

CASE REPORT

Ladder-rung tears of aorta - An unusual presentation of medico-legal significance

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Abstract

Ladder-rung tears have been described in the literature as multiple superficial parallel intimal tears in the aorta. They are mostly associated with a road traffic accident. The isthmus part of the thoracic aorta is more vulnerable to this injury as it is tethered. This injury is also more common with old age due to weakness of the vascular walls with the advancement of age. Multiple mechanisms have been proposed in the literature based on different principles of biomechanics. We report an autopsy case of road traffic accident with ladder-rung tears in abdominal aorta in young motorcyclist, which is a rare occurrence, along with a review of possible mechanisms of aortic injuries in road traffic accidents.

Keywords

Ladder-rung tear; Aorta; Road traffic accident; Autopsy; Acceleration-deceleration injury; Motorcyclist

Introduction

Road traffic accidents often present with a varied spectrum of injuries. Injuries to the great vessels, particularly aorta, are also not uncommon. Aortic injuries can be seen car occupants, pedestrians, motorcyclists or cyclists in varying frequencies. As per recent statistics, aortic rupture is slightly more frequent for pedestrians and motorcyclists in comparison to car occupants or cyclists.¹ Aortic injuries can be confined to intima or may extend to fatal aortic rupture. Kraus et al. in their study on motor cycle accidents found that non-fatal aortic injuries amount to 0.2 % cases whereas fatal aortic injuries to 15.4% of cases.² Intimal tears in the aorta can be multiple and parallel to each other like a step ladder. Hence, they are described as ladder-rung tears.³ Old aged persons are more vulnerable due to the weakening of the vascular wall with the advancement of age.⁴⁻⁷

The most common site of ladder-rung tear is descending thoracic aorta, particularly the isthmus of the aorta. Sudden deceleration injuries, shearing forces, osseous pinch, or a sudden increase in the intrathoracic pressure have been proposed as possible mechanism for its causation^[4,8-10]. Ladder-rung tears are a rarity in the abdominal aorta.^{4,8,9,11,12} We report a case of a young adult who succumbed to head injury, two days after a road traffic accident. Superficial intimal tears in a step ladder pattern were observed in the abdominal aorta at autopsy. The age of the deceased and the site of the intimal tears are being reported as rare atypical findings.

Case report

A 26 year old, male was brought to an emergency with a history of a road traffic accident. The victim was riding a two-wheeler bike and was allegedly hit by a truck. CT scan revealed extradural, subdural, and subarachnoid haemorrhages along with skull fractures. The patient underwent decompression craniotomy for extradural hemorrhage, and was managed conservatively for the rest of the injuries. He succumbed to his injuries two days later. At autopsy, sutured wounds were noted on the scalp, forehead, and right cheek. Besides, there were multiple abrasions, contusions, and lacerations on the head, face, chest, right upper limb, and lower limbs. Internal examination revealed diffuse subgaleal haemorrhage on the scalp and fissured fracture of the middle and posterior cranial fossae. Bilateral subdural haemorrhage and subarachnoid haemorrhage were present. Frontal lobes were contused. Vertebrae were intact. Abdominal visceral organs were intact. Examination of the abdominal aorta showed multiple superficial tears on its intimal surface. They were located about 4 cm below the level of aortic hiatus and present across the length of 11 cm. The tears were multiple, transverse and parallel to each other with size ranging from 0.5cm to 2.5cm and limited only to intima. In the lower most tear, intimal layer is stripped over an area of about 1.5 x 1cm; however the tear it is confined to intima (Figure 1). The external surface of the aorta was unremarkable. These tears are described as ladder-rung tears in the literature. Cause of death was attributed to craniocerebral injuries sustained in a road traffic accident.

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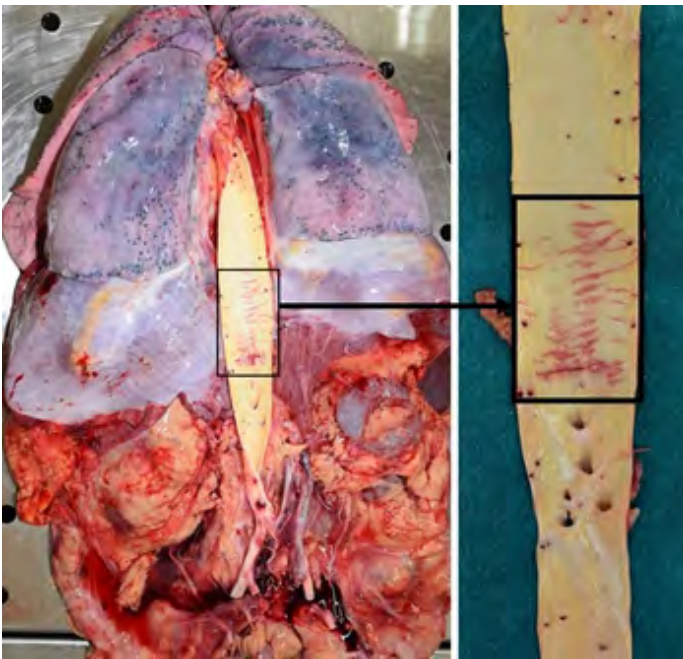
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Discussion

Road traffic accident cases are routinely encountered in medicolegal practice. The pattern of injuries depends upon multiple factors like the type of collision, speed of the vehicle, type of vehicle, relative position, safety measures, etc. Vascular

injuries, particularly involving aorta, are not rare in such cases. Otte et al. in their study on aortic injuries in road traffic accidents spanning from 1973 to 2014 found that majority of the aortic lacerations are present in car occupants (53.3%) followed by pedestrians (19%) and motorcyclist (16.9%). However, with advancement in the safety features, the recent statistics shows that aortic rupture is very seldom reported for car occupants (0.08%) or cyclists (0.04%), and is just slightly more frequent for pedestrians (0.21%) and motorcyclists (0.24%).¹ Aortic injuries can range from non-fatal intimal tear to fatal aortic rupture. Kraus et al. studied 548 cases of motor cycle accidents in which they found that non-fatal aortic injuries amount to 0.2 % cases whereas fatal aortic injuries to 15.4% of cases.² Williams et al. observed total 105 aortic injuries in 90 cases out of 530 cases of motor vehicle accidents in their study. Out of these 105 injuries, 61 were transections and 44 were tears. The aortic injuries were least common in abdominal aorta i.e., 9 injuries, of which 4 were tears and 5 were transections.¹²

Figure 1: *En masse* organ block with abdominal aorta showing multiple superficial intimal tears in step ladder pattern and dissected aorta to show the ladder-rung tears in abdominal aorta



Aortic intimal tears are observed as multiple parallel tears in a step ladder pattern, and hence are described as 'ladder-rung tears' or 'ladder tears' in the literature.³ These intimal tears are usually non-fatal, and are reported in the old age.⁴⁻⁷ The weakening of the aortic wall with progression of age has been cited as the possible reason for the same. The most common site of these tears is the descending thoracic aorta particularly, the isthmus of the aorta, i.e. the part of the aorta just below the

origin of the subclavian artery. Other common sites of aortic intimal tears are at the attachment of ligamentum arteriosum and ascending aorta, just proximal to the origin of the brachiocephalic vessels.^{4,8,9,11,12} The multiple mechanisms for production of aortic injuries are described in the literature, and include sudden deceleration injuries, shearing forces, osseous pinch, or due to a sudden increase in the intrathoracic pressure.^{4,8-10} As the intrathoracic pressure increases, there is an increase in the intra-aortic pressure, which leads to tears. In cases where the pressure is very high and/or the muscle wall of the aorta is weak, it can lead to aortic dissection or even rupture of the aorta. These mechanisms however, are mostly defined for aortic rupture. The same mechanisms are presumed to be applicable for causation of intimal tears when the forces are less severe.

Injuries to abdominal aorta have been associated with seat belt injuries.^{13,14} The proposed mechanisms behind injury to abdominal aorta are direct compression against vertebrae or due deceleration forces transmitted against intravascular pressure resulting in intimal tears.¹⁴ Shearing force is considered less significant in the mechanism of injury to abdominal aorta.¹⁵ In the reported case, the victim was a young male who was riding a two-wheeler bike and was allegedly hit by a truck. On autopsy, intimal tears were observed in the abdominal aorta, which is an unusual site for ladder-rung tears. Thoraco-lumbar spine and intra-abdominal visceral organs were intact in the reported case. Saraf et al. have reported a case of intimal tears in the abdominal aorta in a young adult, but with multiple parallel contusions on the external surface. Osseous pinch was proposed as a possible mechanism in that case.¹⁶ In the case reported by us, the external surface of aorta was intact, and did not show any injury. There was no evidence of atherosclerosis or any other signs suggesting weakness of the muscle wall of the aorta. The ladder-rung tears in the abdominal aorta in our case could possibly have resulted from deceleration forces transmitted against intravascular pressure. If the intimal tear fulminates into a rupture of the aorta with subsequent trauma, then the chances of the victim dying immediately are extremely high.^{9,11,17-19}

The reported case highlights on the unusual presentation of the ladder-rung tear in an aorta with respect to its location and age of the deceased. Such findings can be helpful in the reconstruction of accident by application of principles of biomechanics. The report further emphasizes on the need for careful internal examination of the aorta throughout its length despite of the absence of any intra-abdominal visceral or bony injury, and even when the aorta appears intact and unremarkable from outside.

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