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Blunt inferior vena cava injury associated with AAST-grade V hepatic and renal injuries: A case report

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Abstract
A 56-year-old female patient presented with right chest and upper abdominal pain in a motorcycle accident. Hypotension and low blood hemoglobin were noted. Contrast-enhanced multi detector computed tomography showed hemoperitoneum, retroperitoneal hematoma, injury of the retro hepatic and suprarenal segments of inferior vena cava, grade V hepatic injury, and grade V right renal injury involving the right main renal vein according to the American Association for the Surgery of Trauma. The surgeon repaired the inferior vena cava, ligated the right renal vein, and packed the liver laceration with pads and gauzes during emergency exploratory laparotomy. The condition remained stable until repeated active bleeding of the liver laceration occurred on the 20th post-operative day, which was successfully managed by trans arterial embolization. The patient was discharged with an eventful course on the 41st hospitalization day.

Keywords: Blunt abdominal trauma, inferior vena, cava injury

Introduction
Traumatic inferior vena cava (IVC) injury is rare, occurring in 0.5-5% and 1% of penetrating and blunt abdominal trauma respectively [1]. IVC injuries have a grave prognosis, with mortality rates ranging from 34% to 70% [2]. IVC injuries are generally combined with injuries to the adjacent organs and vessels [3]. Survival in IVC injuries is related to three factors: major vessel injury, level of IVC injury, and any active bleeding during surgery, with the last factor most crucial [2]. Infrarenal IVC injury has the lowest mortality rate (23%) [4], while suprahepatic IVC injury reaches a mortality rate of 100% [2]. Prompt surgical intervention and bleeding control to lower shock period are imperative for improving the survival rate [4]. Contrast-enhanced computed tomography (CT) is the gold standard to evaluate the hemodynamic ally stable patients for the level of IVC injury and injuries to the other vessels and organs [1, 3]. Herein, we present a case of major trauma in a 56-year-old female patient experiencing CT-diagnosed suprarenal and retro hepatic IVC injury, grade V hepatic injury, and grade V renal injury involving tear of the right main renal vein according to the American Association for the Surgery of Trauma (AAST) [5].

Case report
A 56-year-old female patient was a motorcycle rider and suffered from a collision with an automobile in a traffic accident. Right chest and upper abdominal pain and abrasion of right arm and right leg were noted when the patient was sent to the emergency room by an ambulance. The blood pressure was 109/58 mmHg. The blood hemoglobin was 9.1 g/dL. An operation history of subtotal gastrectomy with Billroth-II anastomosis for gastric perforation was noted. Contrast-enhanced 64-row contrast-enhanced multi detector computed tomography (MDCT) of the chest and abdomen revealed hyper dense hemoperitoneum, right retroperitoneal hematoma, a patchy and hypodense lesion with a focal area of extravasation of contrast medium representing active bleeding in the posterior segment of right hepatic lobe, a hypo dense lesion in right renal parenchyma associated with extravasated contrast medium from the right main renal vein, and luminal narrowing and wall irregularity of the retro hepatic and suprarenal segments of the IVC (Fig. 1). Therefore, CT diagnosis of injury of the retro hepatic and suprarenal segments of IVC, grade V hepatic injury, and grade V renal injury involving the right main renal vein according to the AAST was made. Fractures of the right first to eight ribs with right hemothorax were noted. Radiographs of the right upper arm and forearm showed fractures of right proximal humeral shaft and right middle ulnar shaft.

Due to the active bleeding of aforementioned intraabdominal organs, emergency exploratory laparotomy was performed. Liver dome laceration, tear of the right main renal vein, and a 7 cm longitudinal tear at the anterior aspect of the retro hepatic and suprarenal segments of IVC were unveiled. Massive hemorrhage in the intraperitoneal and right retroperitoneal cavities was identified. A total blood loss of 5000 mL was found. Repair of the inferior vena cava, ligation of the right renal vein, and hepatorrhaphy and packing of the lacerated liver with pads and gauzes were performed by a surgeon. In the perioperative period of the first 2 days, a total amount of 66 U packed red blood cells (pRBC) and 80 U fresh frozen plasma (FFP) were transfused. Surgical plate and screw fixation of the right humeral and ulnar fractured sites was carried out on the 9th post-operative day when the patient was in a stable condition. However, progressive dyspnea was noted on the 12th post-operative day. Chest radiograph showed radiopacity of right lung. Ultrasonography revealed massive anechoic fluid in the right pleural space causing passive atelectasis of right lower lobe of lung. Therefore, a 10F pigtail catheter was placed into the right pleural fluid which came out to be hemothorax. The symptom of dyspnea relieved. On the 20th post-operative day, severe right upper abdominal pain and hypotension (88/50 mmHg) were noted. The blood hemoglobin was 5.8 g/dL. After volume repletion and aggressive resuscitation, the patient was hemodynamic ally stable, and repeated contrast-enhanced CT of the abdomen was performed. It showed massive hemoperitoneum and a focal area of extravasated contrast medium representing active bleeding in the previous liver laceration site (Fig. 2a). Angiography of the hepatic artery showed a focal area of extravasation of contrast medium in the superior posterior segmental branch of right hepatic artery, which was successfully emboli zed with gelfoam pledgets through super selective catheterization of the offending arterial branch by using a micro catheter (Fig. 2b and 2c). Transfusion of a total amount of 10 U pRBC and 8 U FFP was performed in the following 2 days. The patient was discharged in a stable condition after 41 days of hospitalization.

Fig 1: a) Contrast-enhanced CT images are obtained. (a) The axial image at the diaphragmatic level reveals a focal area of hyper dense extravasated contrast medium (black arrows) in the hypo dense liver laceration in the posterior segment of right hepatic lobe, hemoperitoneum (white arrows), and fracture of right posterior 8th rib (circle).

Fig 1: b) The coronal reformatted image shows extravasated contrast medium (black arrows) from the right main renal vein (open arrow), retroperitoneal hematoma (ladder arrows), and hemoperitoneum (white arrows).

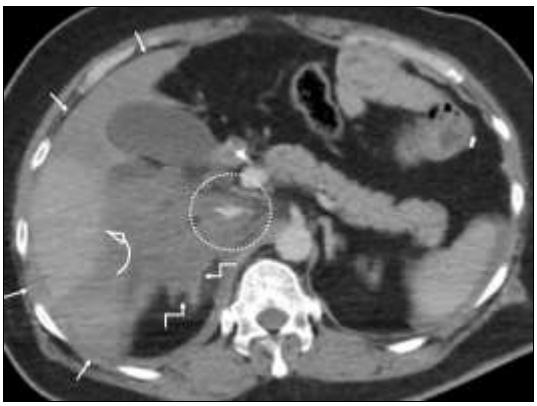

Fig 1: c) The axial image at the level of left adrenal gland demonstrates narrowing and anterior wall irregularity of the inferior vena cava (dotted circle), retroperitoneal hematoma (ladder arrows), and hemoperitoneum (white arrows) surrounding the contrast-enhanced liver parenchyma (curved arrow)

Fig 1: d) Sagittal reformatted image unveils anterior wall irregularity and narrowing of the retro hepatic and suprarenal segments of the inferior vena cava (dotted line rectangle)

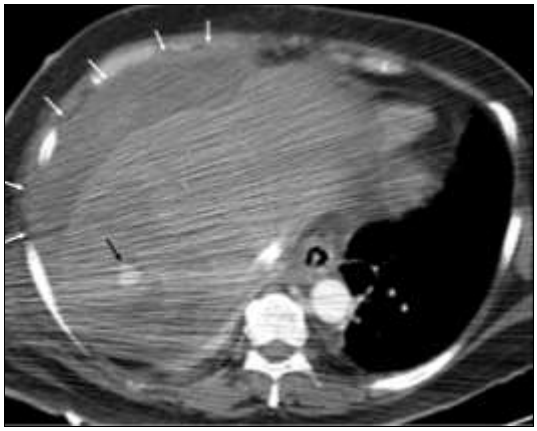

Fig 2: a) Contrast-enhanced CT with axial image performed on the 20 post-operative day shows a focal area of extravasated contrast medium (black arrow) in the hypo dense laceration in the posterior segment of liver, associated with massive hemoperitoneum (white arrows). Beam-hardening artifact is seen due to the right arm placed beside the body of the uncooperative patient

Fig 2: b) Emergency angiography with super selective catheterization of the posterior superior segmental branch of right hepatic artery shows a focal region of extravasated contrast medium (black arrow).

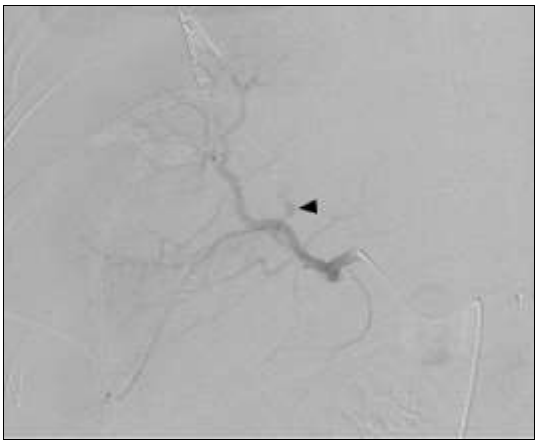

Fig 2: c) Angiography of the right hepatic artery after embolization with gel foam pledgets reveals occlusion of the posterior superior segmental branch of right hepatic artery (black arrowhead) and no more visualization of extravasated contrast medium

Discussion

Blunt caval injury is a rare and potentially life-threatening event, with more than one-third of patients died on hospital arrival, another 50% of patients die in the first 48 in-hospital hours due to hemorrhagic problems [6]. Blunt trauma is an uncommon cause of IVC lesion with a high in-hospital mortality (70%) [7]. The blunt caval injury has a higher mortality than the penetrating injury because the shearing forces produced by the blunt trauma may lead to more irregular lacerations of the IVC and contribute to active bleeding and contour abnormalities [2].

According to the levels of the IVC, it is divided into five segments: the supra hepatic IVC between the right atrium and the confluence of the hepatic veins, the retro hepatic IVC between the hepatic venous confluence and right suprarenal vein, the suprarenal IVC from the right suprarenal vein to the left renal vein, the renal segment between the left and right renal veins, and the infrarenal segment from the right renal vein to the iliac bifurcation [2]. The closer the injuries to the right atrium, the higher the mortality will be [3]. Therefore, the mortality rate is approaching 100% for the injury to the supra hepatic IVC because the thoracic and abdominal cavities are involved simultaneously, and exposure and hemostasis are difficult to be archived in the presence of diaphragmatic muscle [2, 3]. On the other hand, injury to the infrarenal segment of IVC is associated with the lowest mortality rate (23%) due to an easy approach to stop bleeding [3, 4]. With retrohepatic caval injury, associated severe liver laceration is often seen [6]. It is important to note that hepatic laceration is upgraded to grade V in the presence of retrohepatic IVC injury, and laceration of the main renal vein upgrades the renal laceration to grade V according to the AAST [5], as shown in the present case.

The survival of injury to the IVC is determined by the three main factors: the major vessel injury, the level of IVC injury, and any active bleeding during surgery [2]. The main cause of death is due to uncontrollable intraoperative hemorrhage [1]. All the three factors were present in our cases, so-called laceration of the right main renal vein, injury of the higher levels of IVC (suprahepatic and suprarenal segments), and active bleeding from the liver laceration and the major vessels which caused massive hemoperitoneum and retroperitoneal hematoma. These posed a great challenge to the surgeon to achieve hemostasis during surgical intervention. Other factors which influence the mortality rates include the competence and emergency facility of the hospital, blood volume in the blood bank, and the surgeons' skills [3].

Hemodynamic ally unstable patients in the setting of the major vascular injury need emergent laparotomy [2]. Contrast-enhanced CT of the chest and abdomen is reserved for the patients in hemodynamic ally stable condition, and is the gold standard for the evaluation of the patients with IVC injury and associated other chest and intraabdominal injuries including rib and spine fractures [1]. The CT signs for traumatic IVC injuries include active extravasation of contrast medium, retroperitoneal hematoma, IVC contour abnormality, intimal flap or thrombosis, intracaval fat, and hemoperitoneum [2]. Sometimes, extravasation of the caval contrast medium may not be seen due to the low caval pressure or tamponade effect from the adjacent structures or hematoma [6]. In the case presented here, the contour irregularity and the adjacent retroperitoneal hematoma are the only CT signs of the IVC injury.

Surgical repair of IVC is needed for IVC injury [1, 3]. In case of severe IVC injury, ligation of the IVC may be considered.

Ligation of the renal vein may be required for laceration of the renal vein, as shown in our case. Ligation of the renal vein may cause transient acute kidney injury but shows recovery of renal function after a period due to adequate collaterals [8, 9]. This is a safe procedure for not sacrificing the kidney in a traumatic event. In our case, the blood creatinine level of the patient was 0.57 mg/dL at the emergency room, up to 7.23 mg/dL on the 10th

day post-ligation of the right renal vein, and down to the normal value (0.46 mg/dL) on the 30th day.

For liver trauma, nonoperative management is the treatment of choice in the hemodynamic ally stable patients [10]. Trans arterial embolization (TAE) is recommended for clinical suspicion of hepatic arterial injury. TAE can improve the success rate of the nonoperative management and is well tolerated by most patients. Through super selective technique to catheterize the offending hepatic artery with micro catheter system, the complication rate and the occurrence of hepatic necrosis are low. TAE can be considered in patients with clinical evidence of ongoing bleeding, contrast extravasation visualized on CT scan, or suspicion of arterial bleeding despite surgery.

In conclusion, IVC injury is a rare event of IVC lesion with a high mortality rate. Direct CT sign of IVC injury (i.e., extravasation of contrast medium) may not be present. Indirect CT signs including wall irregularity of IVC and retroperitoneal hematoma may be the only imaging appearances suggestive of IVC injury and should be interpreted with a high index of suspicion. Associated adjacent organ and vascular injuries may be present. Prompt surgical intervention and bleeding control are crucial for patient survival.

Conflict of Interest
Not available

Financial Support
Not available

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