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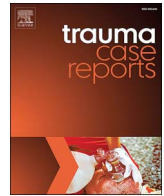
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Case Report

Blunt traumatic celiac artery avulsion managed with celiac artery ligation and open aorto-celiac bypass[☆]

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ABSTRACT

Traumatic celiac artery injuries are rare and highly lethal with reported mortality rates of 38–62%. The vast majority are caused by penetrating trauma with only 11 reported cases due to blunt trauma (Graham et al., 1978; Asensio et al., 2000, 2002). Only 3 of these cases were complete celiac artery avulsions. Management options described depend upon the type of injury and have included medical therapy with anti-platelet agents or anti-coagulants, endovascular stenting, and open ligation. We report a case of a survivor of complete celiac artery avulsion from blunt trauma managed by open bypass.

Introduction

Traumatic celiac artery injuries are rare and highly lethal with reported mortality rates of 38–62%. While the vast majority are caused by penetrating trauma, an estimated 6% of these injuries resulted from blunt force trauma, and there have been only 11 reported cases in the literature (Table 1) [1–10,12–14]. Injury patterns vary and those reported include intimal flaps, thrombosis, pseudoaneurysms, and complete avulsions. Notably only 3 of the cases of celiac artery injury due to blunt trauma reported in the literature were complete avulsions. Management options described depend upon the type of injury and have included observation, medical therapy with anti-platelet agents or anti-coagulants, endovascular placement of stents or stent grafts, and open ligation. We report the case of a survivor of complete celiac artery avulsion from blunt trauma managed by open bypass, and will present a brief review of the literature and a summary of management options.

Case report

A 75-year-old male with history of atrial fibrillation on Rivaroxaban was struck by a motor vehicle. Upon arrival he was hypotensive but with a Glasgow Coma Score of 15. A strategy of permissive hypotension was maintained based upon the patient's mental status. Plain radiographs and CT imaging were obtained and demonstrated multiple rib fractures and a celiac artery injury with contrast extravasation and associated hematoma (Fig. 1A–B). He was immediately transported to our hybrid operating room and placed under general anesthesia. Percutaneous femoral artery access was obtained and aortography was performed. This demonstrated a complete avulsion of the celiac artery with distal reconstitution via retrograde filing from the superior mesenteric artery (Fig. 2). Initially, given the stability of the patient, attempts were made to traverse the injury to perform endovascular intervention in

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Table 1
 Characteristics of the 11 previously reported cases of blunt celiac artery injury as well as our currently reported case.

| Year | Age/gender | Mechanism | Injury type | Management | Outcome | |
|-----------|-----------------------------------|---------------|-----------------------------|--|---|---|
| Brown | 1998 | 24 M | MVC | Superior mesenteric and celiac artery disruptions | Attempted SMA bypass | Operative death |
| Asensio | 2005 (1 of 13 patients in series) | Not specified | MVC | Not specified | Not specified | Not specified |
| Linuma | 2006 | 39 M | Crush injury | Partial tear of celiac artery | Open ligation | Discharged POD# 16 |
| Suchak | 2007 | 41 M | MVC | Delayed recognition of intimal flap of celiac artery HD#3 | Endovascular stenting (Wallstent, Boston Scientific, Boston, MA, USA) | Discharged HD#10 |
| Kirchhoff | 2007 | 66 M | MVC | Delayed recognition of dissection and thrombosis of celiac artery HD#5 | None | Death HD#7 from fulminant liver failure |
| Gorra | 2009 | 29 M | Fall from 9 m | Dissection and thrombosis of celiac artery | Anticoagulation with Heparin and subsequently Warfarin for 3 months | Discharged HD#4, repeat imaging with asymptomatic celiac artery occlusion at 3 months |
| Colonna | 2010 | 17 M | MVC | Complete avulsion of celiac artery | Open ligation | Discharged HD#27 |
| Choi | 2012 | 39 M | Crush injury | Pseudoaneurysm of celiac artery | Endovascular stent graft placement, embolization of splenic, left gastric and inferior phrenic arteries | Discharged, no evidence of complication 6 months post-procedure |
| Sarker | 2012 | 26 M | MVC | Dissection of celiac artery | Anticoagulation with Enoxaparin and subsequently Warfarin for 3 months | Discharged, repeat imaging with resolution of dissection at 3 months |
| Osborne | 2013 | 72 M | MVC | Complete avulsion of celiac artery | Open ligation | Discharged POD#11 |
| Rosenthal | 2015 | 26 M | Fall from 150 ft into river | Dissection of celiac artery | Medical management with Aspirin 81 mg | Discharge, repeat imaging with persistent asymptomatic dissection at 2 months |
| Kronick | 2016 | 75 M | Pedestrian struck | Complete avulsion of celiac artery | Open aorto-celiac artery bypass | Discharged on HD#102, survival to 22 months |

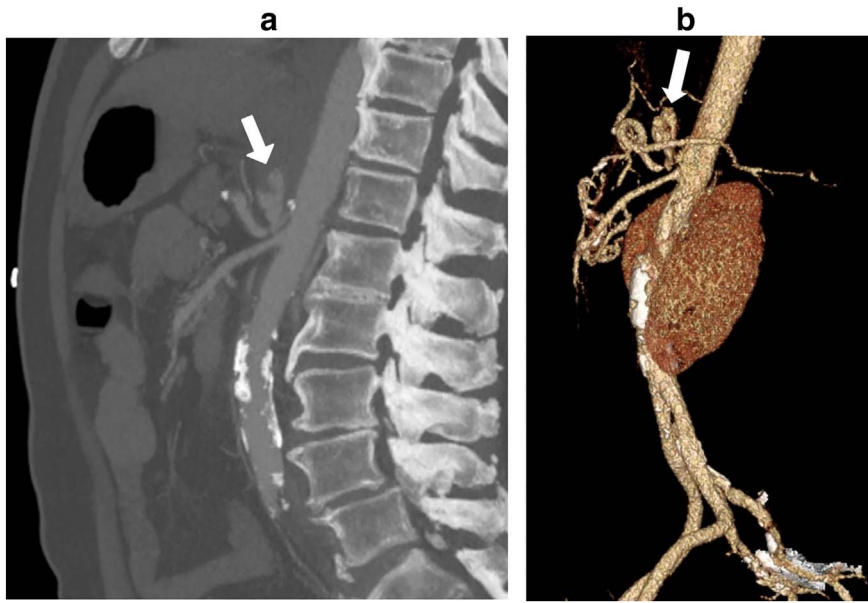


Fig. 1. A–B. Sagittal CT angiogram, 3D reconstructions showing celiac artery origin with arrows marking contrast extravasation.

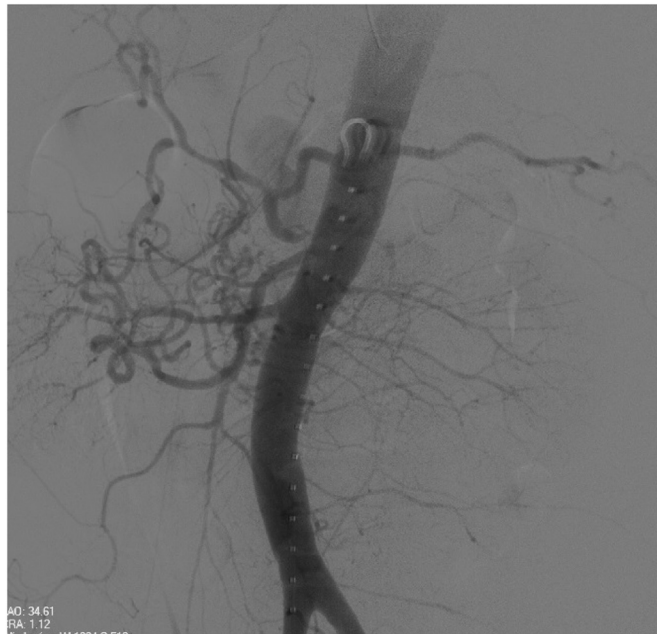


Fig. 2. Angiogram showing complete avulsion of the celiac artery with distal reconstitution via retrograde filling from the superior mesenteric artery.

a hybrid operating room but these were unsuccessful despite the use of multiple wire, catheter, and sheath combinations. The patient was already prepped for and immediately underwent a midline laparotomy, as there was obvious concern that he may either decompensate or the injury might not be amenable to endovascular intervention. The celiac axis and aorta were explored through the lesser sac and control of the celiac origin was obtained with a side-biting aortic clamp with scant back-bleeding from the distal celiac stump. The splenic artery and common hepatic artery were isolated and the left gastric artery was ligated. The gastroduodenal artery was patent; however, worsening hepatic ischemia was visualized during the case this ligation alone was felt to be unsafe. Therefore an aorto-celiac bypass with a 6-mm Dacron graft was performed utilizing the supra-celiac aorta as the inflow source. The celiac stump was over-sewn. A temporary abdominal closure was performed and the patient was transferred to the surgical intensive care unit for resuscitation. His abdomen was closed four days after his initial operation. A prolonged hospital course ensued with complications including a pancreatic leak with pseudocyst formation necessitating ERCP and endoscopic cyst-gastrotomy, pneumonia, acute kidney injury, and splenic artery pseudoaneurysm managed by exclusion and embolization. The patient was discharged home and expired

22 months after his trauma from acute respiratory failure leading to hypoxic brain injury. Consent was obtained for the publication of this report.

Brief literature review

A total of 11 cases of blunt celiac artery injury were identified in the literature (Table 1). Injury occurred due to motor vehicle collision in 64%, crush injury in 18%, and falls from height in 18%. The average age of the patients was 45 years old and all of those whose gender was identified were males. Injury type was specified in 10 of the cases. There were four disruptions of the celiac artery with three complete and one partial disruption. There were four dissections, two of which were associated with complete thrombosis. There was one intimal flap, and one pseudoaneurysm. Two of the injuries were identified in a delayed fashion. Overall survival in the series was 80% with one intra-operative death and one death due to fulminant hepatic failure on hospital day 7. The high overall survival likely represents survivor and reporting bias.

Four of the eleven reported patients (36%) were managed with open surgery. All of the patients who underwent open surgical management had partial or complete disruption of the celiac artery. Of the four, three patients underwent ligation of the celiac artery and survived, and one underwent attempted bypass with intraoperative death; this patient had a concomitant superior mesenteric artery disruption. Two patients underwent endovascular intervention. One patient had a self-expanding bare metal stent (Wallstent, Boston Scientific, Marlborough, MA, USA) placed for an intimal flap which was identified in a delayed fashion, and the other had a balloon expandable covered stent graft placed (Jo stent graft, Abbott Vascular Devices, Santa Clara, CA, USA) for a pseudoaneurysm. Two patients were managed with therapeutic anticoagulation with either Heparin or Enoxaparin initially, and then transitioned to Warfarin for a period of 3 months. One patient was managed with low dose aspirin. One patient, who was found to have a dissection with associated celiac artery thrombosis on hospital day 5, had no attempts at specific management and subsequently died on hospital day 7 from fulminant hepatic failure.

Discussion

Celiac artery injuries are rare with the vast majority due to penetrating trauma. Of those due to blunt trauma, common mechanisms reported include motor vehicle accidents, falls from height, and crush injuries. Injury types described vary and include complete and partial disruptions of the artery, dissections both with and without associated thrombosis, intimal flaps, and pseudoaneurysms. Management options described depend on the type of injury and have included surgical ligation, surgical bypass, endovascular stenting or stent grafting, medical therapy with therapeutic anti-coagulation or anti-platelet agents, and observation. Ideal management is case specific and is dependent upon multiple factors including patient stability, injury pattern, concomitant injuries, presence of vascular disease, and provider experience.

Medical management with anti-platelet agents or therapeutic anti-coagulation, or intervention in the form of endovascular stenting appears to be safe in limited dissections or when an intimal flap is identified. However, caution should be exercised when there is associated celiac artery thrombosis, as one of the reported cases progressed to fulminant hepatic failure and death with medical management alone.

Endovascular intervention has been successful in more significant injuries [11] and was attempted in our case given the patient's stability. Great care must be taken with such attempts however as there is a risk of converting a contained rupture or pseudoaneurysm to a free one, or worsening a mild injury with additional trauma related to crossing the lesion.

More significant injuries leading to hemorrhagic shock have been successfully managed with open surgical ligation of the celiac artery as a damage control measure. In these cases, hepatic flow is supplied via retrograde filling through the gastroduodenal artery via the superior mesenteric artery. In elective settings such as celiac artery aneurysms, this practice is only recommended when the patient has good collateral flow and a non-diseased liver. In our case, the patient had no known liver disease; however because he did not appear to have adequate liver perfusion without antegrade celiac artery flow, perhaps due to a combination of atherosclerotic disease and shock, the decision was made to perform an antegrade celiac bypass for fear of fulminant hepatic necrosis.

Conclusion

Celiac artery injury from blunt trauma is an extremely rare and devastating injury. The patterns of blunt celiac artery injury vary widely, as do the management options. Open surgical ligation is the recommended treatment in the hemodynamically unstable trauma patient undergoing damage control surgery. With concern for hepatic ischemia with ligation alone, we describe a successful open antegrade surgical bypass.

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