

Injuries of the Abdominal Aorta from Blunt Trauma

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Blunt injuries of the abdominal aorta are rarely reported in the literature. If left undiagnosed, these injuries may have catastrophic consequences. Four patients with blunt abdominal aortic lesions, identified in the authors' trauma registry, are presented in this report, along with a discussion of the pertinent literature to illustrate clinical management techniques. The mechanisms of injury include motor vehicular crashes (most frequent) with or without seatbelt use, abdominal blows, falls, and abdominal crush injuries. The spectrum of aortic lesions ranges from simple contusion

or intramural hematoma to intimal disruption, false aneurysm, or frank rupture. Aortography should be performed in all stable patients with suspected aortic injury. All central-medial retroperitoneal hematomas discovered at laparotomy for blunt trauma should be explored after proximal and distal control of the aorta is obtained. Strict adherence to these principles, maintenance of standard vascular technique, and aggressive, expeditious resuscitative evaluation may improve survival.

BLUNT TRAUMATIC injury of the abdominal aorta is a relatively infrequent occurrence. This is easily understandable when one considers the very protected position of the aorta-iliac arterial segment within the retroperitoneum. The aortic lesions resulting from blunt injury may include simple contusion, intimal disruption, intramural hematoma, false aneurysm, dissection, or frank rupture. If left undiagnosed, these lesions may have catastrophic clinical consequences. Surgeons treating victims of blunt abdominal trauma should be thoroughly conversant with diagnosis and management of these injuries. Although most cases occur in association with motor vehicular crashes,^{1,2} other mechanisms do exist. A recent review reported only 33 cases in the English language literature.² Herein, the authors report on four cases of blunt injury to the abdominal aorta, demonstrating different mechanisms of injury, varying lesions from aortic thrombosis to complete transection, and different outcomes.

Case Studies

Case 1

A 29-year-old man was admitted to the Maryland Institute

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for Emergency Medical Services Systems (MIEMSS) Shock Trauma Center, after a 30-foot fall. The patient had a cardiac arrest at the scene but responded to endotracheal intubation and resuscitation. On admission, his heart rate was 50, without palpable blood pressure or pulse. With fluid resuscitation, a radial and apical pulse was apparent without palpable femoral pulses. Diagnostic peritoneal lavage performed for abdominal distention and hypertension showed no gross blood. Cardiac arrest occurred shortly after the diagnostic peritoneal lavage. Anterior thoracotomy, aortic cross-clamping, and open heart massage were performed, and the patient was taken to the operating room. Exploratory laparotomy revealed no free peritoneal blood but a large expanding retroperitoneal hematoma. A complete transection of the abdominal aorta just beneath the renal vessels was noted. An end-to-end repair of the mobilized segments of the aorta was performed, along with a repair of a small inferior vena caval tear. Despite completion of the reanastomosis and restoration of flow to the distal aorta, the patient did not tolerate unclamping of the aorta and died in the operating room.

Case 2

A 19-year-old man was thrown from his motorcycle during an accident. He was admitted to the MIEMSS Shock Trauma Center after an episode of loss of consciousness and amnesia pertaining to the events of the crash. Initial workup revealed a left pneumothorax with pulmonary contusion, left scapular fracture, and right first rib fracture. Diagnostic peritoneal

lavage showed no gross blood but 146,000 red blood cells/mm³ on microscopic analysis. At laparotomy, serosal tears of the jejunum and transverse colon were found, as well as a midline retroperitoneal hematoma. After proximal and distal control of the aorta, a small tear was noted just caudal to the inferior mesenteric artery. This was successfully repaired primarily using pledgeted polypropylene mattress suture technique. The patient had an uneventful postoperative course and was discharged after 10 days. His outpatient follow-up has been unremarkable.

Case 3

A 33-year-old woman was admitted to the MIEMSS Shock Trauma Center after being the driver in a motor vehicular crash. The patient, who had been wearing seat restraints at the time of the crash, complained of epigastric and periumbilical pain. Diagnostic peritoneal lavage was microscopically positive, so exploratory laparotomy was performed. A serosal tear of the transverse colon and a mesenteric tear of the jejunum were found. Additionally, a small hematoma was noted over the infrarenal aorta anteriorly, just cephalad to the inferior mesenteric artery. This hematoma was expanding slowly. After proximal and distal control, the aorta was explored. This revealed complete circumferential intimal and medial disruption of the vessel. The inferior mesenteric artery was excised with an accompanying portion of aorta. A segment of aorta was then removed and a 16 mm GORE-TEX® Graft (W. L. Gore & Associates, Inc., Newark, DE) interposed. The inferior mesenteric artery was then reimplanted into the segment of graft. Systemic heparinization was used for the vascular repair. The patient had an uncomplicated postoperative course and was discharged after 12 days. Her outpatient follow-up has been uneventful.

Case 4

A 49-year-old man was pinned against a wall by a moving truck. He came to a local hospital where workup showed a left pelvic fracture. After several hours, the patient was noted to have gradual loss of sensation and motion of the lower extremities with low back pain. He was transferred by helicopter to the MIEMSS Shock Trauma Center. His history included severe chronic obstructive pulmonary disease and leg claudication (right greater than left) after walking 50 yards. Physical examination revealed complete lower body cyanosis starting at the umbilicus with no femoral pulse bilaterally and no sensory or motor function beneath the umbilicus. At laparotomy, a midline retroperitoneal hematoma over the intrarenal portion of the abdominal aorta was identified and explored after proximal and distal control. The aorta was found to be thrombosed up to the level of the renal vessels with severe arteriosclerotic disease. Arteriotomy in the distal aorta and successful thrombectomy produced excellent antegrade flow. Balloon-catheter thrombectomy allowed retrieval of several clots from the right iliac artery with minimal retrograde flow, but the catheter could not be passed via the left iliac artery due

to severe arteriosclerotic disease. The patient underwent aorta-bifemoral bypass with an 18-mm to 9-mm woven bifurcated bypass graft. Systemic heparinization was not used because of the acute pelvic fracture. Bilateral leg fasciotomies were also performed. Doppler signals of the pedal arteries could be auscultated bilaterally after operation. The patient had a stormy postoperative course complicated by myoglobinuria and subsequent renal failure, pneumonia, and adult respiratory distress syndrome. On postoperative Day 4, he required right hip disarticulation for a nonviable right lower limb. Four days later, right hemipelvectomy was performed. This was associated with severe disseminated intravascular coagulation. The patient died 9 days after the initial operation.

Discussion

Rupture of the abdominal aorta from blunt trauma is rare. Killen³ reported only one patient with abdominal aortic injury among 1,320 blunt trauma victims. Of 8,710 autopsies on trauma victims reported by Parmley et al.⁴ and Strassmann⁵ combined, 16 (4.6 per cent) of 347 patients with blunt aortic injury had involvement of the abdominal aorta. The four cases presented herein represent 0.05 per cent of blunt trauma victims recorded in the MIEMSS Trauma Registry.⁶

The clinical presentation of most patients with blunt abdominal aortic injury should not be a diagnostic dilemma. All blunt trauma patients should be resuscitated according to a preconceived prioritized plan. This is best outlined by the Advanced Trauma Life Support™ course of the American College of Surgeons' Committee on Trauma.⁷ Unstable patients should be evaluated for sites of blood loss. In addition to hemothorax and hemoperitoneum, retroperitoneal hematoma should be suspected because the mortality rate is high.^{8,9} All retroperitoneal hematomas in zone I¹⁰ (central-medial region) found incidentally at celiotomy should be explored because they may contain aortic injuries. This was the case with the patients in Case Studies 2 and 3 presented above. By strict adherence to this guideline, their aortic injuries were identified. In a patient with no indications for laparotomy, a high index of suspicion is essential. The best technique to confirm the diagnosis of aortic injury is aortic angiography. When possible, it should be performed in all patients after blunt abdominal trauma with signs of vascular injury.

The reported mechanisms of blunt abdominal aortic injury vary, with motor vehicular crashes predominating.^{1,2} In a review of the English language literature with 32 patients before 1987, Lock² reported 21 motor vehicular crashes, five abdominal blows, two falls, two pinched by machinery, and one blast accident as the implicating factors. The etiology was unavailable for

2 patients. Eight of the injuries after motor vehicular crashes were directly associated with seatbelt use. The 4 patients presented here represent several of the mechanisms described.

Operative repair of the abdominal aorta depends on the angiographic and operative findings. The anatomic lesions vary, with intimal disruption being the most frequent lesion encountered clinically.¹ The distal intimal flap is often dissected by the blood flow, leading to thrombosis and acute arterial insufficiency. Rupture with intraperitoneal hemorrhage may occur if all layers are involved, and false aneurysm may occur if left undiagnosed. The injury to the aorta should be approached systematically as outlined by Feliciano.¹¹ Basic principles of vascular repair should be maintained. The options may involve lateral repair, intimal flap suture, patch aortoplasty, end-to-end anastomosis, or insertion of a substitute vascular conduit. A synthetic conduit [Dacron (E.I. DuPont de Nemours and Co., Inc., Wilmington, DE) or polytetrafluoroethylene] should be used for interposition because autogenous saphenous veins are never large enough and the risk of infection is extremely rare, even with associated intestinal injury.¹² Visceral artery involvement as a component of the aortic injury, which is quite rare, should be treated by reimplantation if there is any evidence of bowel compromise.¹³

An organized, aggressive approach to the blunt trauma victim makes the diagnosis of abdominal aortic injury less elusive. Furthermore, prompt diagnosis with early vascular repair may improve survival.

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Injury prevention: wave of the future in trauma

Between 10 and 17 million people are injured in the United States each year, 380,000 of them permanently. This steadily rising toll is unacceptably high, and we can no longer afford the economic costs or the human waste. Prevention is the key to changing these staggering statistics.

Of the four major causes of injury—accidents, disasters, wars, and terrorism—accidents are the most preventable.

The public accepts injuries as being inevitable because they have always been with us. By playing up the horror of violent and hazardous actions and downplaying corrective actions, the media may unwittingly fuel this attitude. However, the media can also be a positive influence by helping to increase public awareness about trauma and the need for an effective system to handle life-threatening emergencies.

This attitude of general acceptance of trauma carries over to the field of medicine. Trauma is not taught in medical school or in many residency programs because of lack of patients or disinterest. Only recently have medical professionals begun to realize that something can be done for trauma victims.

Another widely held view that hampers trauma prevention is that regulations, such as the mandatory use of motorcycle helmets and seat belts, represent an infringement of the freedom of choice. Unfortunately, it is difficult to convince those who need it the most that such safety devices are to help save their lives and to reduce the economic burden on society for long-term disability care.

Why aren't we more successful with prevention? Government is one reason. Legislators are insufficiently informed about the field of emergency medical services (EMS) to make sound decisions concerning it. They do not have time to know what the problems of EMS are, much less to study them. Physicians should be educating legislators, but most physicians feel that they have no time for politics. As health care providers, we cannot afford to maintain that belief today, when critical decisions about what is best for physicians, nurses, and most important—patients—are being made by politicians, lawyers, and accountants.

Many legislative efforts in the EMS field have been ineffective because EMS does not provide grassroots support. Giving testimony before legislative committees is important, but impact can be gained if grassroots organizations such as the American Trauma Society or the National Coalition for Emergency Medical Services act as spokesmen for trauma patients, who have no influence by themselves.

Industry also has been slow to adopt preventive measures. In the past, we have tried to goad industry into doing what is right by passing laws, demanding that certain safety standards be met. A far better approach would be to make it profitable for industry to comply with safety standards by providing such incentives as tax breaks. In addition, when a

product causes harm or death the avenue of redress usually is a tremendously costly court proceeding. Other means of determining liability and compensation should be developed to lighten the unfair financial burden that industry must bear for malfunctioning products.

Education for prevention is needed. There are few educational programs on trauma prevention for high-school and grade-school children, and they should begin early and continue through the educational system. Furthermore, many of the programs that do exist are aimed at convincing people to do what is best for them. This approach has had little effect. One Maryland county is experimenting with a different approach: Adolescents found guilty of alcohol abuse are required to tour the shock trauma center to witness the result of drunk driving. Similarly, some people who are sentenced to prison are required, instead, to work in the state's EMS system. Both of these programs are aimed at stopping repeated offenses.

The most important factor in preventing trauma in the future will be education, using the various channels that already exist—the American Trauma Society, the National Coalition for Emergency Medical Services, schools of medicine, and medical conferences—as well as new channels, such as satellite communication and cable television. The public needs to be reminded and stimulated to adhere to minimum safety standards and to support the use of prevention devices.

Another factor will be research. A national trauma institute within the National Institutes of Health is needed to coordinate educational programs and to support research on trauma.

Last, but not least, funding will be needed. A certain percentage of block grants should be mandated for emergency medical programs to assure that the initiative started by the federal EMS program will not have been in vain.

The increased incidence of trauma is due partly to the rapid tempo of living, the increase in violence, and the social stress resulting from population growth, and we have little control over these factors. We do, however, have some control over other factors that contribute to increased trauma. Much effort is needed to change the controllable factors responsible for trauma. If we are to achieve a significant improvement in managing injuries, it must be through preventive measures.

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