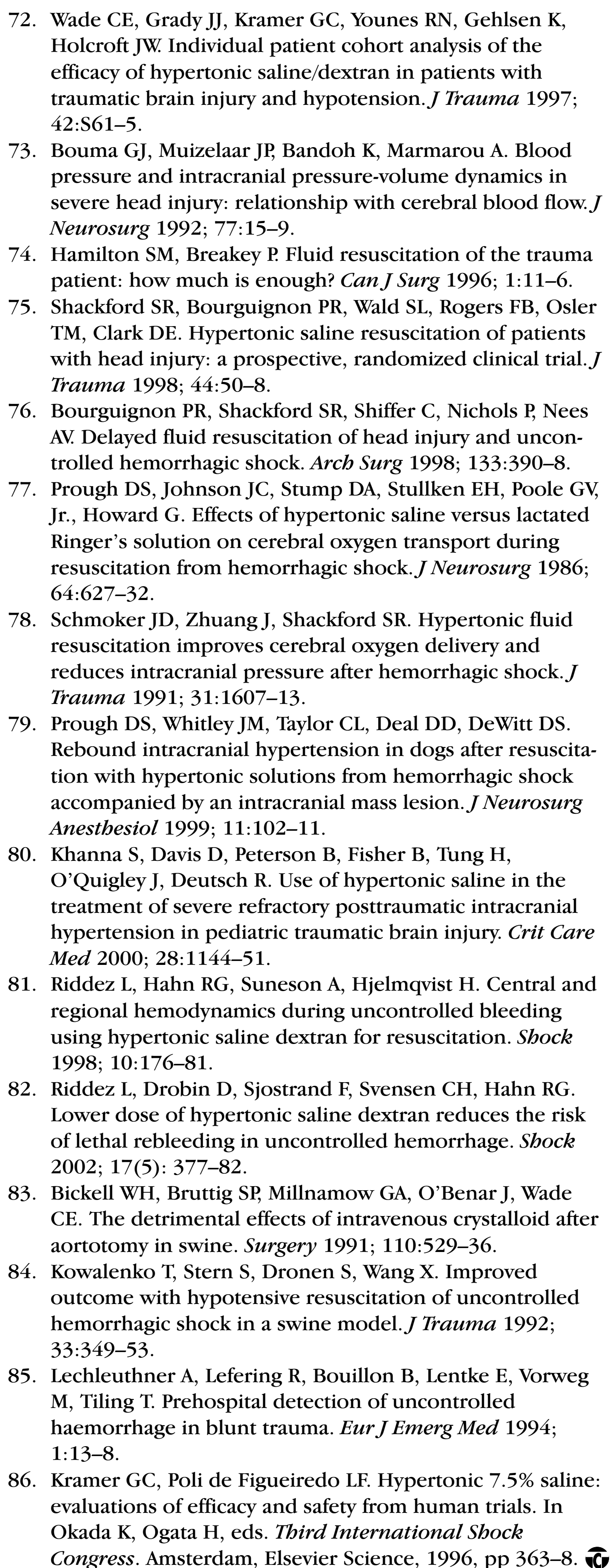

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Blunt Abdominal Aortic Transection in an Abused Child: A Case Report and a Literature Review

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Learning Objectives: 1) To identify the indicators of abdominal aortic injury in children after blunt trauma, 2) to review diagnostic options for pediatric patients with blunt abdominal trauma, and 3) to appreciate the advantages/disadvantages of clamp-and-sew versus intraoperative bypass techniques.

Abstract
Blunt abdominal aortic trauma is most frequently caused by motor vehicle crashes. We report the second successful management, to our knowledge, of a case of pediatric abdominal aortic trauma caused by known child abuse and resulting in almost complete transection of the abdominal aorta.

Case Report

A 2 ½-year-old girl (16 kg, 65 cm) was brought to the emergency department by paramedics, who stated that she had reportedly been thrown against a couch by her mother's boyfriend. The child was lethargic at the scene with bleeding from a scalp laceration and had not lost consciousness.

Upon arrival in the trauma emergency department, the child was lethargic with a Glasgow Coma Scale (GSC) score of 6 (E4, M1, V1). She was not crying; slow movement of the upper extremities and no movement of the lower extremities were observed. She presented with the following vital signs: blood pressure, 67/41 mmHg; heart rate, 120/150 beats/min; respiratory rate, 20 to 32 breaths/min; and temperature, 33°C; O_2 saturation was 90%. Physical examination revealed a distended, tense abdomen, with no bowel sounds. The lower extremities were bluish and cold with no palpable pulses below the femoral vessels. Two intravenous lines (18 gauge) were placed in the upper extremities. A blood sample was sent for type and crossmatch. The patient was intubated with a 4.5 endotracheal tube and was resuscitated using fluids. Radiographs of the chest, pelvis, and C-spine were normal with no sign of fractures. Hemoglobin concentration was 6.0 g/dL.

A computed tomography (CT) scan of the head showed bilateral occipital subdural effusion (hygroma), no intracranial hemorrhage, no fractures, and no shifting or mass effect; CT of the abdomen showed a hematoma (right>left). The hematoma appeared to involve the right kidney as well as possible injuries of the liver, spleen, and aorta. The patient was taken to the operating room suite for exploratory laparotomy. On admission to the operating room, the patient was profoundly acidotic: arterial blood gas analysis showed a pH of 7.19, $PaCO_2$ of 21 mmHg, PaO_2 of 180 mmHg, HCO_3 of 8.0 mEq/L, base deficit of 19.1 mEq/L, O_2 saturation of 97.7%, and Hgb of 5.5 g/dL.

Standard monitoring was used. A right 20-gauge arterial line and a right internal jugular double-lumen catheter were placed. Fluid warmer, Bair hugger™, warming blanket, and autologous red blood cell salvage machine were used. Fluid resuscitation with crystalloids, albumin, and blood transfusion was started prior to incision. Sodium bicarbonate was administered for normalization of profound acidemia. Laparotomy demonstrated a massive central hematoma extending all the way from the liver down to the pelvis. Two hundred milliliters of free blood were found in the abdomen. The spleen and liver appeared to be normal.

A quick mesenteric surgical approach was used. Further exploration of the retroperitoneal hematoma revealed almost complete transection of the aorta approximately 3 cm below the infrarenal artery, which was tamponaded by the massive retroperitoneal hematoma. When clamps were placed suprarenally and infrarenally and on both renal arteries, it was noted that the aorta was 98% transected below the renal artery and was being held together by only a few millimeters of adventitia. A right kidney contusion with parenchymal damage and a right renal artery laceration were observed. A primary end-to-end anastomosis (clamp-and-sew technique) and a right renal artery repair were performed.

During the 6-hour procedure, aortic cross clamp time was 1.5 hours, with an estimated blood loss of 2,500 ml and a urine output of 20 ml. During the anesthetic course, 3 units of packed red blood cells; 10 units of platelets; 1 unit of fresh frozen plasma; 250 ml blood from the red cell saver; 300 ml normal saline, 9%; 1,200 ml lactated Ringer's solution, 500 ml; and 5% albumin were given. Prior to exit from the operating room the patient had a hemoglobin concentration of 13 g/dL, hematocrit of 38%, and platelet count of 98,000/mm^3. Electrolytes were within normal limits, except for a blood urea nitrogen of 26 mg/dL and a creatinine concentration of 1.4 mg/dL.

Following the operative procedure, biphasic Doppler signals on both right and left posterior tibial and dorsalis pedis arteries were normal. After surgery, the patient was admitted to the pediatric intensive care unit (ICU). She was extubated on the 6th postoperative day, discharged from the ICU on the 10th postoperative day, and sent home on the 21st postoperative day.

Discussion

Blunt abdominal aortic trauma, a rarely reported injury, is most frequently caused by motor vehicle crashes.[1] It carries a high mortality rate and significant morbidity for those patients who survive. Most reported injuries have occurred in adults or adolescents and include intimal disruption (with or without thrombosis), pseudoaneurysm, stenosis, and distal embolization of atheromatous debris. Of all aortic injuries, only 4% to 8% occur below the diaphragm.[2]

The hallmark of abdominal aortic injury is the triad of blunt abdominal trauma, acute arterial insufficiency, and lower-extremity paralysis. In patients with lower extremity sensory motor deficits, spinal cord injury is to be suspected. However, pulses may be present distal to an arterial injury. Griffen[3] emphasized the importance of bilateral femoral bruits in association with unexplained shock and flank ecchymosis as being diagnostic, although the latter sign is not commonly reported. In this case, the child presented in similar fashion to other children as reported in the literature (i.e., in shock with cold, pulseless lower extremities but no lower-extremity flaccid paralysis).

Abdominal aortic aneurysms were first described by Vesalius in the sixteenth century,[4] but aortic injuries secondary to blunt trauma have been reported infrequently in the literature. Traumatic aortic rupture (TAR) in the pediatric age group (<17 years of age) is extremely rare. Although the frequency of TAR differs in children and adults, multisystem trauma may be common to both groups. In pediatric patients, the features of TAR that should raise suspicion are the mechanism of injury, chest film abnormalities, and the presence of pseudocoarctation. Most patients present with shock, abdominal pain, neurologic deficit, abnormal vascular examination, or some combination of the above.

Traumatic aortic rupture occurs most commonly in blunt trauma patients between the third and fourth decades, with only rare injuries in children. Among children who sustain complete aortic transection in motor vehicle crashes, 100% of the injuries occur at the aortic isthmus. The lack of atherosclerosis in pediatric aorta implies that the integrity of the intima is maintained. Though unproven, the histologic makeup of the intima and medial layers of the pediatric aorta may be more distensible and stronger, allowing it to withstand greater tension.

Trachiotis et al[5] described 6 children ranging in age from 8 to 16 years treated surgically for thoracic, not abdominal, aortic ruptures resulting from blunt trauma. Our case appears to be the 11th pediatric case reported in the English literature. The 10th case, and the youngest (a 16-month-old girl) to survive, was reported by Fox et al.[6] Our case is unusual because the patient had almost complete transection of the abdominal aorta, which, to our knowledge, has been reported only three previous times, with only two known survivors.

In an article on neurologic signs and symptoms associated with nonpenetrating abdominal aortic trauma, Reisman and Morgan[7] believed them to be due to either peripheral nerve ischemia or anterior spinal artery syndrome. The authors stated that compromise to the spinal cord vascular supply must involve the anterior spinal artery, arising from the TS-L1 area, a point above the renal artery take off (L1–L2 interspace), and therefore not compromised by infrarenal aortic injury. In contrast, it has been shown that some patients had neurologic impairment from cord ischemia (the arterial supply of the cord arising as low as L4) exacerbated by hypotension and lack of collateralization. Blute and Rey[8] believe that a lumbar arterial spasm transitorily affects spinal cord blood supply. According to Brathwaite and Rodriguez, the best technique to confirm a diagnosis of aortic injury is aortic angiography, when possible.[9]

CT allows more rapid diagnosis than aortography, thereby decreasing the time from diagnosis to transport to the operating room, which could have a clinical impact on patients with TAR who have evidence of lower-extremity neurologic or vascular compromise. Another benefit of CT is in the hemody-

namically unstable patient who requires emergency operation. Transesophageal echocardiography (TEE) can be performed rapidly in the operating room, allowing expeditious diagnosis of thoracic aortic injury and selection of the required operative approach. TEE and aortography were not indicated in our case because the diagnosis was confirmed intraoperatively.

It is possible to perform this operation and repair this injury with a clamp-and-sew technique and achieve good results.[10] The majority of adults undergo graft interpositions or bypass. Aortic cross clamp time beyond 30 minutes is associated with paraplegia. In our case (the patient being hemodynamically stable), the clamp-and-sew approach was used. The advantages of clamp and sew are simplicity and the lack of need for heparin. This approach has received significant support in recent literature. A significant controversy has developed over whether there are differences in result comparing direct repair (clamp and sew) with techniques that provide distal aortic perfusion during repair. Specifically, is the risk of paraplegia, the most significant complication of repair, lowered by distal aortic perfusion techniques? An advantage of bypass techniques is that the distal aorta is perfused, which may decrease the rate of paraplegia as well as reduce ischemia and reperfusion injuries associated with sacrifice of hepatic, renal, and mesenteric flow during clamp-and-sew repair. Disadvantages of partial and full bypass are the need for systemic heparinization, which may increase the risk of bleeding complications. Our patient, with an aortic clamp time of 1.5 hr, did not show any sign of spinal cord injury.

The preference for operative repair remains the clamp-and-sew technique in the child with multiple trauma. It is interesting that children with spinal myelopathy have demonstrated both short- and long-term recovery from the deficits. There have been limited reports of neurologic and functional improvement in patients who have sustained postoperative paraplegia or paraparesis. It remains to be shown whether children can sustain spinal cord ischemia longer than adults or whether the pediatric spinal cord has more protective or regenerative capabilities.[11]

Reisman and Morgan[7] reported a case involving a 17-year-old male, a passenger wearing a seat belt, who sustained an abdominal aortic injury during a motor vehicle crash. At operation, the patient was noted to have a complete transection of the intima from a point 2 cm below the renal artery to about 1.5 cm above the bifurcation. Unfortunately, he had a complicated postoperative course, remaining paraplegic with minimal return of sensitivity and ultimately being transferred to a rehabilitation hospital. The authors believed this was a case of anterior spinal artery syndrome (characterized by incontinence and paraplegia).

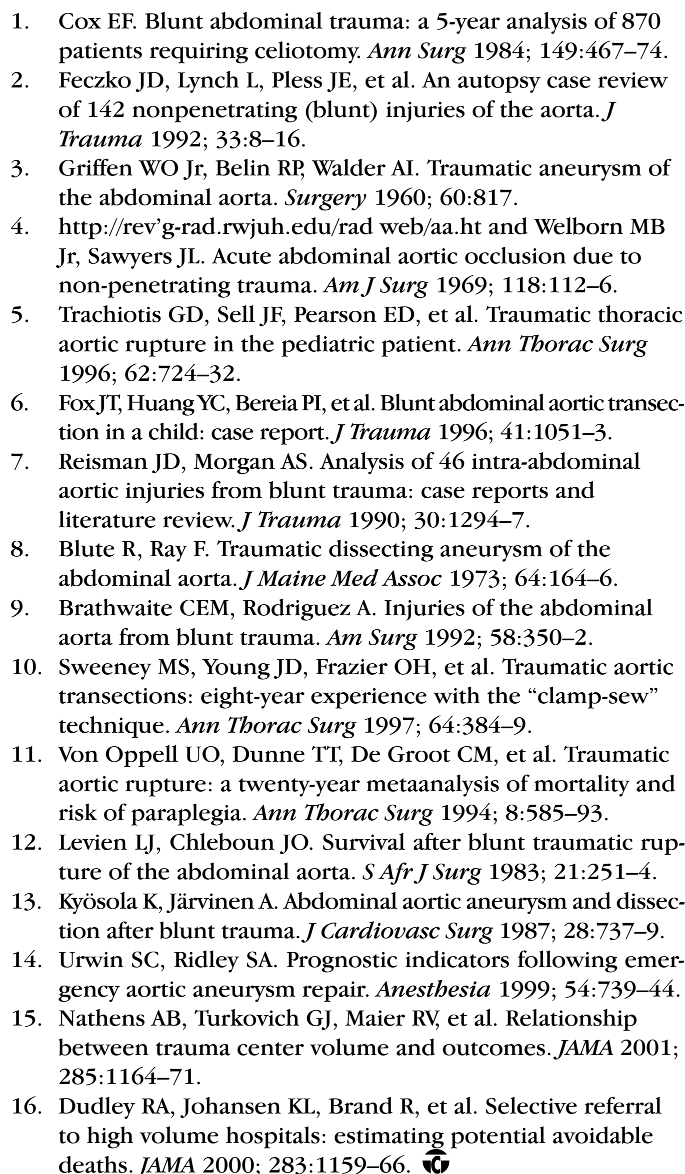
It appears that the first successful repair of abdominal aortic disruption caused by blunt trauma was reported by Levien and Chleboun in 1983.[12] Their patient was a 17-year-old who fell from his motorcycle while crossing an elevation in the track. The cycle landed on his abdomen. If this case is considered in the pediatric category, then this would be the first reported pediatric TAR. Kyösola and Järvinen[13] reported the second case, a 13-year-old boy who was trapped and crushed between a lorry and a trailer. Since the event occurred 11 years before the report was published, it would be the first description of a pediatric survivor of TAR.

In a relatively recent autopsy case review of 142 fatal cases of blunt injuries of the aorta, Feczko et al[2] listed only 9 cases of abdominal aortic laceration (6%) and one of child abuse. Unfortunately, the report does not indicate whether the abused child had a TAR nor the age of the child.

In 1999, Urwin and Ridley[14] stated that survival of patients after emergency repair of abdominal aortic aneurysm is poor though such aneurysms are common. The authors cited an incidence of 17 to 64 per 100,000 population in the United Kingdom. It should be noted that this figure was *not in relation to blunt injury* of the abdominal aorta.

The question as to whether outcome is better if blunt injury of the abdominal aorta is treated in specialized vascular surgical services[15] than in nonspecialized general units[16] is not particularly germane when we consider the pediatric patient. However, for very young patients with this injury, pediatric trauma surgeons would be required.

Many more children are abused than official statistics show. The majority of children victimized are younger than 7 years of age, and deaths occur most often in children aged 3 and under. The article by Fox et al[6] and ours add to the small, but growing, number of reports of pediatric TAR.



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