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J Pediatr Surg. Author manuscript; available in PMC 2011 May 3.

Published in final edited form as:
J Pediatr Surg. 2009 October ; 44(10): 1958–1964. doi:10.1016/j.jpedsurg.2009.01.005.

Outcomes of truncal vascular injuries in children

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Abstract

Background—Pediatric truncal vascular injuries occur infrequently and have a reported mortality rate of 30% to 50%. This report examines the demographics, mechanisms of injury, associated trauma, and outcome of patients presenting for the past 10 years at a single institution with truncal vascular injuries.

Methods—A retrospective review (1997-2006) of a pediatric trauma registry at a single institution was undertaken.

Results—Seventy-five truncal vascular injuries occurred in 57 patients (age, 12 ± 3 years); the injury mechanisms were penetrating in 37%. Concomitant injuries occurred with 76%, 62%, and 43% of abdominal, thoracic, and neck vascular injuries, respectively. Nonvascular complications occurred more frequently in patients with abdominal vascular injuries who were hemodynamically unstable on presentation. All patients with thoracic vascular injuries presenting with hemodynamic instability died. In patients with neck vascular injuries, 1 of 2 patients who were hemodynamically unstable died, compared to 1 of 12 patients who died in those who presented hemodynamically stable. Overall survival was 75%.

Conclusions—Survival and complications of pediatric truncal vascular injury are related to hemodynamic status at the time of presentation. Associated injuries are higher with trauma involving the abdomen.

Keywords

Vascular disease; Abdomen; Thorax; Neck; Pediatric; Trauma

Traumatic injury is the most common cause of morbidity and mortality in the pediatric population. Vascular injury resulting from pediatric trauma is uncommon, and the management of vascular injuries in this patient population is often anecdotal. The incidence is believed to be approximately 1% [1-6]. Large pediatric trauma centers may see an average of 5 vascular injuries per year, consisting mostly of extremity injuries or iatrogenic injuries associated with invasive procedures [1,4,6-9]. In contrast, the management of vascular injuries in adults has been well established based on extensive civilian and military experience. As reported previously, there has been an increase in vascular injuries in children and adolescents related to noniatrogenic causes [7,10].

Little is written about truncal vascular injuries in the pediatric trauma patient. The purpose of this report is to examine the demographics, mechanism of injury, concomitant injuries, and outcome of pediatric patients with noniatrogenic truncal vascular injuries treated at a

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single institution for a 10-year period and to examine diagnostic and treatment algorithms and current morbidity and mortality rates.

1. Materials and methods

The study protocol was approved by the institutional review board at the University of Texas Medical School at Houston. The medical records of all children and adolescents (age ≤17 years) with traumatic truncal vascular injuries treated at a single level I pediatric trauma center (Memorial Hermann Hospital/Children's Memorial Hermann Hospital, the primary pediatric teaching affiliate of the University of Texas Medical School at Houston) were identified using a computerized trauma registry and database. All patients were evaluated and admitted by either the pediatric trauma surgery service (age ≤13) and/or the adult trauma surgery services (age 14-17) (with the assistance of pediatric surgery, as needed) at Memorial Hermann Hospital/Children's Memorial Hermann Hospital.

Truncal injuries were defined as injuries to vascular structures within the abdomen and/or pelvis (excluding mesenteric branch vessels such as the middle colic artery or vascular injuries associated with solid organ injury such as splenic artery or renal branch arteries), thorax, or neck. Extremity injuries were excluded.

Data were compiled regarding demographics, mechanism of injury, hemodynamic status on presentation, time to operation, diagnostic modalities used specific to vascular injuries, associated injuries, operative treatment and approach, outcome, and vascular and nonvascular complications.

2. Results

2.1. Demographics

There were 10,992 total trauma patients (≤17 years) admitted during the 10-year period, with 75 truncal vascular injuries identified in 57 patients (mean age, 12 ± 3 years). The injury mechanism was penetrating in 37% of cases and blunt in 63% of cases. Concomitant injuries occurred with 76%, 62%, and 43% of patients with abdominal, thoracic, and neck vascular injuries, respectively. Multiple vascular injuries occurred in 36%, 23%, and 21% of patients with abdominal, thoracic, and neck vascular injuries, respectively. Overall survival was 75%; survival from abdominal, thoracic, and neck vascular injuries were 80%, 46%, and 86%, respectively.

2.2. Abdominal injuries

There were 39 total abdominal truncal vascular injuries, primarily related to blunt mechanisms. Blunt trauma was responsible for 25 vascular abdominal injuries in 21 patients, including aortic injuries resulting from motor vehicle collisions (MVC) (Fig. 1). Penetrating trauma was responsible for 14 vascular abdominal injuries in 9 patients. The list of associated injuries is shown in Table 1.

Most intraabdominal vascular injuries were repaired primarily using end-to-end anastomoses or primary arteriorrhaphy/venorrhaphy. Exceptions to the primary repairs were as follows. A reversed saphenous vein graft was used to restore continuity to the external iliac artery. Internal iliac artery injuries were embolized in 5 patients. Two additional patients had the internal iliac artery ligated intraoperatively. Of the patients with internal iliac artery injuries, 2 were secondary to gunshot wounds. The rest of the injuries were in the setting of pelvic fractures. Of 4 patients with renal artery injuries, 2 underwent stent placement after angiogram demonstrated dissection. The third patient with a proximal renal pedicle avulsion required a nephrectomy, whereas the fourth was treated nonoperatively.

2.2.1. Survival and complications—

Of the 30 patients with abdominal vascular injuries, 14 were unstable at presentation. There were 5 deaths; 2 died of exsanguination, 2 from a severe head injury, and 1 from multiorgan failure. Nonvascular complications occurred in 9 of 30 patients overall; there were 7 complications in 14 unstable patients. Most complications were infection related. One patient developed severe sepsis and ARDS requiring a prolonged intensive care unit stay. There was one death from a severe head injury in the stable patients. Of the 11 patients who had an initial systolic blood pressure more than 90 mm Hg on arrival, only 2 had nonvascular complications.

2.3. Thoracic injuries

There were 13 patients with 16 total thoracic vascular injuries. The mechanism of injury was blunt in 6 of 13 patients. These included 9 aortic injuries (Fig. 2), 3 subclavian artery injuries, 1 innominate injury, 1 internal mammary injury, and 2 pulmonary vein injuries. Of the 13 patients with thoracic injuries, 7 (54%) died. Associated injuries are listed in Table 2. Patients with associated, severe traumatic brain injuries had a high mortality rate (80%). The number of other associated injuries was not predictive of mortality.

2.3.1. Aortic injuries—

Of 9 aortic injuries, 6 were caused by blunt trauma (MVC). Blunt injuries were managed according to hemodynamic status as follows: unstable patients with a widened mediastinum on chest radiograph were either taken to the operating room or underwent an emergency department (ED) thoracotomy.

Two stable patients were diagnosed with an aortic injury by angiography, and 2 patients were diagnosed by contrast-enhanced chest computed tomography (CT). Four patients required operative intervention secondary to hemodynamic instability, with all dying. The ED thoracotomies were performed on 2 patients with neither surviving. Two patients underwent emergent thoracotomies in the operating room. One penetrating injury transected both the pulmonary hilum and the descending thoracic aorta. One blunt aortic injury in a 16-year-old patient was repaired without complication with the clamp and sew technique using a Dacron graft. Another patient had a blunt aortic transection distal to the subclavian artery. This was repaired with a left thoracotomy and prosthetic interposition graft.

All patients with thoracic aortic injuries were treated by aortic repair and interposition grafting without cardiopulmonary bypass or shunt procedures. Cross clamp times ranged from 15 to 22 minutes, and the repairs were performed by cardiovascular and pediatric surgeons working in conjunction. There was one associated instance of paraplegia related to an associated spinal cord injury from bullet fragments. Nonvascular complications were primarily infectious. Care was withdrawn in one patient with an aortic injury secondary to a severe concomitant traumatic brain injury.

2.3.2. Nonaortic injuries—

The remaining 7 patients' injuries consisted of great vessel injuries, pulmonary vein injuries, an internal mammary artery transection, or subclavian artery injuries. All nonaortic injuries were secondary to gunshot wounds (GSWs) except for a right superior pulmonary vein injury (MVC) and a left internal mammary artery transection (MVC). The subclavian vascular injuries were approached through a median sternotomy with supraclavicular extension; 1 of 3 patients required clavicular resection. One of the patients who sustained a GSW to the chest lost vital signs in the ED and underwent an immediate ED thoracotomy. The patient had a transected descending thoracic aorta and left pulmonary vein and died. One victim of a MVC presented with a massive hemothorax and immediately lost vital signs. Autopsy revealed a transected internal mammary artery, presumably secondary to rib fractures. One hemodynamically stable patient underwent angiography in the interventional radiology suite and was found to have a left distal subclavian pseudoaneurysm from the blast effect of a GSW. This was successfully repaired with an interposition graft.

2.4. Neck injuries

There were 14 patients with 20 head and neck vascular injuries. There were 13 carotid artery injuries, 5 vertebral artery injuries, 1 internal jugular vein, and 1 external jugular (EJ) vein injury. Of the 14 patients, 5 had penetrating mechanisms of injury. Hemodynamically unstable patients underwent emergency exploration. Hemodynamically stable patients underwent diagnostic studies including CT angiography to identify injuries. Associated injuries in patients with neck vascular injuries are listed in Table 3.

2.4.1. Hemodynamically unstable patients—Of the 2 patients who were hemodynamically unstable, 1 died. The patient who died had a combined left EJ vein and left common carotid artery injury from a GSW to the neck. The other unstable patient was attacked by a dog and had a left vertebral artery injury. The patient underwent a neck exploration, and the vertebral artery was ligated.

2.4.2. Hemodynamically stable patients—Twelve patients presented with stable vital signs. Ten of these patients had carotid artery injuries; 2 patients underwent repair. Of the 12 stable patients, 10 had CT angiography of the neck with one requiring a formal angiogram of the neck to further evaluate the injury. Of the patients who required operation, the first had a carotid artery injury from a pellet gun and underwent a neck exploration, excision of the injured segment, and a primary end-to-end anastomosis. The second patient had multiple penetrating stab wounds to the face, neck, and chest and abdomen. The vascular injuries were approached using a median sternotomy, right neck exploration with ligation of the right vertebral artery, primary repair of the right internal jugular vein, and a reverse interposition saphenous vein graft repair of a right common carotid artery injury. Of the patients treated nonoperatively, one blunt right internal carotid artery injury was found to have a middle cerebral artery (MCA) infarct for which no treatment was used; another patient died of a concomitant closed head injury. Of the remaining 8 patients, carotid vascular injuries identified by angiography were small dissections that were nonflow or minimal flow limiting injuries treated with conservative management.

3. Discussion

There are few published reports regarding the treatment of truncal vascular injuries in children. Data for children are often inferred from isolated case reports and the National Pediatric Trauma Registry (NPTR) (Table 4). Data for truncal vascular injuries in adults have changed little in the last 10 years, with a mortality of approximately 50% for all abdominal vascular injuries [11-13]. Reported pediatric vascular injuries often include iatrogenic injuries from cardiac catheterization or from percutaneous vascular access procedures (primarily catheterization of the femoral artery) [3,6,7,10]. Most of both iatrogenic and noniatrogenic vascular injuries that occur in children are extremity injuries [2]. Noniatrogenic injuries are primarily related to broken glass, falls, fractures, and soft tissue injury [3,14,15].

The adult trauma literature demonstrates an increasing frequency of vascular injuries, accounting for between 3% and 25% of patients undergoing laparotomy for blunt and penetrating (stab and GSW) abdominal trauma [10,16].A significant portion of patients with certain major vessel injuries (ie, aorta, inferior vena cava) will die before reaching a trauma center. Stratification of adults according to hemodynamic status on presentation is often useful in predicting outcome. Hypotension has been shown in multiple series to be a factor

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associated with significant mortality [11-13,17-30]. Other factors influencing survival, especially in caval injuries, include anatomical location of the injury, ease of surgical access, and blunt mechanism of injury [31].

Our data suggest that the hemodynamic status on presentation predicts mortality and subsequent complications (Table 5). In a previous report, complications occurred almost exclusively in patients who presented with a systolic blood pressure of less than 90 mm Hg. Most complications were infection related leading to the development of multiple organ failure. In this review, the hemodynamic status on presentation to the ED is again the most critical predictor of mortality and morbidity. In addition, concurrent severe head injury is a bad prognostic factor [1,2,8,28,30,32-44].

The most common thoracic vascular injury seen in this series was to the aorta. Of aortic injuries in blunt trauma, 95% occur in the thorax just distal to the left subclavian artery [34]. There were 4 of 8 blunt aortic injuries just distal to the left subclavian artery. Blunt aortic injury is rare in children (incidence, 0.1%) and survival from the injury is rare. Associated injuries are common, secondary to the mechanical force required to produce an aortic injury. Spine fractures are seen with some frequency with aortic injury [33,45].

The NPTR reports survival from blunt aortic injury to be between 40% and 50%. Several series of patients, however, report survival rates of 66% to 100%. The improved outcome (as opposed to NPTR statistics) seen in our series is difficult to explain, but hemodynamic status on presentation offers insight. None of the surviving patients with aortic injuries in other, previous series were reported to be hemodynamically unstable (as indicated by systolic blood pressure <90 mm Hg) on presentation; some, however, were reported to have heart rates more than 100 [28,33,39]. This series had 4 aortic injuries that were hemodynamically unstable on presentation; all of these patients died.

In evaluating children for blunt aortic injury, our institution previously obtained arch aortograms to diagnose aortic transection/aortic traumatic pseudoaneurysm. In this series, our imaging workup for blunt aortic injury was predominantly from CT scans obtained in the initial workup performed in the ED. Of the 12 aortic (thoracic and abdominal) injuries in this series, 4 patients were hemodynamically unstable and had chest radiographs before operation. The patients who were hemodynamically stable had either CT scans with intravenous contrast (6 patients) and/or angiogram in our interventional radiologic suite (2 patients). Formal angiography has been largely replaced by CT scans; in a recent 10-year study of pediatric trauma patients at a level I trauma center, formal angiography was used in only 25 patients, most of which were for extremity trauma. It is most commonly positive when evaluating patients with suspected limb ischemia and/or pelvic bleeding [46]. Other series have increasingly used high-resolution CT scans for diagnosis. Transesophageal echocardiography may be a valuable adjunct in diagnosis [33,34,39,40,45].

All patients with aortic injuries who had surgery were treated with the “clamp-sew” technique without left atrial to aortic bypass or other shunting mechanisms. Similar to our and other’s previous experiences, this technique was not associated with any adverse outcomes [10,47]. Others have demonstrated good results with shunting [39]. There are no prospective studies comparing the clamp-sew technique vs techniques preserving distal perfusion in children in relation to postoperative paraplegia [41]. In the adult literature, a retrospective review of 67 patients more than 13 years showed judicious use of clamp-sew technique achieved equivalent neurologic outcomes to distal aortic perfusion [48]. Our experience highlights, as others have demonstrated, that children can be safely treated using the clampsew technique [41].

The endovascular approach is being increasingly used in the adult trauma population, but large studies in children are lacking. Several case reports have been published in the recent literature using endovascular repair for aortic transection in pediatric patients. Long-term follow-up data are lacking [49].

Vascular injuries of the head and neck are uncommon in the pediatric population. Large retrospective studies have demonstrated similar findings, with low rates of penetrating neck trauma and lower rates of vascular injury [9,50-52]. We selectively treated patients based on their clinical presentation. Hemodynamically unstable patients or those with obvious vascular and/or aerodigestive tract injuries underwent surgical exploration. Hemodynamically stable patients without overt injury were studied using angiography and endoscopy.

Our present experience showed that only 2 vascular repairs required surgery secondary to significant injury. Excluding one patient with an MCA infarct, diagnostic studies obtained during the initial workup demonstrated no flow or minimal flow limiting injuries and thus conservative nonoperative management was used. Of our 9 blunt trauma patients, 5 had neurologic sequelae, including an MCA infarct (1) and traumatic brain injuries (4; 1 died). Our only penetrating mortality was a GSW to the neck with a left EJ vein and left common carotid artery injury. This series highlights previously published data on morbidity and mortality for blunt carotid injury [53]. In addition, CT angiography may be a useful modality to decrease the rate of surgical neck exploration [54].

The diagnosis and treatment of pediatric patients with truncal vascular injuries is similar to the standard trauma/vascular diagnostic algorithms and surgical techniques used in adults. High-resolution CT has emerged as a more common modality of diagnosis, particularly for thoracic aortic injuries. In our series, 88% of stable patients had a CT scan at their initial presentation, and 96% had a CT scan during their hospital stay. The morbidity and mortality after treatment depends largely on the hemodynamic status at presentation. Survival in children and adolescents should be at least comparable to that reported in adult series and is often better.

References

[1]. Meagher DP Jr, Defore WW, Mattox KL, et al. Vascular trauma in infants and children. J Trauma. 1979; 19(7):532–6. [PubMed: 458896]

[2]. Klinkner DB, Arca MJ, Lewis BD, et al. Pediatric vascular injuries: patterns of injury, morbidity, and mortality. J Pediatr Surg. 2007; 42(1):178–82. discussion 182-173. [PubMed: 17208561]

[3]. Bergqvist D, Karacagil S, Westman B. Paediatric arterial trauma. Eur J Surg. 1998; 164(10):723–31. [PubMed: 9840300]

[4]. Reichard KW, Reyes HM. Vascular trauma and reconstructive approaches. Semin Pediatr Surg. 1994; 3(2):124–32. [PubMed: 8062056]

[5]. Reed MK, Lowry PA, Myers SI. Successful repair of pediatric popliteal artery trauma. Am J Surg. 1990; 160(3):287–90. [PubMed: 2393057]

[6]. Whitehouse WM, Coran AG, Stanley JC, et al. Pediatric vascular trauma. Manifestations, management, and sequelae of extremity arterial injury in patients undergoing surgical treatment. Arch Surg. 1976; 111(11):1269–75. [PubMed: 985076]

[7]. Shaker IJ, White JJ, Signer RD, et al. Special problems of vascular injuries in children. J Trauma. 1976; 16(11):863–7. [PubMed: 994268]

[8]. Cox CS Jr, Geiger JD, Liu DC, et al. Pediatric blunt abdominal trauma: role of computed tomography vascular blush. J Pediatr Surg. 1997; 32(8):1196–200. [PubMed: 9269969]

[9]. de Virgilio C, Mercado PD, Arnell T, et al. Noniatrogenic pediatric vascular trauma: a ten-year experience at a level I trauma center. Am Surg. 1997; 63(9):781–4. [PubMed: 9290521]

[10]. Cox CS Jr, Black CT, Duke JH, et al. Operative treatment of truncal vascular injuries in children and adolescents. J Pediatr Surg. 1998; 33(3):462–7. [PubMed: 9537558]

[11]. Klein SR, Baumgartner FJ, Bongard FS. Contemporary management strategy for major inferior vena caval injuries. J Trauma. 1994; 37(1):35–41. discussion 41-32. [PubMed: 8028056]

[12]. Sirinek KR, Gaskill HV III, Root HD, et al. Truncal vascular injury—factors influencing survival. J Trauma. 1983; 23(5):372–7. [PubMed: 6854672]

[13]. Wiencek RG, Wilson RF. Abdominal venous injuries. J Trauma. 1986; 26(9):771–8. [PubMed: 3746951]

[14]. Richardson JD, Fallat M, Nagaraj HS, et al. Arterial injuries in children. Arch Surg. 1981; 116(5):685–90. [PubMed: 7235961]

[15]. Wolf YG, Reyna T, Schropp KP, et al. Arterial trauma of the upper extremity in children. J Trauma. 1990; 30(7):903–5. [PubMed: 2381010]

[16]. Carrillo EH, Bergamini TM, Miller FB, et al. Abdominal vascular injuries. J Trauma. 1997; 43(1):164–71. [PubMed: 9253935]

[17]. Wilson RF, Wiencek RG, Balog M. Factors affecting mortality rate with iliac vein injuries. J Trauma. 1990; 30(3):320–3. [PubMed: 2313751]

[18]. Kuehne J, Frankhouse J, Modrall G, et al. Determinants of survival after inferior vena cava trauma. Am Surg. 1999; 65(10):976–81. [PubMed: 10515547]

[19]. Haan J, Rodriguez A, Chiu W, et al. Operative management and outcome of iliac vessel injury: a ten-year experience. Am Surg. 2003; 69(7):581–6. [PubMed: 12889621]

[20]. Riesenman PJ, Farber MA, Rich PB, et al. Outcomes of surgical and endovascular treatment of acute traumatic thoracic aortic injury. J Vasc Surg. 2007; 46(5):934–40. [PubMed: 17980280]

[21]. Huerta S, Bui TD, Nguyen TH, et al. Predictors of mortality and management of patients with traumatic inferior vena cava injuries. Am Surg. 2006; 72(4):290–6. [PubMed: 16676849]

[22]. Asensio JA, Forno W, Roldan G, et al. Visceral vascular injuries. Surg Clin North Am. 2002; 82(1):1–20. xix. [PubMed: 11905939]

[23]. Buckman RF, Pathak AS, Badellino MM, et al. Portal vein injuries. Surg Clin North Am. 2001; 81(6):1449–62. [PubMed: 11766185]

[24]. Pearl J, Chao A, Kennedy S, et al. Traumatic injuries to the portal vein: case study. J Trauma. 2004; 56(4):779–82. [PubMed: 15187741]

[25]. Moainie SL, Neschis DG, Gammie JS, et al. Endovascular stenting for traumatic aortic injury: an emerging new standard of care. Ann Thorac Surg. 2008; 85(5):1625–9. discussion 1629-1630. [PubMed: 18442552]

[26]. Roth SM, Wheeler JR, Gregory RT, et al. Blunt injury of the abdominal aorta: a review. J Trauma. 1997; 42(4):748–55. [PubMed: 9137272]

[27]. Asensio JA, Chahwan S, Hanpeter D, et al. Operative management and outcome of 302 abdominal vascular injuries. Am J Surg. 2000; 180(6):528–33. discussion 533-524. [PubMed: 11182412]

[28]. McCarthy MC, Price SW, Rundell WK, et al. Pediatric blunt abdominal aortic injuries: case report and review of the literature. J Trauma. 2007; 63(6):1383–7. [PubMed: 17308495]

[29]. Burch JM, Richardson RJ, Martin RR, et al. Penetrating iliac vascular injuries: recent experience with 233 consecutive patients. J Trauma. 1990; 30(12):1450–9. [PubMed: 2258955]

[30]. Fayiga YJ, Valentine RJ, Myers SI, et al. Blunt pediatric vascular trauma: analysis of forty-one consecutive patients undergoing operative intervention. J Vasc Surg. 1994; 20(3):419–24. discussion 424-415. [PubMed: 8084035]

[31]. Ombrellaro MP, Freeman MB, Stevens SL, et al. Predictors of survival after inferior vena cava injuries. Am Surg. 1997; 63(2):178–83. [PubMed: 9012433]

[32]. Ali IS, Fitzgerald PG, Gillis DA, et al. Blunt traumatic disruption of the thoracic aorta: a rare injury in children. J Pediatr Surg. 1992; 27(10):1281–4. [PubMed: 1403503]

[33]. Anderson SA, Day M, Chen MK, et al. Traumatic aortic injuries in the pediatric population. J Pediatr Surg. 2008; 43(6):1077–81. [PubMed: 18558186]

[34]. Burjonrappa S, Vinocur C, Smergel E, et al. Pediatric blunt abdominal aortic trauma. J Trauma. 2008; 65(1):E10–2. [PubMed: 18580504]

[35]. DeCou JM, Abrams RS, Gauderer MW. Seat-belt transection of the pararenal vena cava in a 5-year-old child: survival with caval ligation. J Pediatr Surg. 1999; 34(7):1074–6. [PubMed: 10442592]

[36]. Horwitz JR, Black T, Lally KP, et al. Venovenous bypass as an adjunct for the management of a retrohepatic venous injury in a child. J Trauma. 1995; 39(3):584–5. [PubMed: 7473929]

[37]. Karmy-Jones R, Hoffer E, Meissner M, et al. Management of traumatic rupture of the thoracic aorta in pediatric patients. Ann Thorac Surg. 2003; 75(5):1513–7. [PubMed: 12735571]

[38]. Milas ZL, Dodson TF, Ricketts RR. Pediatric blunt trauma resulting in major arterial injuries. Am Surg. 2004; 70(5):443–7. [PubMed: 15156954]

[39]. Takach TJ, Anstadt MP, Moore HV. Pediatric aortic disruption. Tex Heart Inst J. 2005; 32(1):16–20. [PubMed: 15902816]

[40]. Tiao GM, Griffith PM, Szmuszkovicz JR, et al. Cardiac and great vessel injuries in children after blunt trauma: an institutional review. J Pediatr Surg. 2000; 35(11):1656–60. [PubMed: 11083446]

[41]. Trachiotis GD, Sell JE, Pearson GD, et al. Traumatic thoracic aortic rupture in the pediatric patient. Ann Thorac Surg. 1996; 62(3):724–31. discussion 731-722. [PubMed: 8783999]

[42]. Wildhaber BE, Kalangos A, Le Coultre C, et al. Traumatic isthmic aortic rupture associated with renal fracture in a child. J Trauma. 2007; 62(6):1501–3. [PubMed: 17563674]

[43]. Myers SI, Reed MK, Black CT, et al. Noniatrogenic pediatric vascular trauma. J Vasc Surg. 1989; 10(3):258–65. [PubMed: 2778889]

[44]. Riches KJ, James RA, Gilbert JD, et al. Fatal childhood vascular injuries associated with seat belt use. Am J Forensic Med Pathol. 2002; 23(1):45–7. [PubMed: 11953493]

[45]. Choit RL, Tredwell SJ, Leblanc JG, et al. Abdominal aortic injuries associated with chance fractures in pediatric patients. J Pediatr Surg. 2006; 41(6):1184–90. [PubMed: 16769359]

[46]. Puapong D, Brown CV, Katz M, et al. Angiography and the pediatric trauma patient: a 10-year review. J Pediatr Surg. 2006; 41(11):1859–63. [PubMed: 17101359]

[47]. Nashef SA, Talwalkar NG, Jamieson MP. Aortic arch rupture in a child following minor blunt trauma. Thorac Cardiovasc Surg. 1987; 35(4):240–1. [PubMed: 2444009]

[48]. Whitson BA, Nath DS, Knudtson JR, et al. Is distal aortic perfusion in traumatic thoracic aortic injuries necessary to avoid paraplegic postoperative outcomes? J Trauma. 2008; 64(1):115–20. [PubMed: 18188108]

[49]. Milas ZL, Milner R, Chaikoff E, et al. Endograft stenting in the adolescent population for traumatic aortic injuries. J Pediatr Surg. 2006; 41(5):e27–e30. [PubMed: 16677872]

[50]. Abujamra L, Joseph MM. Penetrating neck injuries in children: a retrospective review. Pediatr Emerg Care. 2003; 19(5):308–13. [PubMed: 14578829]

[51]. Hall JR, Reyes HM, Meller JL. Penetrating zone-II neck injuries in children. J Trauma. 1991; 31(12):1614–7. [PubMed: 1749031]

[52]. Cooper A, Barlow B, Niemirska M, et al. Fifteen years' experience with penetrating trauma to the head and neck in children. J Pediatr Surg. 1987; 22(1):24–7. [PubMed: 3819988]

[53]. Rozycki GS, Tremblay L, Feliciano DV, et al. A prospective study for the detection of vascular injury in adult and pediatric patients with cervicothoracic seat belt signs. J Trauma. 2002; 52(4): 618–23. discussion 623-614. [PubMed: 11956373]

[54]. Woo K, Magner DP, Wilson MT, et al. CT angiography in penetrating neck trauma reduces the need for operative neck exploration. Am Surg. 2005; 71(9):754–8. [PubMed: 16468512]

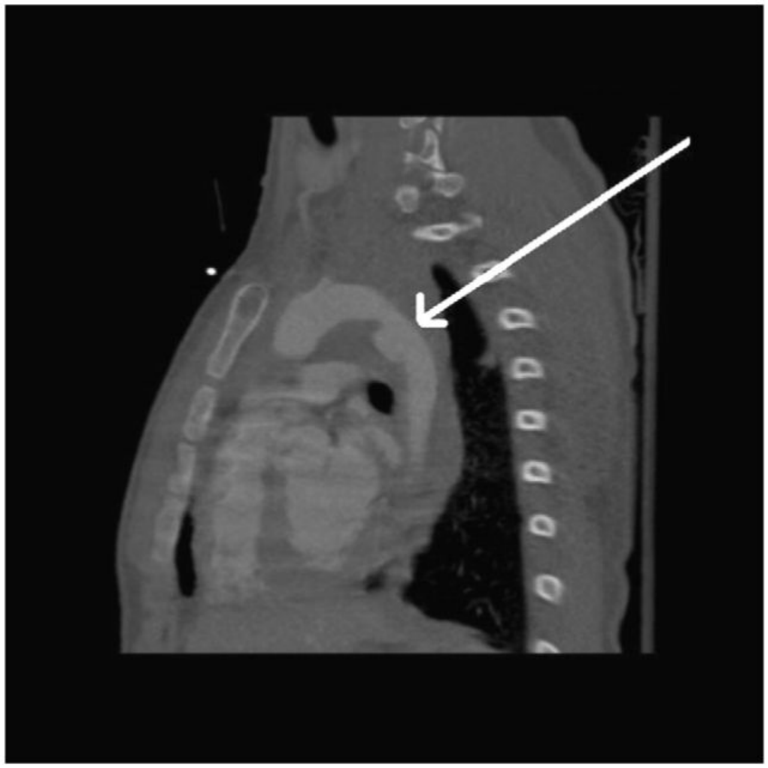

Fig. 1.
Abdominal aortic angiogram demonstrating a transected abdominal aorta secondary to blunt trauma.

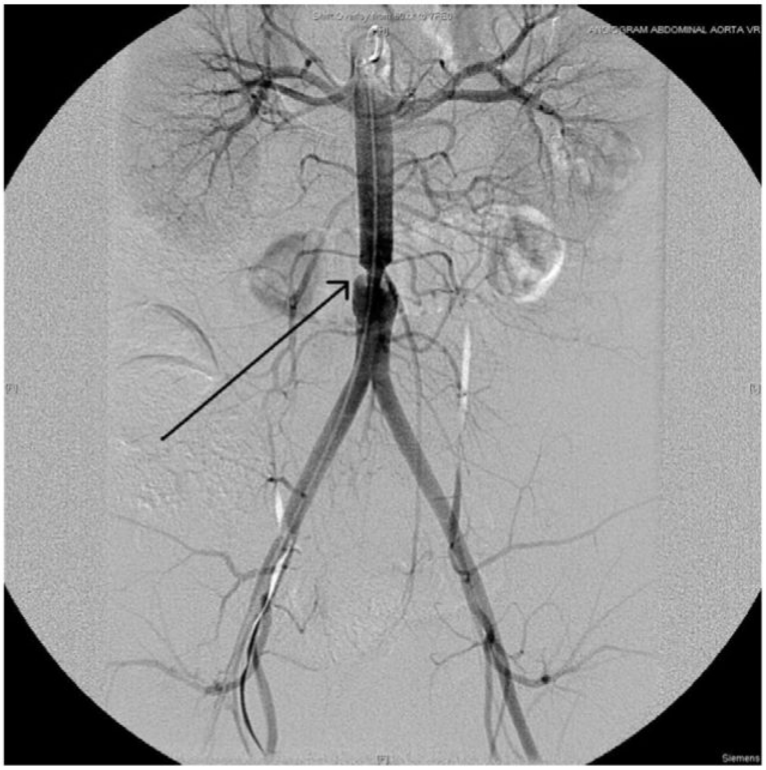

Fig. 2.
Computed tomographic angiogram of the chest demonstrating a traumatic abdominal aorta pseudoaneurysm.

Table 1

Concomitant injuries associated with abdominal vascular injuries

Spleen	4	9.1%
Liver	7	15.9%
Pancreas	2	4.5%
Kidney	4	9.1%
Stomach	1	2.3%
Duodenum	1	2.3%
Small bowel	8	18.2%
Large bowel	3	6.8%
Mesentery/vessels	5	11.4%
Bile duct	0	0%
Bladder	2	4.5%
Orthopedic	4	9.1%
Diaphragm	1	2.3%
Head injury	2	4.5%

Table 2

Concomitant injuries associated with thoracic vascular injuries

Head injury	5	16.7%
Spinal cord injury	1	3.3%
Facial fractures	2	6.7%
Cervicothoracic spine	3	10%
Pulmonary contusion/rib fractures/ hemopneumothorax	8	26.7%
Femur fracture	4	13.3%
Other orthopedic injury	4	13.3%
Splenic laceration	1	3.3%
Brachial plexus injuries	2	6.7%

Table 3

Concomitant injuries associated with neck vascular injuries

Head injury	4	25%
MCA infarct	1	6.25%
Facial fractures	2	12.5%
Cervical spine	1	6.25%
Pulmonary contusion/rib fractures/ hemopneumothorax	2	12.5%
Thyroid laceration	1	6.25%
Superficial neck veins	5	31.25%

Table 4

National Pediatric Trauma Registry truncal vascular injury mortality statistics

Vessel injured	Mortality (%), blood pressure <90	Mortality (%), blood pressure >90	n
Abdominal aorta	100	56	14
Inferior vena cava	64	36	29
Portal vein	50	–	2
Superior mesenteric artery	0	–	8
Hepatic vein	100	33	8

Data from National Pediatric Trauma Registry, Boston, Mass, October 1996.

Table 5

Mortality stratified by hemodynamic status on presentation

Truncal	Survival (%)	Survival (%)	Overall
Vascular injury	Hemodynamically stable	Hemodynamically unstable	Survival
Abdominal	13/16 (81%)	11/14 (62.5%)	80%
Thoracic	6/7 (86%)	0/6 (0%)	46%
Neck	11/12 (92%)	1/2 (50%)	86%