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Traumatic Aortic Injuries – Emerging Threat In India

Traumatic Combined Double Aortic Transaction presenting as Respiratory Discomfort

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Abstract Neurofibromatosis A 35-year-old male presented to ER after a high-speed motor vehicle accident. His mother died on the spot next to the driver's seat. He was fully conscious but anxious with cold sweating and air hunger. His obvious injuries were closed fracture femur. His vitals were heart rate 88/min, regular, NIBP 160/100 mmHg and respiratory rate 20/min, and SpO2 98%. His all peripheral pulses were well felt. Air entry was present bilaterally on auscultation. Chest x-ray was performed which showed widened mediastinum. CT scan was done immediately and revealed double aortic transaction with minimal hemothorax.

In a developing world with limited resources, trained and experienced surgeons, facility and financial restraints management of these complex injuries are challenging. Challenges include overall management particularly long-distance transport and hemodynamics stabilization.

Widened mediastinum with other findings suggestive of aortic injury on plain X-ray chest and CT scan with double transaction and hemothorax.

Our team was not having enough experience for aortic surgery, so the patient was transferred to an advanced cardiac center which was 350 km away via road. Metoprolol 5+5 mg was administered intravenously slowly over 15-20 minutes and sodium nitroprusside infusion was instituted to reduce the rate of rising of pressure to prevent further injury and exsanguination. In the advanced cardiac Centre, vascular stenting failed, and then open surgical repair was done. He

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had a wonderful recovery and then the fractured femur was fixed after 4-5 days. He is on regular follow-up.

Major traumatic vascular injuries can be catastrophic. Patients with an aortic injury who reach the hospital are relatively clinically asymptomatic. A high index of suspicion is important as the presentation can be asymptomatic to variable clinical pictures.

Introduction

Traumatic aortic injury is relatively clinically asymptomatic but the mechanism of injury and circumstantial evidence like the death of other occupant are clues for high suspicion and warrant early definitive investigations, stabilization, and transport to Centre with facility for definitive treatment. We reported a case that had contained a complete double transaction of the aorta and presented with respiratory discomfort.

Traumatic rupture of the thoracic aorta is a common cause of major fatality following motor vehicle collisions affecting the occupants and pedestrian

Consent

Written well-informed consent was taken from the patient in the regional language of Punjabi. The patient was ensured that his personal information will be kept confidential and no identifiable information will be disclosed whatsoever. Permission from the treating physician was also taken.

History

A 35-year male presented to ER after a motor vehicle accident. He was driving a car with his family at high speed (approx. 100kms/hr) when he lost control over a four-wheeler and hit a tree. The passenger sitting next to him died on the spot and others at the back seats sustained minor skeletal injuries.

Examination & Investigations:

On examination, he was fully conscious with an anxious look, cold and clammy. His vitals were Heart rate 88/min, regular, NIBP 160/100 mmHg, and respiratory rate 20/min. His all peripheral pulses were palpable. Air entry was present bilaterally equal on auscultation. There was no evidence of any surgical emphysema. His obvious injuries were closed fracture femur. His oxygen saturation on room air was 98% Oxygen. Oxygen and intravenous access were started. A Chest x-ray (Figure 1) and CT scan (figure 2) of the chest were performed.

Diagnosis

Chest X-Ray done revealed classical features of major vascular injury with mediastinal widening and other features of aortic injury (figure 1). CT scan done immediately showed double aortic transaction with minimal haemothorax (figure 2). Cross consultation was sought from surgeons, cardiothoracic surgeons, and cardiologists. As our hospital was not having enough experience for aortic surgery, thus the patient was planned to be transported to an advanced cardiac center which was 350 km away. During transportation, injection metoprolol was administered intravenously in boluses of 5 mg slowly over 15-20 minutes and infusion of sodium nitroprusside was also started to target systolic arterial pressure of 80 to 90. It took 7 hours by ambulance on a bumpy road with a lot of diversions, to reach the advanced cardiac center safely. After reaching there, vascular stenting was tried by experienced interventional

Figure 1

Figure 2

cardiologists but the guidewire couldn't be negotiated through the proximal and distal end of the lesion. Thereafter, open surgical repair was done by a clamp and sew technique. The fractured femur was addressed after 5 days. He had an uneventful recovery without any apparent neurological or renal deficit. He is still on follow-up.

Challenges Faced

The major challenge was to transport the patient with a major thoracic injury long route and to maintain hemodynamic stability. This was successfully done by judicious use of beta-blockers and sodium nitroprusside. The second challenge was at the time when vascular stenting was tried but eventually, the patient had to be taken up for open surgery.

Follow-up

The patient was then discharged and subsequently lost to follow-up.

Discussion

Our states are having the maximum number of fatal accidents in the country. Fatal accidents involve polytrauma and injury to vital organs and major vessels. Traumatic rupture of the thoracic aorta is a common cause of major fatality following motor vehicle collisions. Complete (full thickness) aortic injury typically results in immediate exsanguination and most patients succumb to exsanguination before getting medical help. Hospitalized patients almost invariably have an

incomplete aortic injury (IAI) with intact adventitia. The outcome is remarkable if an aortic injury is recognized before aggressive resuscitation. Aortic tears are the result of rapid sudden deceleration and compression following impact. Sudden deceleration may be due to the collision of vehicles, or direct impact to stationary trees or other objects. Pedestrians are also victims of these accidents. The incidence of thoracic aorta rupture in pedestrian victims of vehicular collisions, however, is comparatively affecting lesser (12.7% fatalities) but probably with a similar risk of high hospital mortality (66%). In the same retrospective analysis, authors found 42% hospital mortality for patients with rupture of the thoracic aorta secondary to motor vehicle collision.[1] Pioneer work of Parmley et al in 1958 found that 85% of patients who sustain an aortic injury from blunt trauma die at the scene of the accident [2]. 15% who survived for 1 hour, 30% of those would succumb in the first 6 hours and at 24 hours half would be dead. At 4 months only 2% of patients were alive. However, with improving standards of medical understanding and care, mortality of patients once hospitalized has discernible improvement.

Shkrum MJ et al based on autopsy studies in LHSC, Ontario, Canada have shown that motor vehicle collisions cause between 50 and 90% of traumatic aortic ruptures. They analyzed mortality data of 39 fatally injured victims following car collisions (1984-1991) who had sustained aortic trauma[3]. A retrospective autopsy study of 492 fatally injured car-drivers in head-on car collisions there were 194 front-seat passengers[4]. Probably the impact energy to front seat passengers or drivers is the maximum supporting the mechanism of deceleration and compression.

Site and Mechanism

The frequency and site of injury are variable for the type of survey whether it is postmortem or those surviving to hospitalization. The most frequent site of fatal aortic rupture is at the isthmus in most autopsy studies. A majority of victims had associated rib/sternal fractures indicating significant chest compression and impact. The isthmus of the aorta was the most common site of simple blunt rupture among car drivers and front-seat passengers. Among more than half of the observed subjects, there were aortic blunt ruptures as a concomitant injury with heart and pericardium injuries. Heart and pericardium ruptures were most common among fatal cases. The most frequently injured part of the heart was the right atrium. The probability of about 80% that the fatally injured person in head-on collisions was a car-driver was pointed out by concomitant blunt thoracic aorta rupture with fractured sternum and ribs. These injury patterns favor the theory of compression. Ahrar et al found that 96% of injuries occur at the aortic isthmus, 1% at the proximal ascending aorta, 1% at both the aortic isthmus and the proximal ascending aorta, 1% at the distal ascending aorta, and 1% in the descending aorta using gold standard catheter study.[5]

The basic mechanism of the injury of thoracic organs is deceleration, as well as anteroposterior compression with caudo-

rostral hyperextension. That is why thoracic organ injuries are mostly concomitant. Fatally injured car drivers suffered more often of these injuries than other car occupants. Of the various traumatic aortic injury mechanisms proposed following MVA, the favored theories in the literature are the hybrid force of rapid deceleration and chest compression. The other forces which contribute to this injury are torsional and shearing forces that result in transverse laceration and rupture of the aorta, most commonly in the inherently vulnerable isthmus region. Isthmus is being a relatively weak and non-fixed part as compared to the proximal arch and descending aorta, is prone to this insult. Shkrum MJ et al in their study found a disproportionate number of heavy truck and roadside fixed-object impacts. Intrusion into the occupant compartment was a significant factor in most of these fatal injuries[3].

Occupant contact with vehicle interior surfaces was identified in most cases, and occupant restraints were often ineffective, especially in side collisions. In pedestrians, there are associated more injuries and with comparable hospital mortality. Elderly patients have higher mortality than adults and adults higher than the pediatric population.[4]

Causes

It is not surprising that motor vehicle accidents correspond to daily activities, weather conditions, law, and order of the studied area. In an Australian survey, authors observed two peak injury periods with high accident rates; one between 17.00 and 18.00 hours and the other between 20.00 and 22.00 hours. Significantly more injuries occurred on Friday and during the autumn months. Musculoskeletal (34.3%), head (31.8%), and external (20.2%) injuries predominated. In their analysis, 49 percent of patients tested positive for consuming alcohol and these patients with alcohol consumption were associated with a worse outcome in terms of hospital, and intensive care unit stay, morbidity, and mortality [6].

Clinical Presentation

Clinical features are subtle. Diagnosis is more based on a high degree of suspicion following the clinical settings rather than clinical features based on the mechanism of injury and other circumstantial evidence like death or major injury in another occupant, deformed vehicle, etc. signifying major impact. Such high degree impacts are either due to high-speed motor vehicle collisions or fall from height. History of concomitant occupant's death warrants a rule of major vascular injury particularly in hemodynamically stable patients. Before aggressive resuscitation, it is important to rule out major vascular injury as resuscitation may result in dislodging of clot or exsanguination from previously sealed injury. The pain of tears may be difficult to differentiate because of the associated chest or head injuries.

Plain X-ray chest

A plain CXR is the first investigation as per most of the protocols including ATLS protocol with a lot of emphasis on mediastinal widening and other radiological signs. Often it is the portable film in supine with patients on board. The incidences of radiographic signs of TAI, as reported by Stark et al after reviewing the CXR results in 49 cases of aortic rupture and found that a widened mediastinum (70%), partial obliteration of descending aorta (67%), a left apical cap (65%), and downward or right tracheal deviation (65%) were the most common findings. [7]

No patient in his study had normal CXR results.

Table

1)	Wide mediastinum
2)	Partial obliteration of the descending aorta
3)	A left apical cap
4)	Downward displacement of the left bronchus
5)	Tracheal deviation to the right
6)	Obscuration of the aortic arch
7)	A right paratracheal stripe thickening
8)	Deviation of the nasogastric (NG) tube to the right
9)	Enlarged abnormal aortic contour
10)	Left hemothorax
11)	A displaced left paraspinal stripe
12)	A displaced right paraspinal stripe
13)	A fracture of the first rib

Regarding the well-known sign of mediastinal widening, some trauma radiologists believe that the mediastinal contour is a better indication of BAT than is the transverse diameter. It has long been a part of the initial imaging assessment of suspected IAI with a long list of signs described. It is still widely advocated.[8,9] However, it is unreliable with over and under assessing sometimes. Some authors concede it as an unreliable tool.[10] The mediastinum commonly appears widened on a supine CXR, but the subsequent CT will show no aortic injury or mediastinal hemorrhage. Conversely, and more importantly, a normal CXR does not exclude an aortic injury. Thus, a chest x-ray should be carefully evaluated and considered along with other clinical predictors to plan for further investigations and management strategy. Supplementary signs can reduce this number further, but for a potentially lethal condition, it is inadvisable to put the patient to risk. Even a value of 95% negative predictive value is not acceptable for a lethal condition. Thus, if a patient has evidence of high-speed deceleration or high impact injury with high suspicion of major vascular trauma, he or she must undergo an early definitive imaging assessment to exclude major vascular injury. Elderly patients can sustain an aortic injury with lower-level impacts, which should lead to a heightened awareness in this group. Additionally, Trupka et al found CT to be superior to a CXR in detecting other thoracic injuries and that it significantly influenced management [11]

Chest CT scan

Helical CT scanning and CT angiography (CTA) are being used more commonly in the diagnosis of patients with possible blunt aortic injuries. However, in developing countries, it may not be feasible for all subsets of the population, but it is highly desirable for victims with high suspicion of aortic injury. In one study, 50% of patients with normal chest radiographs were found to have multiple injuries on chest CT scans. Most authors advocate those positive findings or suggestive findings of an aortic injury (e.g., mediastinal hematoma) be augmented by aortography to define the location and extent of the injury more precisely. Traumatic aortic injury (TAI) may be diagnosed from CT scans based on direct or indirect signs. Direct signs (eg, aortic intimal flap, contour abnormality) are more accurate than indirect signs (e.g., mediastinal, periaortic hematoma). The current facility of faster spiral (helical) CT scanners with equivalent negative predictive value and sensitivity, has resulted in the investigation of preference by many authors. Wicky et al found spiral CT to have a sensitivity of 100% and specificity of 99.8%. [12]

The advantages of CT scanning are that it is quick, non-invasive, useful in evaluating multiple traumas at the same time, and capable of providing a larger field of interest, particularly with fast spiral technology. A single intravenous administration of contrast material can be used for a combined vascular and nonvascular evaluation. Advanced tools with image reconstruction provision using data management may help plan treatment modality also. These reconstruction techniques produce images that simulate anatomic dissections and angiograms.

Ultrasonography

The use of ultrasonography is now routine in trauma patients in emergency settings. With newer portable machines having provision of multiple probes including transthoracic and transesophageal echocardiography is feasible. FAST can be expeditiously performed by surgeons and emergency department (ED) physicians within the ED. Pericardial effusions or tamponade can be reliably recognized, as can hemothoraces associated with trauma. The sensitivity, specificity, and overall accuracy of ultrasound in these settings are all more than 90%. Experienced physicians can pick up more findings. Pain and surgical emphysema may preclude transthoracic examination. With TEE it is possible to identify intimal tears, intramural hematoma, pseudoaneurysms, pseudocoarctation, and active bleeding with a sensitivity of 91% and a specificity of 98%. However, in trauma patients with multiple other injuries like cervical spine injuries, head injury, etc. its use may be limited. However, it can substitute for a definite diagnosis and management plan as TEE does not demonstrate the full spectrum of injuries that cross-sectional imaging can. In addition to its utility in diagnosis, TOE is a useful adjunctive imaging technique.

Treatment modalities

The rationale for treating IAI is to prevent early rupture from the acute injury and prevent late aneurysm formation and rupture. Initial management till a definite plan has been set in is to avoid aggressive resuscitation and use of beta-blockers to prevent exsanguination from rupture. The traditional treatment for IAI is early open surgery with a left thoracotomy and single-lung ventilation to do clamp and sew aorta. Endovascular stenting has evolved over the years and is now a semi-invasive treatment choice.

Conclusions

A high index of suspicion is important as the presentation can be asymptomatic to the variable clinical pictures. Mechanism of injury and circumstantial evidence is sufficient to warrant evaluation to rule out major vascular injury. The safety question of transporting such a case to a far of an advanced facility is difficult to comment on with an isolated report.

Ethics Approval

Treating Physician and competent authorities agree upon the case being published by the aforementioned authors.

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