A Case of Acute Traumatic Aortic Injury of a Right-sided Aortic Arch with Rupture of an Aberrant Left Subclavian Artery

Sawsan Taif[1*], Jokha Al Kalbani[2]

1. Department of Radiology, Khoula Hospital, Muscat, Oman

2. Department of Radiology, Royal Hospital, Muscat, Oman

* **Correspondence:** Sawsan Taif, Khoula hospital, Menaa al fahal, Po Box 90, Postcode 116, Muscat, Oman (*sawsantaif@gmail.com*)

Radiology Case. 2013 Dec; 7(12):1-9 :: DOI: 10.3941/jrcr.v7i12.1994

ABSTRACT

Acute traumatic aortic injury is a potentially lethal condition with most patients die at the scene of the accidents. Rapid deceleration due to motor vehicle accidents is the commonest mechanism of injury. These injuries can be successfully repaired in the few patients who survive the initial trauma if proper diagnosis and rapid treatment are provided. The occurrence of acute traumatic aortic injury in patients with congenital abnormality of the aortic arch has been rarely reported; however, it renders the diagnosis and treatment more difficult. In this paper, we describe an extremely rare case of aortic injury in a young patient who had a right sided aortic arch with rupture of an aberrant left subclavian artery. The patient was suspected to have a Kommerell's diverticulum in the aberrant subclavian artery origin. This injury resulted in an unusually huge pseudoaneurysm involving part of the mediastinum and extending into the neck. Unfortunately; patient succumbed in spite of surgical intervention.

CASE REPORT

CASE REPORT

A 28-year-old man was brought to the emergency department after being involved in a motor vehicle accident; he was a driver who hit a concrete wall and was ejected from his car. On arrival, the patient was complaining of severe breathing difficulty and stridor with progressive oxygen desaturation.

Clinical examination showed 3/15 Glasgow coma scale, no external wound in the chest or abdomen, but a progressive hard swelling was noted in the neck. Intubation was initially tried, but it failed so that emergency tracheostomy was performed.

The chest x-ray (CXR) showed widening of the mediastinum and an obscured aortic arch that raised suspicion of a vascular injury. Left tension pneumothorax was also observed in this x-ray; thus intercostal chest drain was inserted (Fig 1).

Once the patient was stabilized, he was referred to undergo computed tomography (CT). Head and cervical spine CT was performed as part of the multiple trauma work up; which showed a well-defined large pre-vertebral fluid structure severely compromising the upper airways (Fig 2 a). The brain and cervical spine were otherwise normal.

The study was followed quickly by contrast enhanced CT for the neck, chest and abdomen to evaluate the mediastinal vessels. CT revealed a huge contrast filled structure extending over the chest and neck, from the level of the carina inferiorly to just above the level of hyoid bone superiorly (Fig 2b and 3). The overall size was 18x7x4 cm with the largest component being located in the neck. It was arising from a 1.7 cm defect at the junction of the aortic arch and the descending aorta; from the lesser curvature side (Fig 3b and c). Also, unexpectedly; the aortic arch was found to be right sided with the defect located at the orifice of an aberrant left subclavian artery (ALSCA) which formed the last branch of the aortic

arch (Fig 3). Beyond the site of the rupture, the ALSCA continued to the left side and looked intact.

Taken these findings, the patient was diagnosed to have acute traumatic aortic injury (ATAI) with the formation of a large pseudoaneurysm. The site of injury was at the origin of the ALSCA.

CT showed in addition, a large mediastinal hematoma and a large amount of mediastinal air (Fig 3). It was not clear whether this finding was related to concomitant tracheobronchial injury at the time of the collision or iatrogenic due to the tracheostomy.

Following this diagnosis, the patient was transferred to the cardiothoracic care in another hospital; multidetector CT angiography was performed which confirmed the previously detected findings (Fig 4 and 5). Owing to the size of the aneurysm and the abnormal anatomy, surgical rather than endovascular treatment was decided. During this period; the patient general condition started to deteriorate. Open surgery under deep hypothermia and circulatory arrest technique was performed eight hours following the patient's first admission to the emergency department. Median sternotomy approach was selected. A large aneurysm and mediastinal hematoma were seen during the surgery. Every effort was made to expose the site of the injury, but it was deep and difficult to access; therefore, the ascending aorta was opened longitudinally. Finally; these attempts revealed a large aortic defect in the region of an avulsed ALSCA, located posterior to the trachea and esophagus. Moreover; the ALSCA origin was found to be unusually large in caliber giving an impression of aneurysmal dilatation. We believe that this ruptured aberrant vessel was abnormal from the start showing an aneurysm even before the patient was involved in this collision and developed avulsion. Repair of the aortic wall defect with re-anastomosis of the ALSCA was established.

Unfortunately, in the next few hours following surgery; the patient's general condition further deteriorated with development of metabolic disturbances and deranged coagulation functions. In spite of the surgical repair and all supportive measures, the patient expired seven hours following surgery; about twenty hours after admission to the hospital.

DISCUSSION

ATAIs following blunt thoracic trauma are associated with high mortality. They are immediately fatal in 80-90% of patients with the rate increased up to 50% within the first 24 hours if untreated. With the recent advances in the pre hospital care as well as the improvement of both imaging evaluation by multidetector CT and the definitive treatment; these injuries are now considered potentially curable in the few patients who survive the initial trauma and are able to reach the hospital [1]. Consequently; radiologists have to be familiar with the variable presentation and imaging findings of ATAI. Since the presence of aortic arch anomalies can change the management plan; radiologists should also be able to recognize the presence of these anomalies prior to surgery.

The coincidence of ATAI in a right sided aortic arch has been reported in only few cases. The right aortic arch by itself, is a relatively rare congenital anomaly; occurring in about 0.5 % to 1% of the normal people. Three main subtypes have been identified: type 1 is a mirror image of the normal aortic arch; type 2 is a right aortic arch with an ALSCA and type 3 is a right aortic arch with an isolated subclavian artery.

The patient in the current case demonstrated type 2 right aortic arch in which the major arteries are arising in the following manner: the first branch is the left common carotid; second is the right common carotid; third is the right subclavian and the last branch is the ALSCA. Right aortic arch with ALSCA is found in 0.05% to 0.1% of the general population [2-4]. In some patients; the origin of this aberrant artery demonstrates aneurysmal dilatation forming what is called Kommerell's diverticulum. Literature has shown that these Kommerell's diverticula are prone to spontaneous rupture resulting in a very high mortality rate [2,4].

In the current case, the origin of ALSCA was found to be abnormally large during surgery raising a strong doubt that this patient originally had a Kommerell's diverticulum that had ruptured as a result of high deceleration during collision.

Although few cases of spontaneous rupture of Kommerell's diverticulum have been reported in the literature with variable treatment plans and outcomes; traumatic rupture of this diverticulum or the ALSCA as noticed in the current case was not previously described.

Moreover; this case is also unique because of the development of such a huge pseudoaneurysm in a patient who survived the initial trauma.

Etiology

Pathophysiology of aortic injury is complex. Although the mechanism is not definitely known; rapid deceleration creating a shearing force at sites of relative immobility in the aorta is the most acceptable theory. Osseous pinch resulting from compression of the aorta between the manubrium, first rib and medial clavicle anteriorly, and the thoracic spine posteriorly is another proposed mechanism for aortic injury [1,5].

Many authors consider the aortic isthmus in the normal left aortic arch, within 2 cm of the left subclavian artery origin, as the site most commonly involved by ATAI. However; other authors believed that fatal ruptures frequently occur in the ascending aorta near the root and the descending aorta near the diaphragm and that they probably represent the commonest sites of injury.

Most cases of ATAIs complicate high-speed motor vehicle accidents resulting from head-on or side- impact collisions. Motorcycle accidents are the second common cause of injury followed by fall from a height [1,6].

Presence of Kommerell's diverticulum in patients with ALSCA by itself is a risk factor making the artery liable for spontaneous rupture [2,4]. Although not previously described, high deceleration caused by collision, not surprisingly, is

expected to induce the rupture of a previously asymptomatic Kommerell's diverticulum.

Clinical Presentation

There are no definite signs and symptoms of ATAIs. The majority of patients are asymptomatic until they develop sudden hemodynamic instability. Chest pain, dyspnea, cough and hoarseness are some of the presenting complaints. Possible signs of ATAIs are diminished femoral pulses and upper limb hypertension [1].

Four predicting factors have been identified which should increase the index of suspicion for ATAI; they are the presence of abdominopelvic injury, thoracic injury, hypotension and being unrestrained [7].

ATAI of the ascending aorta or the aortic arch should be considered in any patient with significant thoracic trauma who develops cardiac tamponade, aortic valve regurgitation or myocardial contusion. Furthermore; aortic injuries are associated with a high incidence of neurological injuries that can be also life-threatening. For these reasons; treatment has to be modified according to every individual case [6].

Non-traumatized patients who have their aberrant subclavian forming Kommerell's diverticulum may remain asymptomatic until they suffer from a spontaneous rupture. The average size at which these aneurysms rupture was found to be 5.8 cm [2]. Occasionally these lesions are discovered incidentally during CT scan done for other reasons. However, some patients with this diverticulum may complain from compressive effects producing asthma like symptoms [3], cough and rarely dysphagia [8].

In the current case; a huge pseudoaneurysm and mediastinal hematoma were formed due to traumatic rupture of the ALSCA/ Kommerell's diverticulum with resultant pressure effects on the upper airways. Consequently; neck swelling and stridor were the striking clinical manifestations, and they even rendered intubation impossible.

Imaging Findings and Diagnosis

CXR remains an important primary tool of investigation aimed at detecting mediastinal hematoma. Mediastinal widening more than 8 cm or 25% of the width of the thorax is a frequent observation in mediastinal hematoma. More specific findings like abnormalities of the aortic arch and loss of the aortopulmonary window can also be noted. Other possible CXR signs are deviation of the trachea or nasogastric tube to the right, depression of left mainstem bronchus and a left apical cap. However, in a small percentage of patients, CXR reveals no positive finding.

Multidetector CT is now considered the diagnostic test of choice for ATAIs with about 98% sensitivity. CT angiography is not considered an essential study for diagnosing this condition as contrast enhanced multidetector CT is sufficient to provide high quality reconstructed images. Axial sections, as well as multi planar reformatted, and three-dimensional volume-rendered images are helpful to show the exact morphology and the full extent of the injury [1].

Direct and definitive CT findings of ATAI include the presence of an intimal flap, traumatic pseudoaneurysm, contained rupture, intraluminal mural thrombus, abnormal aortic contour, and sudden change in aortic caliber. Possibility of involvement of one of the major vessels should be carefully evaluated prior to surgery as it may indicate the need to change the surgical approach, for example, to median sternotomy.

Although mediastinal hematoma is an indirect sign of aortic injury; it is considered to be nonspecific. Hematoma can result from hemorrhage originating from small mediastinal veins as well as from the internal mammary and intercostal arteries.

In the majority of cases, multidetector CT should replace the need for conventional angiography before surgery so that patients with unequivocal CT findings require no further imaging evaluation.

Conventional angiography, which was previously considered the gold standard test, has only a limited role in the current practice. It is reserved for stable patients whose CT findings are equivocal and in planning treatment before endovascular stent grafting.

Multiplanar reformatted maximum intensity projections, and volume rendered CT images can provide full delineation of the vascular anatomy and demonstrate any vascular abnormality of the aortic arch as in the current case.

Literature has shown several cases of traumatic and non-traumatic vascular rupture associated with anomalies of the aortic arch and described their treatment options. Of these abnormalities, there were only three previous cases of traumatic rupture of a right-sided aortic arch with an ALSCA. All the three cases had the injury in the aortic wall located near the origin of the aberrant artery [9-11].

Other cases of vascular ruptures in association with aortic arch anomalies include few cases of spontaneous rupture of an ALSCA with Kommerell's diverticulum [4, 12] and a case of aortic injury in a patient with situs inversus [13]. A case of dissecting aortic aneurysm involving a right aortic arch [14] and traumatic rupture of an aberrant right subclavian artery in a left sided aortic arch have also been described [15].

However, to best of the authors' knowledge; this is the first case to show traumatic rupture of the ALSCA itself in a patient with right sided aortic arch. Presence of a preexisting aortic arch abnormality in the form of Kommerell's diverticulum probably accounts for this injury.

Transesophageal echoaortography (TEA) is another tool which is occasionally performed and proved to be of help in patients with ATAI. When available; it is fast and relatively noninvasive, so it can be used immediately preoperatively to evaluate the aorta in unstable patients taken to the operating room for another reason, and even intraoperatively in certain circumstances. However, unavailability and lack of experience has limited its use in many cases.

Another less commonly used imaging modality for the diagnosis of ATAI is intravascular ultrasound which is considered as an adjunctive tool for evaluating patients having equivocal findings [1].

Differential diagnosis

ATAI of the right sided aortic arch is a rare entity. CT scan can easily confirm the aortic arch anomaly and the presence of any vascular injury.

Occasionally ATAI leads to aortic dissection with an imaging appearance similar to non-traumatic dissection of the aorta. However, these two conditions can readily be differentiated in the setting of the trauma.

Dissection is the result of an intimal tear which allows blood to enter the media leading to longitudinal separation of the aortic intima and adventitia. The commonest risk factor for the development of dissection is hypertension. CT scan characteristically shows an intimal flap with true and false lumens.

Two types of aortic dissection have been identified; the commonest one is Stanford type A dissection which involves the ascending thoracic aorta and may extend into the descending aorta [16]. The less common stanford type B dissection involves the descending thoracic aorta distal to the left subclavian artery. Management of these two types of dissection is also different as type A dissection typically requires urgent surgical intervention, whereas type B dissection can often be treated medically.

Presence of a disease known to affect the aortic wall and predispose to dissection is another factor that aids in the diagnosis of non-traumatic dissection. Marfan syndrome, Ehlers-Danlos syndrome, relapsing polychondritis, Behcet disease, Turner syndrome, aortitis, infections and aortic root anomalies are known to cause dissection [16].

True aortic aneurysm is another differential diagnosis of ATAI. They most commonly involve the descending aorta with 70% of them resulting from atherosclerosis. Unlike traumatic pseudoaneurysm, which is only surrounded by the adventitial layer; true aortic aneurysm involves all the three layers of the aortic wall and usually demonstrate a fusiform rather than a saccular shape. The absence of trauma and the presence of a predisposing disease like atherosclerosis, connective tissue disease, or other diseases affecting the aortic wall like Marfan syndrome are the main differential points [5].

Spontaneous rupture of Kommerell's diverticulum is another differential diagnosis. The absence of trauma and the association with ALSCA and right aortic arch can differentiate this condition from ATAI.

Treatment and Prognosis

Although the survival rate of ATAIs has recently been improved; these conditions are still causing substantial morbidity and mortality. Mortality is increased in the presence of more severe injury score, other serious injuries, prolonged transport to the hospital, hemodynamic instability at the presentation and in the older age group [1].

Mosquera et al found in-hospital mortality rate of more than 50% in patients with ATAI. Half of the deaths were related to other concomitant injuries. They also found only 46% one year survival rate [6].

Rapid diagnosis and treatment are shown to be the most important factors in improving the patients' survival. Thus, once the diagnosis is achieved, definitive treatment has to be provided as fast as possible. Open surgical repair; usually through left thoracotomy (anterolateral or posterolateral) represents the traditional treatment and considered by many authors to be the mainstay of therapy. Precise delineation of the vascular anatomy with the aid of CT is important during surgical planning as the choice of the incision depends on the site of the injury. In addition; the presence of some variations may require a different surgical approach. A right lateral thoracotomy or median sternotomy approach is sometimes recommended for the repair of a ruptured right sided aortic arch.

Recently, endovascular treatment by stent grafting is increasingly performed in different centers with promising results. This procedure is relatively new as it was first described for the treatment of aortic injuries in 1997 [17]. Its aim is to prevent further rupture by the exclusion of the site of the aortic injury from the systemic blood pressure. As it is less invasive; endovascular repair can be used as an alternative to open surgery in multiply traumatized patients. It is especially helpful in injuries involving multiple arch vessels and in high risk patients. This procedure also carries a lower risk of pulmonary embolism [1,18-21].

In the current case; despite the fact that the patient had survived the initial trauma and reached the hospital; he passed in less than 24 hours following trauma. The huge pseudoaneurysm size originating from a large aortic defect, as well as the abnormal anatomy, probably accounts for the poor outcome in this case. Another cause is the relative delay in providing the definitive treatment since the time factor is regarded as the single most important prognostic factor in the patients' survival. As the rupture was involving the origin of the ALSCA, on the lesser curvature side of the aortic arch, different surgical approach like a left posterolateral thoracotomy might have provided better exposure of the defect. Another alternative treatment plan by using the endovascular stent graft could also have been tried in our patient.

Patients having a Kommerell's diverticulum are very difficult to treat. Repair of these lesions carries a high mortality rate, therefore; treatment is usually indicated in symptomatic aneurysms and asymptomatic patients who have large aneurysms. Several reports discussed the management of intact as well as ruptured Kommerell's diverticula which have described two treatment options; the endovascular procedure and open surgery [4,12,22-24]. A right thoracotomy approach is usually recommended over left thoracotomy and median sternotomy for treatment of these lesions [2].

TEACHING POINT

Acute traumatic aortic injuries continue to have a high mortality in spite of the improvement in the pre hospital care, the recent advances in the diagnosis by multidetector computed tomography and the options for the definitive treatment. Early diagnosis and fast treatment are considered the most important factors in improving the prognosis. Presence of aortic arch anomalies may complicate the radiological appearance and delay the management of these injuries and even complicate the surgical procedure; therefore, radiologists should be familiar with the imaging features and provide details of any abnormal anatomy prior to surgery.

REFERENCES

1. Steenburg SD, Ravenel JG, Ikonomidis JS, Schönholz C, Reeves S. Acute traumatic aortic injury: imaging evaluation and management. Radiology 2008;248:748-62. PMID 18710974.

2. Cina CS, Althani H, Pasenau J, Abouzahr L. Kommerell's diverticulum and right-sided aortic arch: a cohort study and review of the literature. J Vasc Surg 2004;39:131-9. PMID: 14718830.

3. Morel V, Corbineau H, Lecoz A, Verhoye JP, Heautot JF, Bassen R et al. Two cases of 'asthma' revealing a diverticulum of Kommerell. Respiration 2002;69:456-60. PMID: 12232456

4. Ebner L, Huber A, Christe A. Right aortic arch and Kommerell's diverticulum associated with acute aortic dissection and pericardial tamponade. Acta Radiol Short Rep 2013;2:2047981613476283. PMID: 23986854

5. Agarwal PP, Chughtai A, Matzinger FR, Kazerooni EA. Multidetector CT of Thoracic Aortic Aneurysms. Radiographics 2009;29:537-552. PMID: 19325064

6. Mosquera VX, Marini M, Muniz J, Gulias D, Asorey-Veiga V, Adrio-Nazar B et al. Blunt traumatic aortic injuries of the ascending aorta and aortic arch: a clinical multicentre study. Injury 2013;44:1191-7. PMID: 23294894

7. Kirkham JR, Blackmore CC. Screening for aortic injury with chest radiography and clinical factors. Emerg Radiol 2007;14:211- 217. PMID: 17618473

8. Kanza RE, Berube M, Michaud P. MDCT of right aortic arch with aberrant left subclavian artery associated with kommerell diverticulum and calcified ligamentum arteriosum. World J Radiol 2013;5:184-6. PMID: 23671755

9. Matsumoto M, Tanemoto K, Inagaki E, Hamanaka S, Masaki H, Nakata M. Traumatic rupture of a right aortic arch in a patient with an aberrant left subclavian artery. J Thorac Cardiovasc Surg 2006;131:464-5. PMID: 16434279

10. Singh SP, Nath H, Soto B, Nanda NC . Traumatic transection of a right aortic arch. AJR Am J Roentgenol 1998;171:586. PMID: 9725277

11. Berkoff HA, Crummy AB, Katz M. Traumatic disruption of a right aortic arch. J Cardiovasc Surg (Torino). 1984;25:78-80. PMID: 6707077

12. Kim HW, Chun HJ, Suh JH, Yoon JS. Endovascular repair of an intra-thoracic ruptured aneurysm of left subclavian artery in a patient with a right-sided aortic arch with aberrant left subclavian artery. Eur J Cardiothorac Surg 2010;37:1233. PMID: 20060311

13. Bilello JF, Birnbaum PL, Venugopal C, Fong LL. Endovascular repair of blunt aortic injury in a patient with situs inversus and dextrocardia. J Vasc Surg 2011;54:857-9. PMID: 21571491

14. Floten HS, Rose DM, Cunningham JN Jr. Surgical therapy of a dissecting aortic aneurysm involving a right-sided aortic arch. J Am Coll Cardiol. 1984;4:1058-61. PMID: 6491073

15. Schneider J, Baier R, Dinges C, Unger F. Retroesophageal right subclavian artery (lusoria) as origin of traumatic aortic rupture. Eur J Cardiothorac Surg 2007;32:385-7. PMID: 17560115

16. McMahon MA, Squirrell CA. Multidetector CT of Aortic Dissection: A Pictorial Review. Radiographics 2010;30:445-60. PMID: 20228328

17. Kato N, Dake MD, Miller DC, Semba CP, Mitchell RS, Razavi MK et al. Traumatic thoracic aortic aneurysm: treatment with endovascular stent-grafts. Radiology 1997;205:657-62. PMID: 9393517

18. Waldenberger P, Fraedrich G, Mallouhi A, Jaschke WR, Perkmann R, Jung T et al. Emergency endovascular treatment of traumatic aortic arch rupture with multiple arch vessel involvement. J Endovasc Ther 2003;10:728-32. PMID: 14533971

19. Jakimowicz T, Rowinski O, Galazka Z, Solonynko B, Szmidt J. Endovascular repair of traumatic thoracic aortic rupture-a single centre experience. Kardiol Pol. 2013; 21. PMID: 23799621

20. Watanabe KI, Fukuda I, Asari Y. Management of traumatic aortic rupture. Surg Today 2013;43:1339-46. PMID: 23338596

21. Marone EM, Kahlberg A, Tshomba Y, Chiesa R. Single-center experience with endovascular treatment of acute blunt thoracic aortic injuries. J Cardiovasc Surg (Torino) 2013;54:123-31. PMID: 23296422

22. Motoki M, Hattori K, Kato Y, Takahashi Y, Kotani S, Nishimura S et al. Endovascular repair of ruptured aberrant left subclavian artery with right aortic arch. Ann Thorac Surg 2013;95:699-701. PMID: 23336883

23. Yamashiro S, Nagano T, Kuniyoshi Y, Kise Y, Maeda T, Arakaki R. Endovascular repair of intrathoracic ruptured Kommerell's diverticulum. Asian Cardiovasc Thorac Ann 2012;20:587-90. PMID: 23087307

24. Naoum JJ, Parenti JL, LeMaire SA, Coselli JS. Endovascular repair of a right-sided descending thoracic aortic aneurysm with a right-sided aortic arch and aberrant left subclavian artery. Ann Thorac Surg 2008;85:1074-6. PMID: 18291202

FIGURES

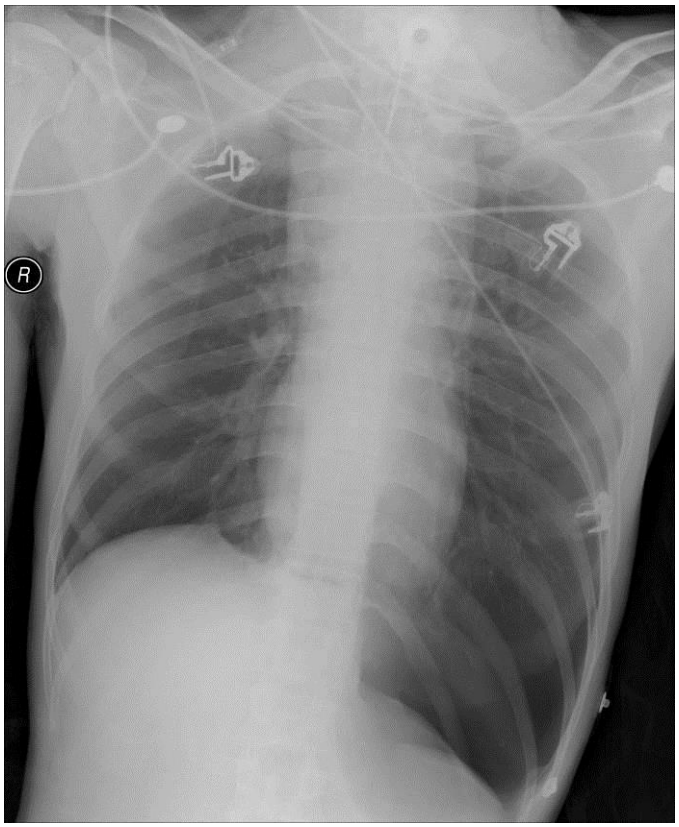

Figure 1 (right): 28-year-old male with rupture of an aberrant left subclavian artery in a right sided aortic arch forming a huge pseudoaneurysm. CXR supine AP projection shows widening of the mediastinum with obscured aortic arch and a left tension pneumothorax. Pneumomediastinum can also be noted as thin radiolucency outlining the heart and mediastinal borders. KV 60 , MAS 10.

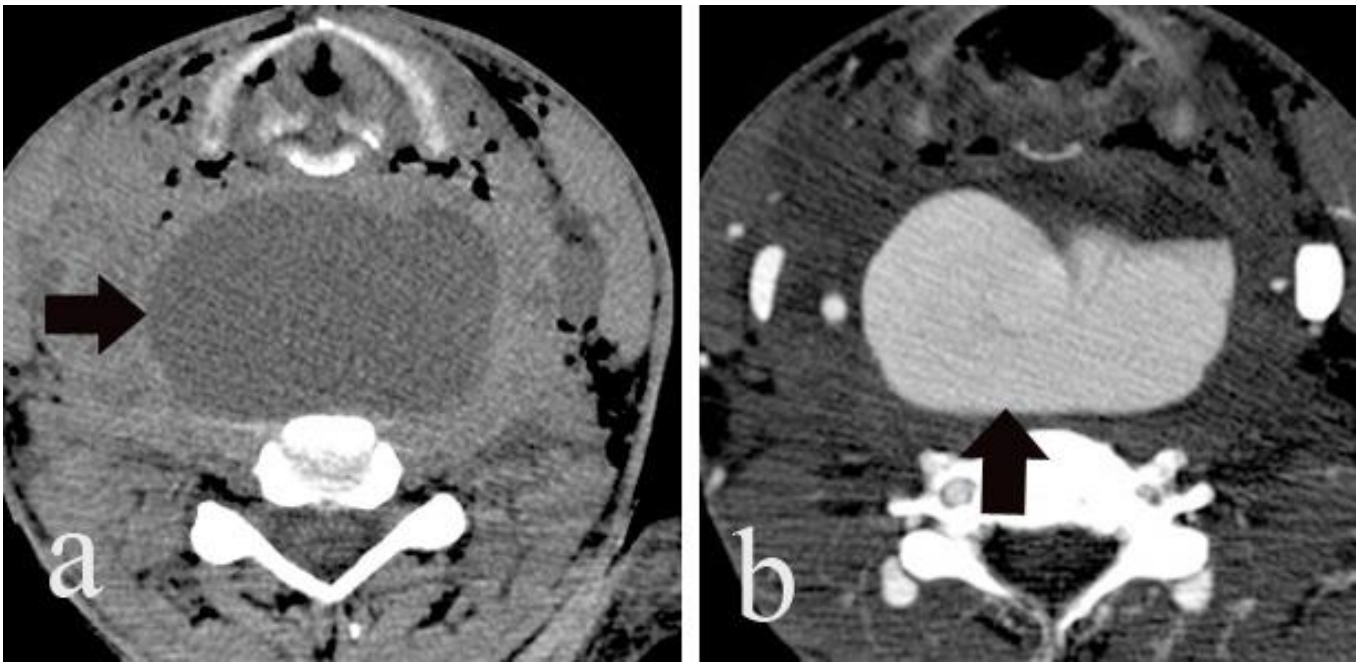

Figure 2: 28-year-old male with rupture of the aberrant left subclavian artery in a right sided aortic arch forming a huge pseudoaneurysm. (a) Cervical spine CT shows large prevertebral fluid-containing structure. (b) Contrast enhanced neck CT shows contrast-filling of the prevertebral collection (black arrows) indicating a huge pseudoaneurysm that is extending into the neck. Overall aneurysm size was 18x7x4 cm. Subcutaneous emphysema can also be noted in these images. Spiral CT scanner, axial with 1 mm slice. KVP 120, exposure 200. Intravenous contrast 70 ml Omnipaque 300 mg/100 ml.

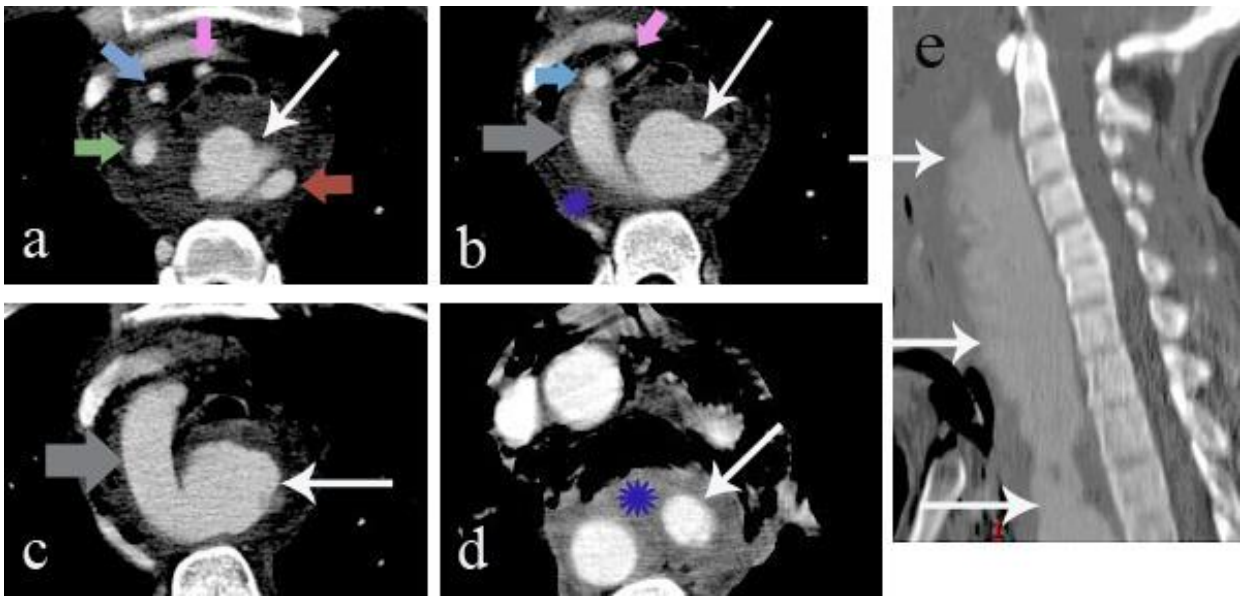

Figure 3: 28-year-old male with rupture of aberrant left subclavian artery in a right sided aortic arch forming a huge pseudoaneurysm. Contrast enhanced CT of the neck and chest. Axial cuts: (a) At level of the major vessels. (b) and (c) at the level of the aortic arch (grey arrows). (d) At level of the carina. Sagittal reconstructed image in the midline (e). Images show a huge pseudoaneurysm (white arrows) measuring 18x7x4 cm in size which is arising from 1.7 cm defect in the aortic wall at the origin of the aberrant left subclavian artery (red arrow), extending superiorly to the neck and inferiorly to the level of the carina. Left common carotid artery (pink arrow), right common carotid artery (blue arrow) and right subclavian artery (green arrow) are seen. Mediastinal hematoma (blue asterix) and pneumomediastinum can also be noted in these images. Spiral CT scanner; 1 mm slice. KVP 120, exposure 200. Intravenous contrast 70 ml Omnipaque 300 mg/100 ml.

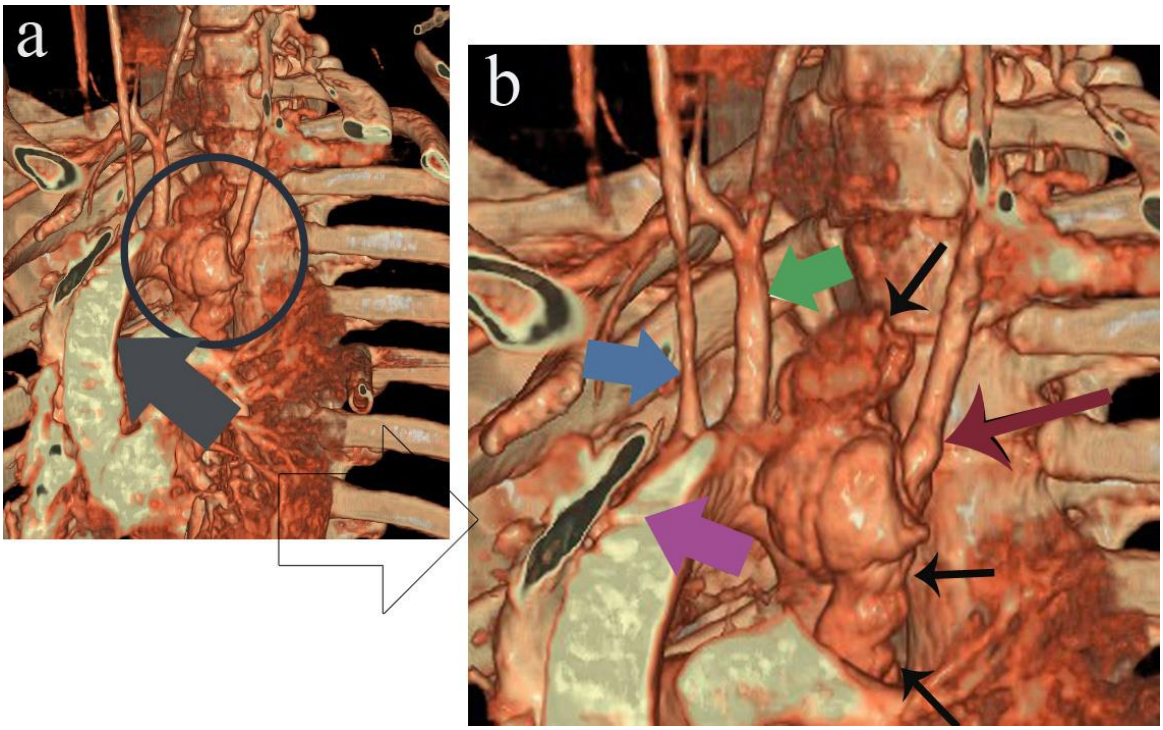

Figure 4: 28-year-old male with rupture of the aberrant left subclavian artery in a right sided aortic arch forming a huge pseudoaneurysm. CT arteriography of the neck and chest. (a) Volume rendered three-dimensional image, left anterolateral view, shows part of the huge pseudoaneurysm (circle) arising from the distal part of the aortic arch (large grey arrow). (b) Magnified view shows the aneurysm (black arrows) originating at the base of the aberrant left subclavian artery (deep red arrow). Only the proximal part the left common carotid artery, which was originating as the first branch from the aortic arch, is visible in in this image (pink arrow) as this vessel is passing obliquely to the left side. The right common carotid artery (blue arrow) and the right subclavian artery (green arrow) are also seen. Multi slice 16 CT scanner, axial 0.6 mm slice. Intravenous contrast 90 ml Omnipaque 300 mg/100 ml. KVP 120, exposure 200.

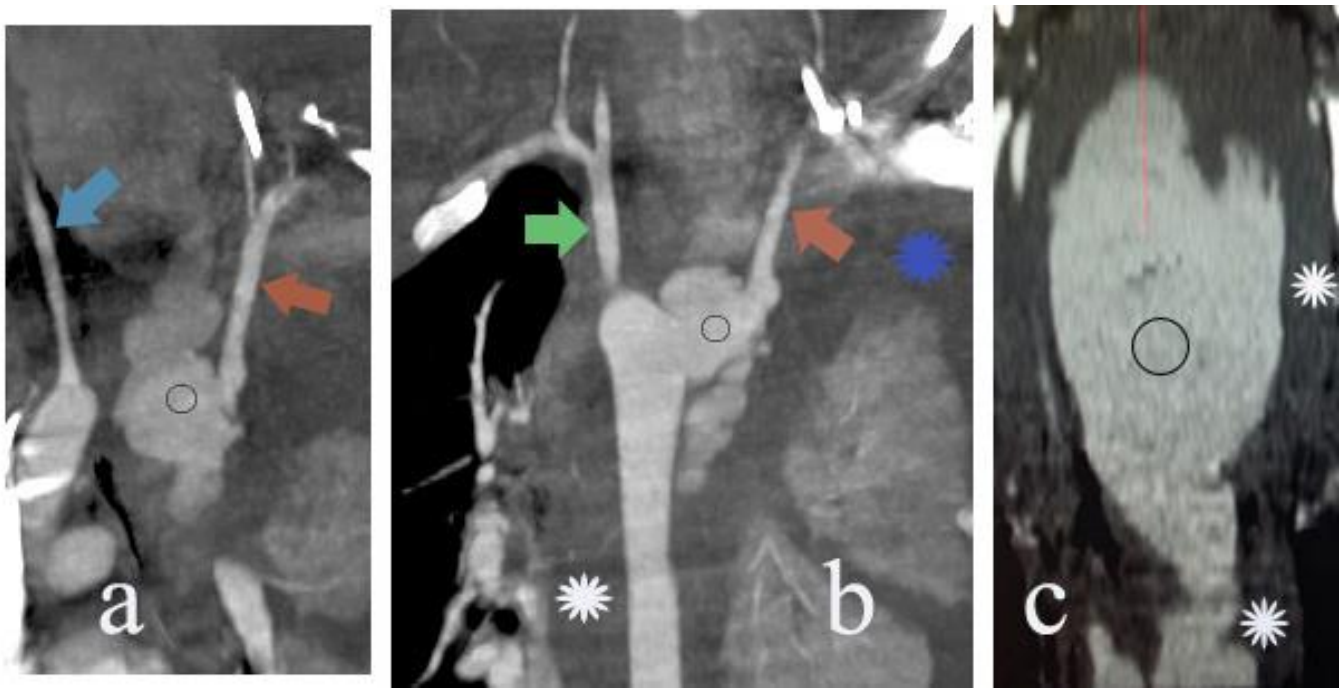

Figure 5: 28-year-old male with rupture of the aberrant left subclavian artery in a right sided aortic arch forming a huge pseudoaneurysm. CT arteriography of the neck and chest. Multiplanar reformatting, thin maximum intensity projection (MIP) images. (a) Left sagittal oblique. (b) Left coronal oblique. These reconstruction images show part of the huge pseudoaneurysm (small circles) arising from the distal part of the aortic arch at the base of the aberrant left subclavian artery (red arrow). Right common carotid artery (blue arrow) and right subclavian artery (green arrow) are also seen. The left common carotid artery, the first branch of the aortic arch, was not shown in these reformats. (c) Coronal reconstructed image in the neck demonstrates the largest aneurysm component (large circle). The pseudoaneurysm is measuring 18x7x4 cm in size. Furthermore; images show mediastinal hematoma which is extending to the neck (white asterix) and a large left hemothorax (blue asterix). Multi slice 16 CT scanner, axial 0.6 mm slice. Intravenous contrast 90 ml Omnipaque 300 mg/100 ml. KVP 120, exposure 200.

Incidence	-Acute traumatic aortic injuries (ATAIs) in right aortic arch: only 3 previously reported cases. -Right aortic arch with aberrant left subclavian artery (ALSCA): 0.1%. incidence of Kommerell's diverticulum is even less -Traumatic rupture of Kommerell's diverticulum: not reported
Age	ATAIs can occur at any age; but risk is increased in older people
Gender	ATAIs can occur in both sexes
Etiology and risk factor	-ATAIs result from rapid deceleration especially in high speed collisions. -Being unrestrained -Kommerell's diverticula in patients with right sided aortic arch are liable for spontaneous rupture
Imaging appearance	-Mediastinal hematoma on chest x-ray and computed tomography (CT) is an indirect sign of ATAI. -Definitive CT findings of ATAI are presence of an intimal flap, traumatic pseudoaneurysm, contained rupture, intraluminal mural thrombus, abnormal aortic contour, and sudden change in aortic caliber. -Presence of vascular anomalies of the aortic arch can be diagnosed on reformatted CT images.
Treatment	-Rapid diagnosis and treatment is most important factor. -Open surgery and endovascular stent grafting are the treatment options.
Prognosis	-ATAI still carries a high mortality (immediately fatal in 80-90%). -Rapid diagnosis and treatment improve prognosis.

Table 1: Summary table of acute traumatic aortic injury (ATAI) in a right aortic arch with an ALSCA

Aortic lesions	Patient setting	Site	CXR	CT	MRI
Acute traumatic aortic injury (ATAI) in a normal left sided aortic arch	High deceleration trauma especially motor vehicle accidents	Commonest sites are isthmus; aortic root and near the diaphragm	-Mediastinal widening. -Other findings: obscured aortic arch, loss of the aortopulmonary window, deviation of trachea or nasogastric tube, depressed bronchus, left apical cap	-Definitive signs are intimal flap, pseudoaneurysm, contained rupture, intraluminal mural thrombus, abnormal aortic contour, and sudden change in aortic caliber. -Mediastinal hematoma	No role in the ATAI.
ATAI in a right sided aortic arch	High deceleration trauma especially motor vehicle accidents	Few reported cases: injury was located near the origin of the aberrant left subclavian artery (LSCA)	-Right aortic arch seen on CXR -Widened mediastinum	-Similar findings of rupture in left aortic arch -Abnormal vascular anatomy	No role in the ATAI.
Non-traumatic aortic dissection	-No trauma -Most: hypertension -Others: connective tissues diseases and infection	-Commonest: type A involves the ascending aorta -Type B involves only the descending aorta	-Widened mediastinum -Displacement of aortic calcification -Abnormal cardiac contour	-Intimal flap separating true and false lumens - Sometimes thrombosed false lumen -Medial displacement of intimal calcification	MR angiography can be used in the stable patients or chronic cases. Show similar findings to CT
True thoracic aortic aneurysm	-No trauma -Most due to atherosclerosis. - Others: connective tissue and arterial wall diseases	Most frequently involve the descending aorta	-Enlarged aortic shadow -Focal bulge -Sometimes calcification	-Aneurysm has all the three layers of the vessel wall -Usually fusiform dilatation. Less commonly saccular -Sometimes wall calcification	-MR has a role in stable patients -Appearance is similar to CT
Kommerell's diverticulum	-Right aortic arch -Sometimes there is history of compressive symptoms -Sometimes spontaneous rupture or incidentally detected	The origin of the ALSCA (aneurysmal dilatation)	-Right aortic arch -In case of rupture: widened mediastinum and other findings of mediastinal hematoma	-Aneurysmal dilatation of the origin of ALSCA from a right aortic arch -If ruptured: mediastinal hematoma, pseudoaneurysm, leak, irregular contour	-No role in acute rupture -In stable patients may show similar findings to CT

Table 2: Differential diagnosis table of acute traumatic aortic injury (ATAI) in a right sided aortic arch from other aortic lesions
CXR = Chest x-ray, CT = Computed tomography, MRI = Magnetic resonance imaging

ABBREVIATIONS

ALSCA: aberrant left subclavian artery
ATAI: acute traumatic aortic injury
ATAIs: acute traumatic aortic injuries
CXR: chest X-ray
CT: computed tomography
MRI: magnetic resonance imaging
TEA: transesophageal echoaortography

KEYWORDS

aortic; injury; pseudoaneurysm; rupture; subclavian