Blunt multifocal aortic injury with abdominal aortic intimointimal intussusception

Richa Kalsi, MD,[a] Charles B. Drucker, MD,[a] Jose H. Salazar, MD,[a] Lauren I. Luther, BS,[a] Jose J. Diaz, MD, CNS, FACS, FCCM,[b,c] *and* Rishi Kundi, MD, FACS,[a] *Baltimore, Md*

ABSTRACT

Blunt abdominal aortic injury is an infrequent occurrence after blunt trauma. The majority of these injuries result from deceleration forces sustained in motor vehicle collisions. Effects of these forces on the thoracic aorta are well described, but associated spinal compression or distraction can also lead to injury of the affixed abdominal aorta. We present a case of multifocal blunt thoracic and abdominal aortic injury with circumferential abdominal aortic dissection, resulting in aortoaortic intussusception associated with a thoracolumbar spinal injury. The unique diagnostic challenge and subsequent successful endovascular management of a rare nonocclusive abdominal aortic intussusception are herein discussed. (J Vasc Surg Cases and Innovative Techniques 2018;4:37-40.)

Blunt abdominal aortic injury (BAAI) is uncommon; retrospective studies report an annual incidence of 0.02% to 0.1% among trauma admissions.[1,2] Autopsy series demonstrate BAAI in 0.2% of patients dying of blunt trauma.[3,4] Approximately 60% of BAAI results from motor vehicle collisions secondary to differential deceleration of fixed and adjacent mobile anatomic components.[4-6] In the thoracic aorta (TA), this commonly occurs at the ligamentum arteriosum between the mobile arch and immobile descending aorta. In the abdominal aorta (AA), injuries ranging from intimal tears to complete transection can arise from forceful aortic compression between mobile abdominal contents and the fixed spinal column.[4,7]

Circumferential AA intimal injury is rare, described exclusively in association with transection or occlusion.[2,3,6,7] Intimointimal intussusception (III) has previously been reported only in the TA.[8-10] We report a case of circumferential dissection and III of the AA associated with thoracolumbar spinal fracture (TLSF) and a radiographically patent lumen. As part of surgical consent, our patient agreed for his deidentified case records and images to be used for this report.

CASE REPORT

A 55-year-old unrestrained male driver in a head-on motor vehicle collision was found hypotensive and minimally responsive in the field. He was nasotracheally intubated and flown to the R. Adams Cowley Shock Trauma Center. On arrival, he was hemodynamically unstable. The Focused Assessment with Sonography for Trauma examination and plain radiography demonstrated free intraperitoneal fluid, right hemopneumothorax, and multiple fractures. Pelvic binding and resuscitation allowed whole body computed tomography, demonstrating grade IVb splenic, grade II liver, and grade I renal injuries. Bone injuries included depressed sternal fracture, dislocated left acetabular fracture, T12 vertebral body anterior dislocation, T12-L1 bilateral facet fractures and dislocation, and L2-L3 transverse process fractures (Fig 1). The patient suffered associated spinal cord injury with incomplete paraplegia below T11 (American Spinal Injury Association Impairment Scale level C) and temporary loss of bowel and bladder function, which returned 1.5 months later with some motor and sensory function.

The diffusely atherosclerotic aorta exhibited multifocal thoracic and abdominal injuries. Descending thoracic injuries included pseudoaneurysm in zone 3 and intimal injury with intramural hematoma in zone 4. Bilateral renal perfusion was severely diminished with abrupt infrarenal diminution of luminal diameter extending through bilateral common femoral arteries (Figs 1 and 2).

The patient was taken to our hybrid operating room. After the trauma surgeon performed a splenectomy, repaired bowel injuries, and packed the abdomen, the vascular surgeon performed bilateral femoral cutdowns and cannulations. Arch aortography confirmed one intimal injury and pseudoaneurysm 5 mm distal to the left subclavian artery and a second 4 cm distal to the subclavian. One 28- × 100-mm Gore TAG endograft (W. L. Gore & Associates, Flagstaff, Ariz) was deployed to address both with intentional occlusion of left subclavian artery origin. Completion arch aortography demonstrated exclusion of all injuries and delayed filling of the left subclavian with persistent antegrade left vertebral flow.

With attention turned to the AA, aortography in multiple obliquities demonstrated a 20-mm pararenal aorta abruptly transitioning to a 10-mm infrarenal segment. Preoperative imaging and associated injuries suggested that this was due to focal, circumferential intimal injury and subsequent dissection. Aortic size was estimated from the patient's habitus and hypotension, and the shortest appropriate endograft, a 23- × 33-mm Gore Excluder Aortic Extender (W. L. Gore & Associates), was deployed immediately caudal to the renal arteries. Completion angiography

From the Division of Vascular Surgery,[a] and Division of Acute Care Surgery,[c] Department of Surgery, University of Maryland School of Medicine; and the R. Adams Cowley Shock Trauma Center.[b]

Author conflict of interest: none.

Correspondence: Rishi Kundi, MD, FACS, Division of Vascular Surgery, Department of Surgery, University of Maryland School of Medicine, 22 S Greene St, S10B00, Baltimore, MD 21201 (e-mail: rkundi@som.umaryland.edu).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

https://doi.org/10.1016/j.jvscit.2017.11.007

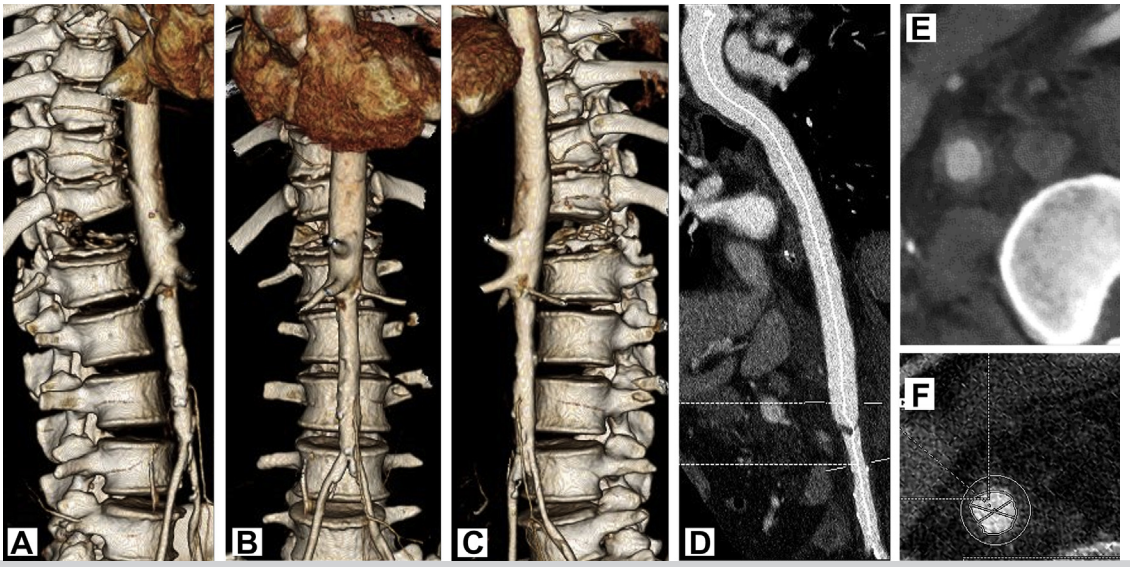

Fig 1. A-C, Three views of a three-dimensional reconstruction of the aortic injury, highlighting the drop-off in aortic diameter and extensive bone spinal injuries (anterior dislocation of the T12 vertebral body, T12-L1 bilateral facet fractures and dislocation, and L2-L3 transverse process fractures). **D,** Sagittal view of computed tomography angiography (CTA) image used to construct the three-dimensional figures demonstrating the intimointimal defect. **E** and **F,** Zoomed in axial views of the circumferential dissection.

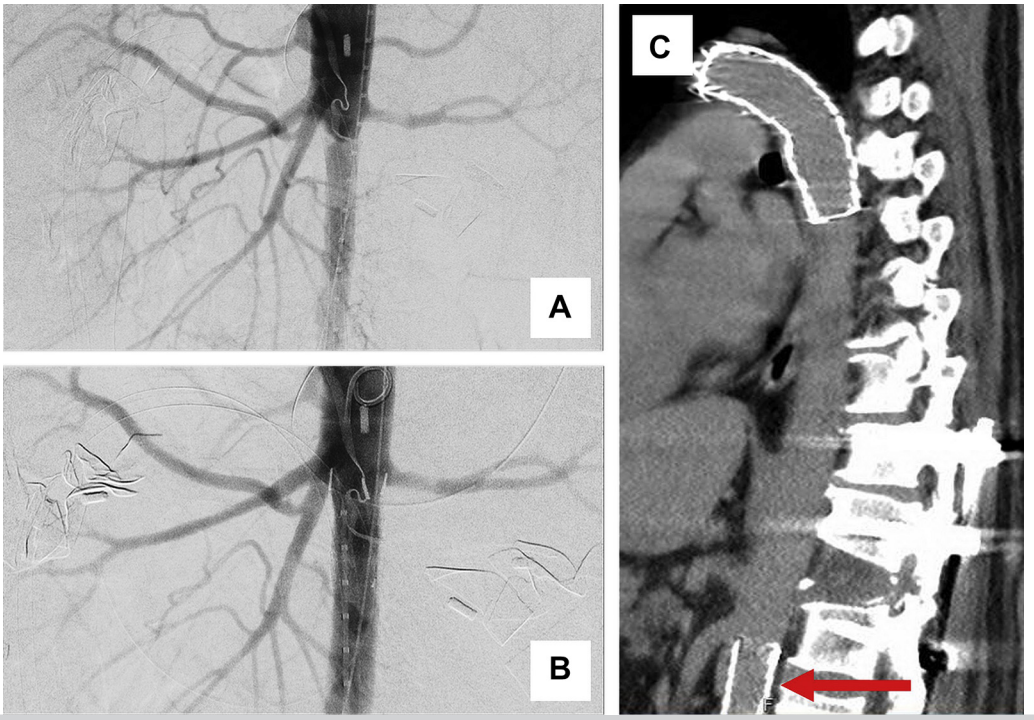

Fig 2. A, The intraoperative angiogram obtained before graft deployment demonstrates the abrupt infrarenal diminution in aortic diameter seen in Fig 1, *A-C*. **B,** Completion angiogram demonstrating improvement in aortic diameter after graft deployment. **C,** Sagittal view from computed tomography angiography (CTA) of the chest done 1 month after injury and repair. The inferiormost extent of this study demonstrates the superiormost aspect of the abdominal endograft with continued exclusion of dissection.

demonstrated increased infrarenal aortic and iliac diameters (Fig 2). Femoral arteriotomies and incisions were closed, and after distal pulses and perfusion were confirmed, the patient was yielded to trauma surgery.

DISCUSSION

After severe blunt abdominal trauma, 9% to 10% of patients present with at least one TLSF. Associated visceral and mesenteric injuries are seen in 60% to 70% of these

cases.[7] Stambough et al[11] highlighted the presence of TLSF as a sign of potential aortic injury. In the last 40 years, 21 cases of subdiaphragmatic aortic injury with associated TLSF have been reported, typically at L1-L3.[7] These studies indicate that attention should be paid not only to the mobile TA but also to the AA because of the common biomechanical patterns underlying BAAI and flexion-distraction TLSF.[4,7,11]

Lap belts and steering columns may decelerate a segment of the lumbar spine while forward motion of the rostral and caudal spine continues, leading to simultaneous flexion and separation (distraction) of the vertebrae (Chance fracture). Notably, this patient was unrestrained and suffered a depressed sternal fracture secondary to forceful impact with the steering column. Here, the degree of flexion and distraction was more severe, as forward motion was arrested more anteriorly by the steering column than a lap belt would allow. This led to TLSF rather than purely lumbar spinal fracture. The same traction forces transmitted to the AA can result in a range of injuries from intimal tear to complete transection.[4,7,12]

Here, several aortic injuries resulted, including an abrupt infrarenal diminution in luminal area due to circumferential intimal tear with distal III. Traction forces were transmitted to the patient's stiff, atherosclerotic AA in the rostral-caudal axis concurrently with aortic compression on impact with the steering column and provided an outward circumferential force on the intima that likely created this circumferential intimal tear. Release of traction forces after the moment of impact likely led to the III. We were unable to find any prior literature regarding AA III.[8,9,13] Traumatic circumferential intimal tears in the AA have been reported; however, diagnosis was generally later, involving complete aortoiliac or branch occlusion.[13,14] Absence of malperfusion in this patient initially led to interpretation of the diminished aortic caliber as hypotension in an atherosclerotic aorta rather than intimal injury, understandably as this unusual pattern of BAAI-associated dissection was not previously described.

An association of TA and AA injuries may be understood within the context of deceleration injury and compression by a seat belt or steering column. The literature suggests that AA compression on impact can transmit significant hydraulic pressure proximally to the arch, particularly if this column of blood encounters a closed aortic valve.[7,14] Such a mechanism likely contributed to the injuries of the TA treated concurrently.

From a diagnostic perspective, aortic injuries were detected on the computed tomography angiography (CTA) component for the chest and abdomen of the whole body computed tomography protocol at our institution. Resolution of this pan-scan is sacrificed to provide a swift whole body read.[15] In the setting of equivocal CTA findings in the diagnosis of BAAI, intravascular ultrasound is an excellent tool to confirm diagnosis or to clarify an intravascular anomaly.[16] In this case, CTA was adequate for diagnosis and planning for intervention. Furthermore, without a specific management-changing question in mind, intravascular ultrasound in this multitrauma patient would have contributed to a lengthened operative time.

Endovascular treatment of BAAI has been previously described.[2,17] In this case, deployment of an endograft cuff at the origin of the circumferential tear resolved the long-segment dissection by inflow occlusion. Restoration of true lumen flow resolved the intussusception and allowed return to normal distal diameter. Given high risk of progression to complete occlusion from evolving circumferential dissection, conservative management with serial imaging or renal stenting alone was considered inadvisable.

In addition to presenting a rare injury, our report demonstrates the feasibility of endovascular repair for even complex subdiaphragmatic aortic injuries. Follow-up CTA examinations at 1 week and 1 month have demonstrated enduring repair of aortic injuries.

CONCLUSIONS

We present a case of rare BAAI including circumferential dissection and intussusception successfully managed with endovascular techniques concurrently with endovascular management of additional thoracic aortic injuries. BAAI is a significant and life-threatening injury that should be considered in patients with Chance fractures and significant mechanisms of injury. Endovascular methods can be successfully applied in the management of these lesions.

REFERENCES

1. Michaels AJ, Gerndt SJ, Taheri PA, Wang SC, Wahl WL, Simeone DM, et al. Blunt force injury of the abdominal aorta. J Trauma 1996;41:105-9.
2. Harris DG, Drucker CB, Brenner ML, Sarkar R, Narayan M, Crawford RS. Patterns and management of blunt abdominal aortic injury. Ann Vasc Surg 2013;27:1074-80.
3. Roth SM, Wheeler JR, Gregory RT, Gayle RG, Parent FN, Demasi R, et al. Blunt injury of the abdominal aorta: a review. J Trauma 1997;42:748-55.
4. Domenicucci M, Ramieri A, Landi A, Melone AG, Raco A, Ruggiero M, et al. Blunt abdominal aortic disruption (BAAD) in shear fracture of the adult thoraco-lumbar spine: case report and literature review. Eur Spine J 2011;20(Suppl 2):314-9.
5. Shalhub S, Starnes BW, Tran NT, Hatsukami TS, Lundgren RS, Davis CW, et al. Blunt abdominal aortic injury. J Vasc Surg 2012;55:1277-85.
6. Dajee H, Richardson IW, Iype MO. Seat belt aorta: acute dissection and thrombosis of the abdominal aorta. Surgery 1979;85:263-7.
7. Inaba K, Kirkpatrick AW, Finkelstein J, Murphy J, Brenneman FD, Boulanger BR, et al. Blunt abdominal aortic trauma in association with thoracolumbar spine fractures. Injury 2001;32:201-7.
8. Sanchez Oro R, Ibáñez Muñoz D, Salceda Artola J, Quintana Martínez I. Circumferential type A aortic dissection with

intimal intussusception. J Cardiovasc Comput Tomogr 2015;9:459-60.
9. Niino T, Unosawa S, Shimura K. Stanford type A aortic dissection with intimal intussusception. Gen Thorac Cardiovasc Surg 2012;60:578-80.
10. Kim H, Chung H, Choi J. Intimointimal intussusception in traumatic type B aortic dissection: CT and aortographic findings: case reports. Clin Radiol 2000;55:487-9.
11. Stambough JL, Ferree BA, Fowl RJ. Aortic injuries in thoracolumbar spine fracture-dislocations: report of three cases. J Orthop Trauma 1989;3:245-9.
12. Freni L, Barbetta I, Mazzaccaro D, Settembrini AM, Dallatana R, Tassinari L, et al. Seat belt injuries of the abdominal aorta in adults—case report and literature review. Vasc Endovascular Surg 2012;47:138-47.
13. Orrit J, Kalangos A, Trindade PT, Christenson JT. Circumferential dissection with intimal intussusception: an unusual case of acute aortic type A dissection. Cardiovasc Surg 2003;11:173-5.
14. Randhawa MP, Menzoian JO. Seat belt aorta. Ann Vasc Surg 1990;4:370-7.
15. Nguyen D, Platon A, Shanmuganathan K, Mirvis SE, Becker CD, Poletti PA. Evaluation of a single-pass continuous whole-body 16-MDCT protocol for patients with polytrauma. AJR Am J Roentgenol 2009;192:3-10.
16. Shi Y, Tsai PI, Wall MJ Jr, Gilani R. Intravascular ultrasound enhanced aortic sizing for endovascular treatment of blunt aortic injury. J Trauma Acute Care Surg 2015;79:817-21.
17. Azizzadeh A, Ray HM, Dubose JJ, Charlton-Ouw KM, Miller CC, Coogan SM, et al. Outcomes of endovascular repair for patients with blunt traumatic aortic injury. J Trauma Acute Care Surg 2014;76:510-6.

Submitted Mar 8, 2017; accepted Nov 26, 2017.