

CASE REPORT

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Traumatic Rupture of an Abdominal Aortic Aneurysm Associated with the Use of a Seatbelt

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ABSTRACT: Injury to the abdominal aorta after blunt trauma continues to be a relatively infrequent occurrence. In this report, we describe a case of traumatic rupture of an abdominal aortic aneurysm associated with inappropriate seatbelt use.

KEYWORDS: forensic science, forensic pathology, rupture, abdominal aortic aneurysm, seatbelt injury, traffic accident

Many different injuries have been described in association with the use of seatbelts including fractures of the spine, clavicle, ribs, and sternum as well as injuries of the abdominal and pelvic organs (1). However, blunt injuries to the abdominal aorta associated with the use of seatbelts have been uncommon (2), and the injury is hardly mentioned in forensic literature (3,4). Moreover, traumatic rupture of an abdominal aortic aneurysm associated with the use of seatbelts has not been reported. We present here a case of traumatic rupture of an abdominal aortic aneurysm associated with inappropriate use of a seatbelt.

Case Report

A 62-year-old male driver was wearing a three-point seatbelt when his car simply drifted without explanation into the oncoming lane and collided head-on with a dump truck whose driver had stopped because of the unexplainable movement of the car. The car was not equipped with an air bag. He was admitted to hospital but died about 2 h after the accident. The clinical diagnosis made by an ultrasonographic examination was rupture of an abdominal aortic aneurysm. An autopsy was performed to determine whether the rupture was traumatic.

Inspection by police revealed that the right front area (driver's side) of the car was severely crushed and the driver's space was compromised. The steering wheel was intruded and somewhat raised. There was, however, no evidence of the occupant coming into contact with the steering wheel. The seatbelt functioned without disorder. The cause of the accident was considered the driver's error in driving.

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Autopsy Findings

On external examination at autopsy, there were bruises and abrasions in the face, hands, and legs. On the right anterior abdominal wall, there was a transverse ecchymotic band (8 × 5 cm in size) near the level of the umbilicus (Fig. 1) and the subcutaneous fat tissue under the ecchymosis was damaged. There was approximately 1300 mL of blood in the abdominal cavity. A laceration of the mesentery of approximately 10 cm in diameter was observed under the ecchymosis. Under the right side of the laceration and slightly inferior to the left renal artery, there was an aortic aneurysm which was ruptured in its anterior wall with the formation of a flap of approximately 10 cm in length (Fig. 2). A hemorrhage into the adventitia around the ruptured site was not severe. In the aneurysmal sac, there was a large fibrin thrombus. Most parts of the aneurysmal wall were covered with the thrombus and the thrombus was also lacerated (Fig. 2). The thickness of the aneurysmal wall at the ruptured site was approximately 2.5 mm. Many atheromatous plaques were observed in the inner surface of the aneurysmal wall. However, there was no deep ulceration. Aortic dissection was not observed. A hemorrhage in the retroperitoneum was also observed around the ruptured aneurysm. The right femur was fractured but no fractures were observed in the spine or pelvis.

Histologically, the aneurysmal wall showed moderate to severe atherosclerotic changes. In most parts of the ruptured site, the intima showed atheromatous thickening and the media was attenuated and atrophic.

Ethanol was not detected in blood and urine by gas chromatography.

Discussion

Before the accident, the deceased's car had drifted without explanation into the oncoming lane and collided head-on with a dump truck. This and the clinical diagnosis of abdominal aortic rupture suggested before the autopsy that the abdominal aortic rupture might have occurred first causing incapacitation of the driver, following which the car collided head-on with the dump truck. Spontaneous rupture of an atherosclerotic aneurysm is usually accompanied with a severe hemorrhage in the adventitia and occurs through an area of atheromatous thinning where the media is largely absent due to a deep ulceration or severe atheroma extending to the adventitia (5). In the present case, however, the rupture was a flap-like tear of approximately 10 cm in length. The thickness of the aneurysmal wall at the ruptured site was approximately



FIG. 1—A transverse ecchymotic band on the right anterior abdominal wall near the level of the umbilicus.



FIG. 2—Rupture of the abdominal aortic aneurysm with formation of a flap. The ruptured aneurysmal wall was turned to show the laceration of the fibrin thrombus. Arrow heads indicate the ruptured site of the abdominal aneurysm and an arrow indicates the lacerated fibrin thrombus.

2.5 mm. The hemorrhage into the adventitia around the ruptured site was not severe. On the other hand, the abdominal ecchymosis and laceration of the mesentery were observed almost at the same level of the abdominal aortic rupture. Moreover, the mural fibrin thrombus was also lacerated. These findings strongly indicated that the rupture of the abdominal aortic aneurysm was traumatic.

Blunt injuries of the thoracic artery are well known and approximately 95% of blunt aortic injuries occur at this site (2,6). Blunt injuries of the abdominal aorta, on the other hand, are rare. Roth et al. (2) reviewed 62 cases of blunt abdominal aortic injury reported in the English literature. While the causes varied, motor vehicle accidents were the most common mechanism, representing 36 of 62 cases (57%). Seventeen of 36 (47%) of the aortic injuries were directly associated with the use of seatbelts. Compared with an earlier report (7), the incidence of blunt abdominal aortic injuries associated with the use of seatbelts have increased while those due to the steering wheels have decreased because seatbelts are more frequently used now. Moreover, in studies in the late 1930s and early 1940s, less than 1% of abdominal aortic injuries was caused by blunt trauma. More recent studies, on the other hand, have reported an incidence of 10 to 15% (8). This increase is also probably due to the use of seatbelts, as well as faster motor vehicles, and a decrease in the number of fatal head injuries. In the present case, the width of the ecchymosis on the abdominal wall was similar to that of the seatbelt and there was no evidence of the occupant contacting the steering wheel. These findings indicate that the abdominal aortic injury of the present case was also associated with the use of a seatbelt.

Blunt injuries of the abdominal aorta are caused by both direct and indirect forces. The direct force can injure the abdominal aorta by compressing the vessel onto the lumbar spine because the aorta is relatively fixed by the vertebral column and lumbar vessels. If the direct force against the trapped aorta is strongly enough, the resultant rupture could occur associated with or without lumbar spine fractures. Rapid deceleration, with the aorta mobile between two relatively fixed positions, can also produce a shearing force sufficient to disrupt the intimal layer (2,4). Dajee et al. (9), on the other hand, have proposed that longitudinal stress upon the abdominal aorta resulted from forces created by the sudden movement of an appreciable mass of blood, propelled toward the aortic arch by a deceleration force and rotation about the seatbelt as an axis. In the present case, the flap-like tear of the aneurysm might indicate that the rupture occurred due to direct force coming from the lap seatbelt itself.

Atherosclerosis was found in almost half of the cases reported (2). An atherosclerotic aorta might increase the likelihood of intimal fracture or embolization of atherosclerotic plaques. In some cases, the role of atherosclerosis was found to be significant in the genesis of blunt abdominal aortic injuries (10). Atherosclerosis may lead to weakening of the aortic intima in addition to a loss of elasticity and compliance of the vessel. Thereby, this may increase susceptibility to disruption, dissection, and embolization (2). An abdominal aortic aneurysm may also be an increased risk for the injury.

Abdominal aortic injuries associated with the use of seatbelts have been frequently implicated with associated abdominal injuries, including abdominal organ injury, lumbar spine fracture, and abdominal wall transection (2). Abdominal aortic injuries associated with the use of seatbelts, moreover, showed the unique sign of a transverse ecchymotic band on the abdominal wall. There are now 31 reported cases of blunt abdominal aortic injuries associated with the use of seatbelts in the English literature (2,7,9–19) including the case reported herein. Among them, 17 showed transverse ecchymotic bands, and the bands were observed near the umbilicus in 6. The umbilical location of the band indicates inappropriate seatbelt use and it is well-known that inappropriate seatbelt use makes abdominal organs more susceptible to injury (1). In the present case, inappropriate seatbelt use was the probable cause of the abdominal aortic rupture.

The most common lesion of the blunt abdominal aortic injury is an intimal disruption which can be partial or involve the entire circumference of the aorta. The inferior flap is then dissected by the blood flow, leading to thrombosis and acute arterial insufficiency. If all layers of the aorta are involved, this will lead to either formation of a false aneurysm or intraperitoneal bleeding, resulting in death. Other frequent lesions of blunt abdominal aortic injuries are aortic thrombosis and traumatic aneurysm. Abdominal aortic ruptures after blunt trauma are infrequent. According to a review by Roth et al. (2), an abdominal aortic rupture was found in only 5% of the patients (3 out of 62 patients). Thus, the mortality rate for blunt abdominal aortic injuries is not high. About one quarter of the patients died and the most common cause of death was associated injuries. In 31 cases of blunt abdominal aortic injury associated with seatbelt use, abdominal aortic rupture occurred in only 2 cases. One case was a 71-year-old woman who had a complete circumferential disruption of the calcific intima and media with a tear of the adventitia as a belted passenger in a motor vehicle accident (19). An abdominal aortic aneurysm was not observed. The second case was the present case. A rupture of the abdominal aorta associated with the use of a seatbelt has not been a common subject of forensic autopsy, probably because of the rarity of the injury, and thus has not been reported in forensic literature. However, the rupture of an abdominal aortic aneurysm associated with the use of a seatbelt should be of forensic interest because an autopsy is needed to distinguish this rare injury from a spontaneous rupture.

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