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Case report

Survival following devastating penetrating gunshots polytrauma with grade 5 liver injuries requiring multiple massive transfusion protocols: A case report and review of the literature

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ABSTRACT

Introduction: A devastating injury to the liver from a gunshot wound (GSW) challenges the most seasoned trauma surgeon. This challenge is intensified when patients develop severe shock with a high-grade injury. We present the case of a patient with a grade 5 liver injury after a GSW treated with operative and interventional radiology (IR) treatment simultaneously.

Case presentation: A 25-year-old male presented to our Trauma Center with hypotension, after an abdominal GSW. He was taken emergently to the operating room, which revealed a Grade 5 liver injury with massive hemorrhage. Operative intervention was initiated immediately and a non-anatomic left lobectomy with hepatorrhaphy was performed. IR was consulted intra-operatively and performed a left hepatic artery angioembolization. The patient received over 50 units of blood products during the combined procedures, with eventual bleeding control. On post-operative day 33, the patient became acutely hemodynamically unstable, and angiography revealed a splenic artery pseudoaneurysm, which was embolized but re-bled and resulted in splenectomy. The patient eventually recovered and follows up at 1-year revealed a patient doing well.

Discussion: High-grade liver injuries carry significant mortality. Mortality worsens when severe shock is present. Operative intervention is the standard approach for patients who remain in shock. To help improve outcomes patients may benefit from a combined approach with the interventional radiology team.

Conclusion: The acute management of severe liver injuries when presenting with ongoing shock is beneficial to include both trauma surgeons with interventional radiologists. Further studies are needed to determine the best approach for this devastating injury.

1. Introduction

Penetrating abdominal trauma (PAT) injuries are complex and high-risk requiring time-sensitive decisions in order to provide efficient care. Emergent operative exploration is warranted in cases of hemodynamically unstable patients and individuals with diffuse peritonitis.

Stab wounds (SWs) are low-velocity insults that often occur at close range, whereas gunshot wounds (GSWs) are higher-energy injuries that can result in serious tissue destruction. Historically, SWs have been associated with a higher rate of non-therapeutic laparotomy, and therefore level 2 evidence suggests that routine laparotomy is not indicated in hemodynamically stable patients without signs of peritonitis or diffuse abdominal tenderness [1].

Alternatively, PAT secondary to GSWs requires thorough clinical evaluation to identify the possible injuries promptly. The patient's physiology may permit the acquisition of imaging studies to help guide operative decision-making by radiographically delineating the path of the ballistic. However, the physical behavior of the ballistic itself may make these injuries difficult to define both anatomically and radiographically. The factors that determine these pathways include the anatomy of the entrance wound, the shape of the bullet, and its velocity [2]. Ultimately, defining the trajectory of the injury is necessary to

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dictate the definitive management.

Furthermore, the energy transfer associated with the temporary cavitation caused by high velocity GSWs can cause tissue destruction remote from the bullet trajectory [3]. In PAT, these cavities can involve solid organs, hollow viscus, and vasculature, and can result in pseudoaneurysms (PSAs), bullet embolism, and lead toxicity [4,5]. PSAs can result from direct injury or irritation from retained ballistics. Bullet emboli have been reported in the heart, pulmonary, femoral, and popliteal arteries. These complications may present in a delayed and catastrophic fashion and should be considered with penetrating trauma secondary to GSWs.

This case report discusses the workup of GSWs to the liver with associated class 4 hemorrhagic shock and a grade 5 devastating liver injury. Liver injuries can challenge even the most seasoned surgeon. The mortality associated with grade 5 liver injuries has been reported between 65 and 80 % [6–8]. Our patient underwent exploratory laparotomy for a GSW to the abdomen and was found to have Grade 5 liver injury and later a delayed rupture of a splenic PSA. Multiple in-patient events of hemorrhagic shock required operative exploration as well as rapid transfusion of blood products. This case highlights not only the need for rapid operative decision-making but also for prompt initiation of a massive transfusion protocol (MTP) in the setting of hemorrhagic shock. This case was reported in line with the SCARE criteria [9].

2. Case presentation

A 25-year-old male patient presented to the emergency department with a GSW to the right upper quadrant. He was hypotensive and tachycardic with altered mental status; findings consistent with class 4 hemorrhagic shock. Advanced Trauma Life Support (ATLS) protocol was undertaken, and an MTP was initiated. Focused Assessment with Sonography in Trauma (FAST) was positive for intra-abdominal fluid. The patient was taken emergently to the operating room for an exploratory laparotomy. A Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) was not undertaken, due to uncertainty of a severe chest injury. Upon entry to the abdomen, massive hemoperitoneum was revealed. The quadrants were subsequently packed with laparotomy pads. A devastating injury was found on the left lobe of the liver (Fig. 1). Initial suture hepatorrhaphy and packing did not control bleeding. In response, a non-anatomic partial left hepatic lobectomy was undertaken. Despite numerous mechanisms to control bleeding there was still hemorrhage throughout the shattered liver parenchyma. Intra-operative IR consultation was requested and angioembolization of the left hepatic artery to control the bleeding was performed. During treatment, the patient was transfused with 12 units of PRBCs, 11 units of FFP, 3 “six packs” of platelets, and 1 Cryoprecipitate. On postoperative day (POD) 1, the patient underwent a second laparotomy with abdominal washout, further left lobe debridement for necrotic tissue, and closure of the abdominal wall.

On POD 2, the patient developed Acute Respiratory Distress Syndrome (ARDS) and on POD 4 the patient also developed acute kidney injury requiring hemodialysis. The patient slowly improved but on POD 33, from the index operation, during preparations for discharge the patient became acutely unstable, with tachycardia, hypotension, and altered mental status. An MTP was again initiated, and a bedside FAST examination was grossly positive for free fluid. The patient was urgently taken to the operating room and an emergency exploratory laparotomy revealed a massive hemoperitoneum with no clear source. The abdomen was closed with a temporary vacuum dressing and the patient was transported to the IR suite. IR identified a PSA of the proximal splenic artery, which was embolized. During these procedures an MTP was initiated resulting in the patient receiving 20 units PRBC, 17 units FFP, 3 “six packs” of platelets, and 1 Cryoprecipitate.

On POD 5 from this operation (POD 38 from index surgery), the patient developed hypotension, tachycardia, and abdominal pain. FAST was again positive and the patient again underwent an emergent abdominal exploration and an MTP. During this operation, a bleeding spleen was encountered, and a splenectomy was performed. MTP was initiated and the patient received 45 PRBC, 20 FFP, 4 Platelets, and 5 Cryoprecipitate. Following the serial laparotomy for abdominal washout post splenectomy–delayed abdominal closure was performed. On hospital day 102 the patient's patient was taking an oral diet and ambulating and was discharged. Follow-up a year later showed the patient to be doing well, with no residual issues.

3. Discussion

Traumatic injuries when accompanied by shock require immediate assessment and intervention to optimize the chances of survival. Professor Richard Cowley defined the first 60 min after an injury as the “golden hour”, the period when the majority of trauma deaths occur. Approximately 80 % of deaths occur within the first few hours of injury secondary exsanguination or traumatic brain injury [10]. In an effort to conserve time, ATLS algorithms approach the trauma patient in an

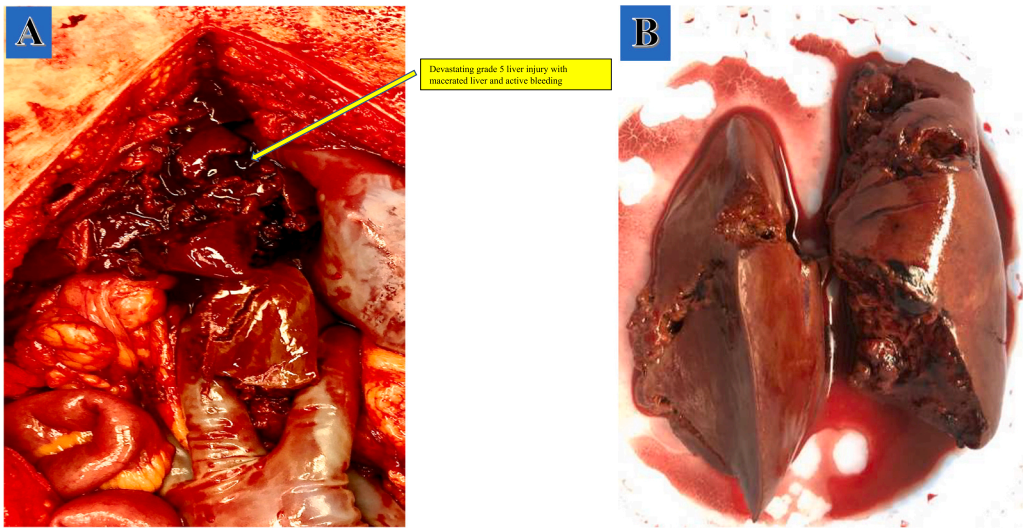

Fig. 1. A) Intraoperative view of the abdomen following exploratory laparotomy due to gunshot wound (GSW) resulting in grade-V liver laceration involving both left and right lobes with macerated liver and signs of active bleeding.
B) Partial non-anatomic liver lobe resection involving devitalized, lacerated parts of the liver following a GSW to the abdomen.

organized manner to quickly identify imminent threats to life by use of the mnemonic ABCDE ("A" - Airway, "B" – Breathing, "C" – Circulation, "D" – Disability, "E" – Exposure/Environment) in the primary survey. Evaluation then proceeds to the secondary survey but is interrupted at any point in patient decompensation and subsequent reevaluation of the ABCs is performed.

With the exception of flank and tangential subcutaneous ballistic injuries, PAT differs from the workup of blunt abdominal trauma (BAT) in that injuries are more commonly operative. GSWs should be rapidly evaluated to determine serious injuries. Plain radiography can assist in locating the anatomical regions of retained ballistics and help guide operative planning, especially in thoracoabdominal injuries. However, hemodynamically stable patients may be appropriate for CT evaluation. One study identified solid organ injuries, with no evidence of hollow viscus injury in 28.3 % of patients with PAT. It was concluded that selective nonoperative management of these patients has a high success and low complication rate [10].

Although PAT to solid organs may in properly selected patients be managed non-operatively, these injuries need to be carefully screened and graded, especially when involving the liver. Of hepatic trauma, 80–90 % are Grade 1 or 2 injuries, furthermore, mortality increases with the grade of injury [11]. However, the severity of the injury on a CT scan does not uniformly predict the need for operative intervention [12]. The presence of associated injuries may determine the need for laparotomy with one study concluding that associated injuries including the diaphragm (39.3 %), stomach (30.9 %), and colon/rectum (29.2 %) are more common in patients with GSWs rather than SWs (88.0 % vs 60.4 %) [12]. Failure to identify hollow viscus injuries can lead to sepsis. Therefore, some centers recommend contrast-enhanced CT scans in hemodynamically stable patients without signs of peritonitis on index evaluation to not only define the degree of the hepatic injury but the presence of active bleeding, PSAs, thoracoabdominal and hollow viscus injuries [12].

Successfully achieving hemostasis as rapidly as possible is critical in producing positive patient outcomes. Kataoka et al. discuss the benefits of hybrid treatment of emergent surgery combined with intraoperative IR [13]. The investigation of over 60 severely injured patients found that this hybrid treatment strategy led to improved patient outcomes, by effectively reducing therapeutic damage and preserving organ functions [13]. The case study highlighted in this article also emphasizes the importance of rapid intervention of emergent surgery in combination with intraoperative IR. This treatment strategy in GSW patients with grade 5 liver injuries should be further investigated in order to implement guidelines on the role of intraoperative IR.

Furthermore, this case report highlights a highly unusual complication of PAT. This patient suffered the rare complication of traumatic splenic PSA in the absence of trauma to the spleen, which became evident 33 days after the index injury. PSAs of the splenic artery are extremely rare and deadly. There is a disparity in the literature describing the incidence, complications, and risk factors of this important clinical finding. Splenic PSA is most commonly attributed to chronic pancreatitis and blunt abdominal trauma [14,15]. One study identified delayed splenic vascular injury in 23 % of patients by repeat CT scan of the abdomen 48 h after the index injury in patients with Grade 2 injuries and higher [16]. Although these findings suggest the need for the development of guidelines to rule out the development of this potentially fatal complication, the patient presented in this case report had a definitive absence of splenic injury by radiographic and multiple exploratory laparotomies.

Even more interesting is that splenic PSA after trauma most commonly develops from blunt injuries, thought to be secondary to a deceleration injury and damage to the layers of the arterial wall [14]. Most commonly, patients present with abdominal pain (29.5 %), hematochezia or melena (26.2 %), hemorrhage into the pancreatic duct (20.3 %), and hematemesis (14.8 %) [15]. Management options include embolization, but splenectomy usually with distal pancreatectomy, is another treatment option but the specimen must include the PSA [14]. Although this patient underwent prompt intervention, failure of angioembolization resulted in subsequent hemorrhage and near-fatal shock.

To our knowledge, failure of angioembolization requiring subsequent splenectomy for devastating hemorrhage has not been reported in the literature. Studies have reported splenectomy for post-embolization complications such as persistent intra-parenchymal PSA and abscess formation with overall reported 90–100 % success rates of IR management [16–18]. Reported major complications of splenic angioembolization include bleeding, infarction, or abscess formation in the spleen as well as contrast-induced nephropathy, and minor complications have included fever, pleural effusions, and coil migration [17]. There are currently no practice management guidelines available from nationally recognized trauma societies to guide clinical decision-making in the presence of splenic PSA or the complications that may arise after blunt or penetrating trauma.

4. Conclusion

This case report emphasizes the management of complex hepatic trauma and the rare presentation of delayed splenic PSA after penetrating trauma. As previously mentioned, the lack of scientific society-based guidelines for penetrating hepatic injury with the evolution of selective nonoperative management complicates decision-making and represents the need for the review and development of clinical algorithms. Similarly, there is a wide disparity of studies addressing the complication of splenic pseudoaneurysm after trauma for both blunt and penetrating injuries and no evidence-based guidelines exist to screen for nor manage these complications. Both of these complex management issues should be addressed, by engagement with scientific societies to create a consensus and practice management guidelines.

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Ethical approval

This is a case report study. Informed patient written consent has been obtained and all identifying information was omitted.

Consent

Informed patient written consent has been obtained and all identifying information is omitted.

Author contribution

DB, MM, MC, AE – Conception of study, acquisition of data, analysis, and interpretation of data.

DB, MM, MC, AE – Drafting the article.

DB – Management of case.

DB, MM, MC, MN, AE – Critical revision of the article and final approval of the version to be submitted.

Registration of research studies

Not applicable.

Guarantor

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Declaration of competing interest

None.

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