Case Report

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Blunt Abdominal Aortic Injury: A Hybrid Approach to Combined Injuries

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Blunt abdominal aortic injury (BAAI) is a relatively rare pathology, usually the result of a seat belt injury in motor vehicle accidents (MVAs), mostly combined with other injuries. Time is a crucial factor for the successful early management of these cases. Hybrid operating theaters, which support the integration of surgical treatment and interventional radiology, provide opportunities to reduce the time-to-surgery for life-threatening conditions. We report the case of a 24-year-old female who was involved in a high-kinematics MVA. On presentation, she was hemodynamically stable but had a prominent seat belt sign and peritoneal signs. A computerized tomography (CT) scan revealed an intimal flap of the infra-renal aorta and a peri-aortic hematoma together with a suspected laceration of the small bowel. The patient was operated with a hybrid approach; emergent endovascular repair of the aortic injury with stent deployment immediately followed by an explorative laparotomy for the intestinal injury. Her postoperative course was uneventful. The hybrid staged approach allowed a clean and efficient repair of a potentially lethal aortic injury and addressed a contaminated injury in the same compartment, hence preventing redundant morbidity. With the advances and growing availability of endovascular techniques, the hybrid approach has to be an important component of trauma management in the modern era.

Keywords: *Blunt Aortic Injury; Abdominal Aortic Injury; Hybrid Approach; Interventional Radiology; Endovascular Graft Stent*

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INTRODUCTION

Time is a crucial factor for successful outcome in the early management of traumatic critical situations. The complexity of poly-traumatized patients requires different approaches in order to cope with the different injuries. This sometimes requires transferring the patient between different locations in the hospital such as the operating room and the angiographic suite. Transferring an injured patient, especially if hemodynamically unstable and is subjected to damage control strategy, is cumbersome, time-costly, and doomed to complications. Hybrid operating theaters, integrating fixed high-quality angiography equipment within the surgical environment, eliminate the need to transfer unstable patients from one location to another. As such, hybrid operating theaters are increasingly becoming available worldwide and could improve the survival rate of severe multi-trauma victims. In this case report, we describe the use and the sequence of a hybrid approach in the management of a 24-year-old female who presented with a BAAI combined with a hollow viscus injury. The case demonstrates the dilemmas of treatment prioritizations and of choosing the right operative approach from those available in the management of complicated injuries.

Case Report

A generally healthy 24-year-old woman arrived at the emergency department after being involved in a head-on collision as a front passenger. The driver who suffered from multi-organ injuries was evacuated in a helicopter to

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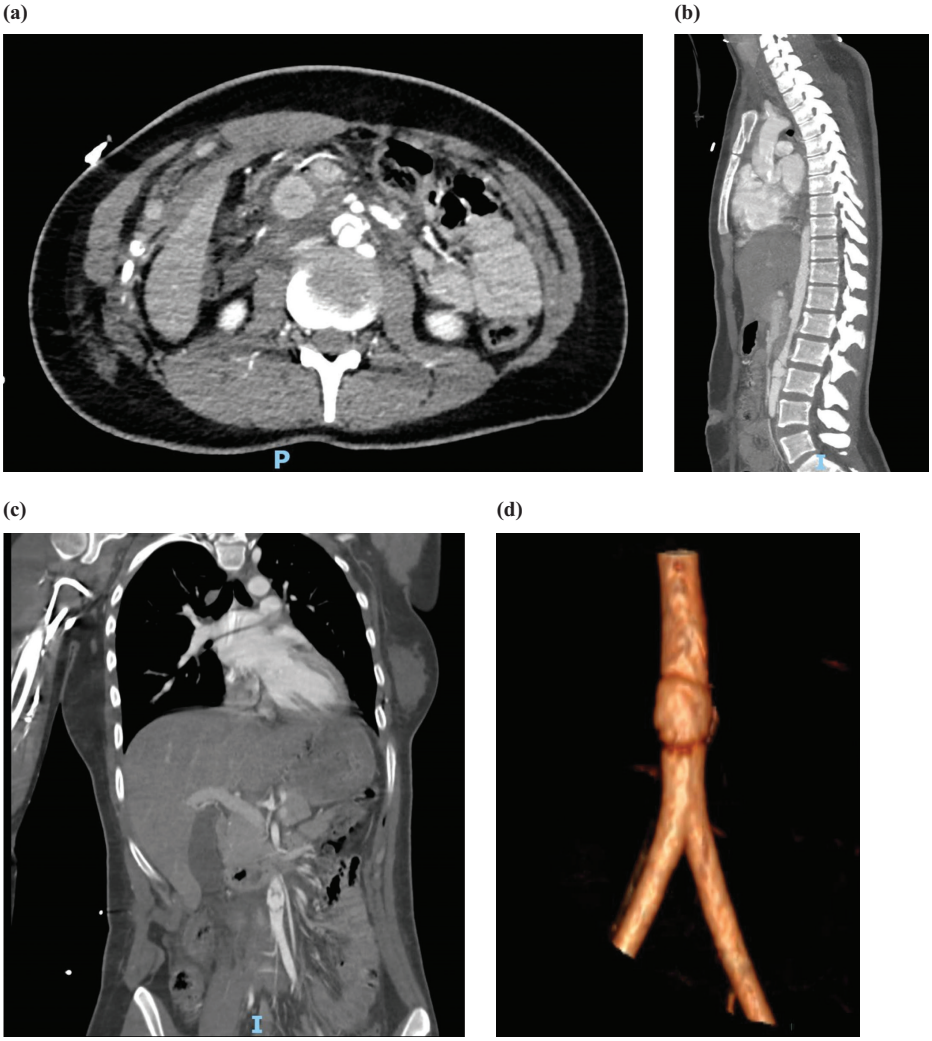

Figure 1 (**a**) Abdominal CT scan, axial view. (**b**) Abdominal CT scan, sagittal view. (**c**) Abdominal CT scan, coronal view. (**d**) 3D reconstruction of the infra-renal aorta.

another trauma center but succumbed within a few hours. On arrival, the presented patient had hemodynamic and respiratory indices within the normal range and was fully alert (HR 81, BP 115/55, Saturation 97%, and Glasgow coma scale 15). The patient complained of hypogastric abdominal pain and low back pain. On physical examination, she had a seat belt sign – abraded cutaneous bands with ecchymosis and diffuse abdominal tenderness. Bilateral femoral and radial pulses were normal. A FAST examination was performed and fluid was observed in the Morrison pouch. As she was stable, the patient was transferred to a total body computerized tomography (CT) scan that showed free fluid in the pelvis, an infrarenal intimal flap 17 mm in length with a hematoma adjacent to it (Figure 1*a–d*), and a hematoma of the small bowel mesentery with a suspected perforation in a mid-jejunal loop.

A multidisciplinary team, including trauma and vascular surgeons, was involved in the surgery of the patient. In the hybrid operating room, an intra-aortic access was gained through the right common femoral artery under general anesthesia. The angiography depicted the infra-renal intimal flap (Figure 2). A BeGraft Aortic Stent Graft System (Bentley™, Hechingen, Germany) with a 12 mm diameter and 39 mm length was placed and lodged with balloon inflation (Figure 3). Subsequently, an explorative laparotomy was performed. There was a small amount of enteric fluid in the peritoneal cavity that was cleansed and a perforation in the mid-jejunum was identified and primarily repaired. The operative time of the combined procedures was 68 minutes. After the operation, the patient was transferred to the ICU for observation. The patient awoke within a few hours. Intravenous antibiotic therapy was given for 24 hours and prophylaxis anticoagulation for prevention of venous thromboembolism was given. After 2 days in the ICU, the patient was transferred to the surgical ward for further observation and 11 days from her admission she was discharged home after an uneventful course.

Figure 2 On-table pre-graft insertion angiogram.

Figure 3 On-table post-intervention angiogram.

DISCUSSION

Incidence

Traumatic blunt abdominal aortic injury (BAAI) is rare and sparsely reported. In an autopsy series of 8,710 injured patients, there were 400 aortic injuries, only 4% of them involved the abdominal aorta [1]. In some series, the incidence of abdominal aortic injury was 0.05%–0.12% [2–5]. In a literature review on BAAI from 1996 to 2012, motor vehicle crashes accounted for more than 60% of the reported causes [6].

Pathophysiology and Clinical Manifestation

Most BAAIs are located infra-renal or below the inferior mesenteric artery [7], as in the current case. On admission, the most common presentation is abdominal pain and signs of acute abdomen usually associated with a seat belt sign. In addition, the patient may complain about different symptoms including lower limb symptoms such as dysesthesias and/or painful paresthesia, painless paralysis, and back pain. Vertebral fractures and hemorrhagic shock may accompany this type of injury. But more importantly, the patient may be asymptomatic and only high suspicion may lead the team to diagnose the injury. The aortic injury is probably the result of the compression and shear forces that are created between the seat belt and the vertebral column. BAAIs to the aorta between T5 and L1 were described with complete obstruction of the Adamkiewicz artery, leading to irreversible lower spinal cord ischemia. In cases of mesenteric vessel involvement, a bowel ischemia can occur either by direct occlusion or by thromboembolism. The presentation may be either acute or slowly advance over a few days. Other common concomitant injuries in the presence of BAAI are spinal fractures (Chance-like fracture) and visceral involvement. Hollow viscus injury is more frequent than the injury of solid organs, with lesions varying from contusion or serosal tear, to transection and avulsion of the vascular pedicles leading to necrotic ischemia. Extra-aortic vascular injuries, notably inferior vena cava laceration and superior mesenteric vein tear, were reported as well [8–12]. Regarding the aortic injury itself, the injury can be an intimal tear associated with disruption of the vasa vasorum that can be asymptomatic. However, subsequent progression to subintimal fibrosis and stenosis may lead to chronic limb ischemia. Full-thickness disruption of the intima and media, with sparing of the adventitia, results in the development of a false aneurysm over hours to weeks. A full-thickness transection will result in massive hemorrhage with a high probability of death due to exsanguination. When no thrombosis or dissection of the aortic lumen is detected, atheromatous plaque fracture with distal embolization is the most likely mechanism of peripheral limb ischemia, either acute or chronic [13,14].

Diagnosis

The diagnosis of a BAAI may be challenging. In an unstable patient, the high-resolution imaging that a CT scan can offer is usually not available pre-operatively. Aortic injuries, especially intimal lesions, may be missed. BAAI can be revealed when retroperitoneal hematoma in Zone I is explored during the emergent explorative laparotomy. CT angiography has a very high sensitivity and specificity for identifying aortic injuries. Due to its high accuracy in identifying most of the vascular lesions

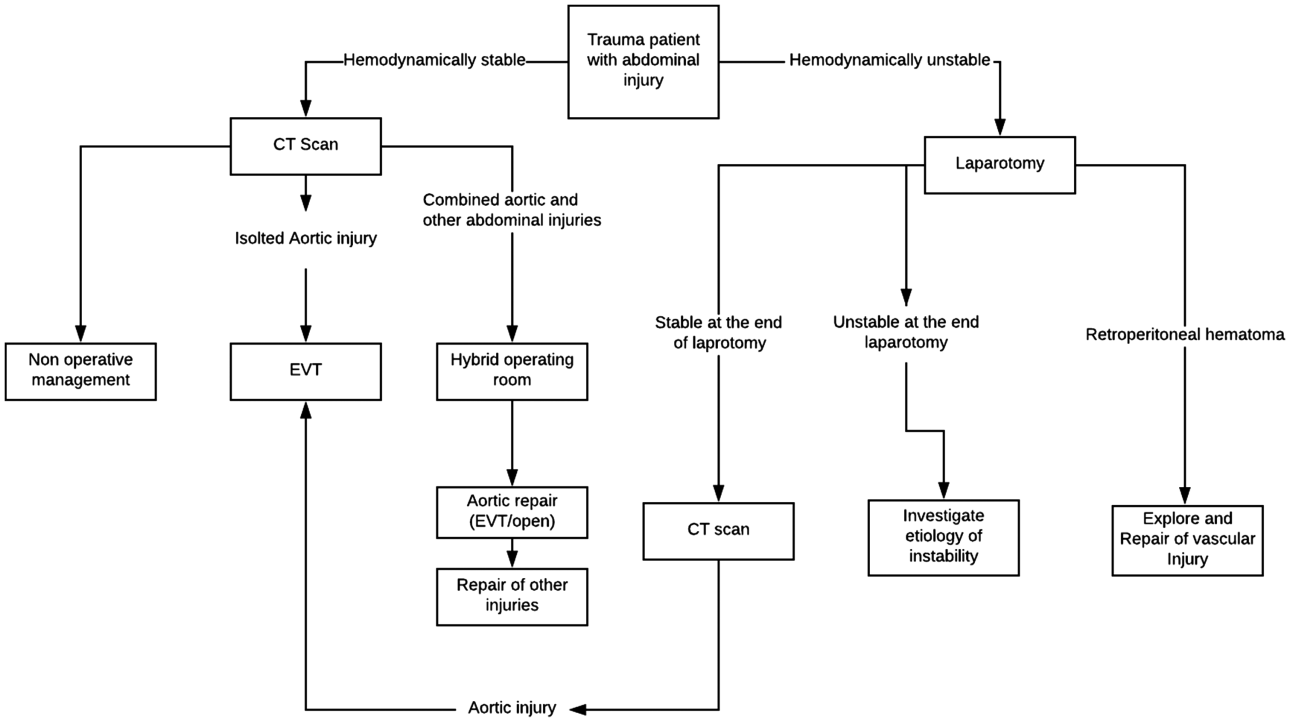

Diagram 1 Proposed use of EVT in abdominal trauma cases.

such as double channel, intimal flap, dilation of the aortic lumen, dissection, thrombosis, pseudoaneurysm, and aortic rupture, it has replaced angiography as the modality-of-choice [15].

Treatment

In the past, laparotomy was used to manage BAAI. In the last few decades, sporadic reports about successful endovascular treatment (EVT) for the acute treatment of blunt abdominal aortic injuries have been published and have revolutionized the treatment of BAAI [3,16–19]. In the present case, it was clear that there was no need for rapid hemorrhage control so a decision had to be made about which of the two injuries identified should be addressed first. In order to manage the patient in the most efficient, rapid and safe way, we decided to treat the patient in a hybrid operating room with angiography capabilities. Although laparotomy was planned in any case and could include a trans-abdominal aortic repair, it was decided that it would be performed using EVT. This approach prevents the contact of a synthetic graft with intestinal contents. The aortic repair preceded the laparotomy due to the potential risk of exsanguination from the transected vessel, which overcomes the risk of further contamination due to the intestinal injury. Today, all cases of poly-traumatized patients are operated in our center on a carbon fiber surgical table with a portable C-arm x-ray machine which enables intraoperative imaging and treatment of suspected orthopedic and vascular injuries. The approach of emergent EVT represents a beneficial solution in the case of abdominal contamination and may be particularly advantageous to patients requiring either damage control surgery or non-operative management of associated lesions. In damage control surgery, the seriously injured patient has physiological derangements and the open procedure which includes entering into a retroperitoneal hematoma, getting proximal and distal control of the injured aorta, and repairing or replacing it with a graft is time-consuming and associated with more blood loss and further physiological deterioration. EVT is an elegant, minimally invasive, rapid option. In non-operative management of abdominal injuries, this approach prevents an unnecessary laparotomy. The method and sequence of managing such injuries are dictated by a few factors including patient hemodynamics, concomitant injuries, and the availability of modalities such as EVT and the necessary setup. For an aortic injury discovered during an urgent laparotomy in unstable patients, a repair, replacement or exclusion with extra-anatomic bypass are options. However, after bleeding control is achieved it is possible to perform an endovascular repair. This approach should be considered especially if there is contamination of the abdominal cavity. In cases where there are concomitant injuries that require laparotomy but the patient is hemodynamically stable, the laparotomy may be preceded by EVT of the aorta. In our opinion, an endovascular approach is preferred because it can save further dissection of abdominal viscera, bleeding, and contamination. This superiority over the conventional open approach justifies transferring patients with BAAI

to trauma centers with EVT ability. In Diagram 1 we propose an algorithm for the integration of EVT in a trauma patient.

CONCLUSION

BAAI is uncommon but should always be considered especially in incidents of high energy mechanism and in the presence of a seat belt sign. Missed or delayed diagnosis may lead to devastating complications. Therefore, for investigation of the vascular involvement peripheral signs of acute ischemia must be assessed, followed by a CT angiography. Once a diagnosis is made, prompt treatment has to be taken. The presented case and other recent reports convince us that the advantages of EVT will make it the preferred approach in the future, even in cases of planned laparotomy, although open surgical repair is still considered state-of-the-art. Nevertheless, the long-term results of such therapy are yet to be evaluated. Hybrid operating rooms are a necessity to enable the implementation of this management strategy.

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