
Penetrating injuries to the aortic arch are extremely rare and are associated with a very high pre-hospital mortality rate. Most patients succumb to massive hemorrhage even before reaching definitive care. In hemodynamically stable patients such injuries may be radiologically silent posing significant diagnostic and therapeutic challenges. Mediastinal hematoma can occasionally tamponade bleeding obscuring radiologic evidence of vascular injury, and delaying intervention.

Case Report:
An 18-year-old male presented to the emergency department after sustaining a penetrating stab wound over the suprasternal notch. He was hemodynamically stable with no external bleeding or signs of respiratory compromise. Initial investigations including transthoracic echocardiography and non-contrast computed tomography (CT) showed no evidence of major vascular injury however a retrosternal hematoma and mediastinal widening was evident. Surgical exploration via median sternotomy was done which revealed a full-thickness tear at the superior aspect of the aortic arch. This tear was seen to be involving the origins of the innominate and left common carotid arteries. The hematoma had effectively tamponaded the lesion thereby masking active bleeding. Cardiopulmonary bypass was instituted to provide optimal visualization. The tear was successfully repaired and the patient had an uneventful recovery.

Conclusion:
A high index of suspicion is essential in cases of penetrating chest injuries. Early surgical exploration should be strongly considered when clinical presentation and mechanism of injury raise concern for major vascular trauma regardless of reassuring imaging findings.

Keywords: Aortic Arch, Cardiopulmonary Bypass, Mediastinal Hematoma, Penetrating Wounds, Vascular System Injuries.

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INTRODUCTION

Aortic arch injuries are associated with extremely high mortality, with nearly 90% of patients dying at the scene due to massive hemorrhage, as noted by Demetriades et al.[1] The true survival rate remains unclear as most patients die from their injuries before reaching the hospital. Only a small proportion survive long enough to undergo evaluation and treatment. Patients with abdominal aortic injuries are likely to survive three times more than thoracic aortic injuries.[2]Here, we present a rare case of an aortic arch injury that was occluded and masked by a hematoma in a hemodynamically stable patient.

CASE REPORT

An 18-year-old male with no known past medical history presented to the emergency department with a penetrating stab wound over the suprasternal notch (Figure *1*).

There was no significant external bleeding. He was hemodynamically stable on admission (BP 110/70 mmHg, HR 110 bpm, SpO2 96% on room air), fully conscious, well-perfused and clinically stable. Serial transthoracic echocardiography (TTE) revealed no pericardial effusion or signs of major vascular injury. However, a computed tomography (CT) scan of the chest showed a retrosternal hematoma (Figure *2*)

There was no evidence of pneumothorax, hemothorax, or pericardial effusion on imaging, which supported the decision to proceed with surgical exploration. Chest X-ray demonstrated a widened mediastinum (Figure *3*).

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Figure 1: Stab wound located just above the suprasternal notch, prior to wound exploration.

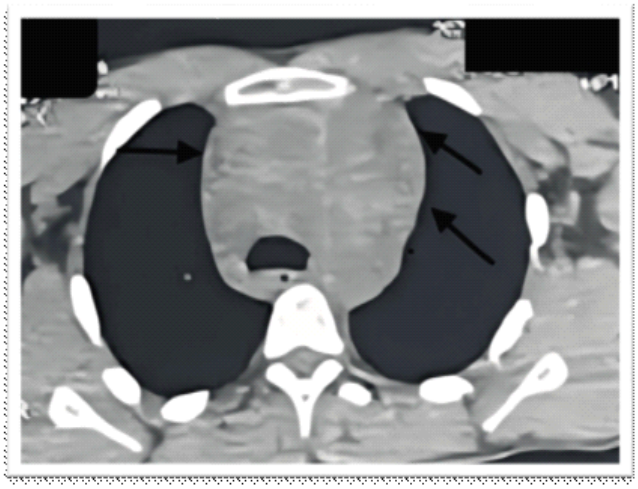

Figure 2: Axial chest CT image showing a retrosternal mediastinal hematoma adjacent to the aortic arch.

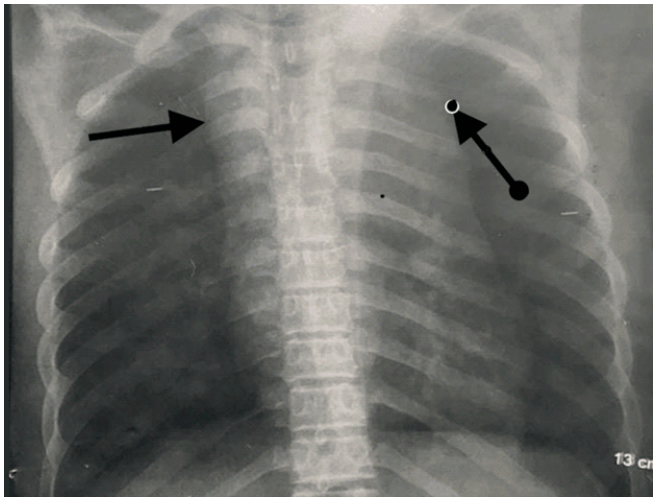

Figure 3: . Chest X-ray showing a widened mediastinum. The transverse width of the mediastinal silhouette is markedly increased . No evidence of pneumothorax or hemothorax is seen.

A superficial ultrasound at the wound site showed a mild subcutaneous hematoma. The patient was admitted to the intensive care unit (ICU) for close monitoring. A follow-up CT scan revealed a thin rim of left-sided hemothorax. The patient was taken to the operating room for wound exploration and closure. A median sternotomy was performed after preparation and general anaesthesia was given with full monitoring. After sternotomy a hematoma was visible extending through the thymic tissue. Partial thymectomy was performed to expose the great vessels. Significant hemorrhage was encountered which was difficult to control. A decision was made to use cardiopulmonary bypass first to minimize blood loss and second to clearly visualize the bleeding site, which was important to make a clear and dry field for optimum repair without taking blind stitches which might either be superficial, non-controlling or deep occluding an important vessel.

After starting bypass by aortic and right atrial cannulation, and by decreasing the pump flow, we could dissect the congested adventitia and reach the injury site, which was on the top of the aortic arch, between and involving the origin of both the innominate and left common carotid arteries (Figure *4*).

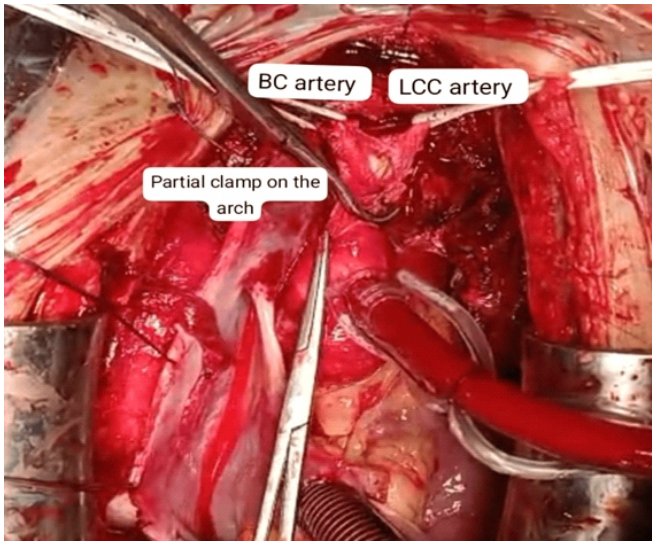

Figure 4: Intraoperative image showing the aortic arch injury site between the origins of the brachiocephalic and left common carotid arteries. Vascular clamps applied during repair.

Primary repair was performed after applying vascular clamps. Postoperatively, the patient remained hemodynamically stable (BP 120/70 mmHg, HR 60 bpm, SpO_2 99% on room air). He was fully conscious, ambulating well, and experienced no postoperative complications.

DISCUSSION

A widened mediastinum of more than 8 cm and/or 25% of the thoracic width (at the level of the aortic knob) is the most frequent observation. It is highly sensitive (81%-100%) and can detect mediastinal hematoma.[3] The combination of clinical stability, absence of hemothorax and non-contrast CT findings led to an underestimation of the injury which was later found to be a full-thickness tear at the superior aspect of the aortic arch, involving the origins of the innominate and left common carotid arteries. The hematoma likely acted as a tamponade, masking the vascular tear until surgical exploration.

Intraoperatively, Cardiopulmonary Bypass (CPB) or Deep Hypothermic Circulatory Arrest (DHCA) provides good exposure to the aortic arch in a bloodless field, allowing the surgeon to examine the entire arch from inside the lumen and to protect the brain when great vessel injury or uncertainty about the extent of damage coexists.[4] Furthermore, the choice of incision depends on the location of the injury with further extension if needed.

If surgical repair of a contained aortic injury is delayed, the consensus across trauma and vascular literature is that early aggressive blood pressure control using short-acting β-blockers (e.g., esmolol, metoprolol) is essential. This approach reduces shear stress and dP/dt against the aortic wall, decreases the risk of in-hospital rupture and is recommended by established trauma management guidelines.[5,6] In 2022, Ariaka et al reported a patient with a ballpoint pen impaled in the aortic arch, where the foreign object served as a tamponade, allowing for survival and successful repair.[7] Similarly, our case demonstrated a form of "self-sealing" although here, the hematoma itself masked the tear.

Another case by Al Ali et al involved a penetrating chest stab wound resulting in aortic arch injury which was promptly identified on contrast-enhanced CT due to active extravasation.[8] That patient was hemodynamically unstable and required immediate surgical intervention. In contrast our patient remained stable, with no imaging signs of active bleeding-creating a false sense of reassurance despite the widened mediastinum on chest X-ray.

Mohammed et al reported a case of a 31-year-old male who sustained multiple stab wounds to the chest.[9] He was hemodynamically stable, and contrast-enhanced CT revealed a mediastinal hematoma with a subtle "nipple sign" indicating a small aortic arch injury. This early radiological identification allowed the team to adopt a conservative, nonoperative approach with close monitoring and a favorable outcome. In contrast, in our case, the aortic injury was not visualized on CT and no signs of active extravasation were present. The hematoma acted as a tamponade, concealing the tear until it was unexpectedly discovered during surgical exploration. This difference in radiologic detectability critically influenced the management pathway.

In a similar case reported by Vural et al a patient with a penetrating injury to the upper chest was found to have a full-thickness aortic arch tear, suggested by a subtle abnormality on imaging, leading to early surgical intervention.[10] In contrast our patient's imaging showed no direct signs of vascular injury and only retrosternal hematoma and mediastinal widening was noted on imaging. The aortic tear was entirely masked and was sealed by the hematoma-creating a radiologically silent presentation. This difference highlights how even subtle radiologic signs may not always be present in life-threatening vascular injuries and that clinical context and anatomical proximity to the aortic arch should strongly influence management decisions even when imaging appears unremarkable.

CONCLUSION

Penetrating injuries to the aortic arch are frequently fatal with the majority of patients dying before reaching definitive care. This case underscores a rare but critical presentation in which a full-thickness aortic arch tear was masked by a mediastinal hematoma and not evident on imaging. The hematoma likely acted as a tamponade, temporarily preventing exsanguination and permitting timely surgical intervention. Clinicians should maintain a high index of suspicion for great vessel injury in cases of penetrating chest trauma even when initial imaging doesn't show any significant findings pointing towards major vascular injuries. Mediastinal widening on chest X-ray-although nonspecific-remains an important red flag. Early surgical exploration should be strongly considered when clinical presentation and mechanism of injury raise concern for major vascular trauma regardless of reassuring imaging findings.

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