Surgical management of a retrohepatic inferior vena cava injury following blunt abdominal trauma

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ABSTRACT

The clinical scenario of a 3 year-old child who sustained a retrohepatic inferior vena cava injury following blunt abdominal trauma is reported. The presentation, evaluation, and surgical management are discussed.

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Blunt abdominal trauma is common in the pediatric population with the liver being the most commonly injured solid organ [1]. Blunt injury to the inferior vena cava (IVC) is rare with poor overall outcomes [2–4]. Several surgical options have been reported, including use of the atirocaval shunt, endovascular repair, and hepatic packing [5–8]. This case report discusses the clinical scenario of a 3 year-old child who sustained a retrohepatic IVC injury from blunt abdominal trauma. The presentation, evaluation, and surgical management of this challenging injury are discussed.

1. Case report

This is the case of a 3 year-old female who arrived unresponsive by emergency medical services (EMS) to our emergency department (ED). The mother stated that she had been found unconscious at her father’s house between her bed and the radiator. The EMS technician had placed a right tibial intraosseous (IO) line and initiated fluid resuscitation. Her initial vital signs were: temperature 34.7 °C, heart rate (HR) 139 beats per minute (bpm), blood pressure (BP) 61/52 mm Hg. The ED treating physician initiated a medical code response. On primary survey her airway was noted to be patent, but not guarded due to depressed mentation. She was breathing spontaneously with normal bilateral breath sounds and was found to be tachycardic with weak pulses and cool extremities. Her Glasgow coma scale (GCS) was noted to be 3. She underwent rapid sequence intubation and a left femoral central venous catheter was placed to assist in resuscitation. A post-intubation chest X-ray (CXR) was performed and demonstrated the endotracheal tube to be in good position without evidence of a hemo- and/or pneumothorax.

Upon secondary survey, multiple contusions were noted on the torso, as well as a markedly distended abdomen and swollen right thigh. Initial arterial blood gas (ABG) revealed: pH < 6.630, CO2 64.3 mm Hg, O2 81 mm Hg, base deficit of 27 mmol/L, and hemoglobin (Hgb) of 3.4 g/dL. Four units of emergency release packed red blood cells (pRBCs) were issued and given through rapid infusion resulting in improvement of her vital signs to: HR 124 bpm, BP 95/56 mm Hg. Repeat ABG revealed: pH 7.23, CO2 40.6 mm Hg, O2 389 mm Hg, base deficit 10 mmol/L, and Hgb 7.5 g/dL. A social worker had been interacting with the family since arrival to the ED and discovered that the father had beaten the child with a belt for urinating in her pants earlier in the day. After responding to initial resuscitation, the patient was taken to radiology for a computed tomography (CT) scan and the trauma team was activated due to suspicion of non-accidental trauma (NAT).

CT scans of the head, thorax, abdomen, and pelvis were obtained. No acute injuries were noted on head and thoracic imaging.
The CT scan of the abdomen and pelvis revealed massive hemo-
peritoneum with active hemorrhage from the inferior margin of the
liver and the lower pole of the spleen. Most notable was a retro-
hepatic hematoma with active extravasation of contrast extending
from the retrohepatic IVC (see Fig. 1). In addition, findings of diffuse
bowel wall edema consistent with global ischemia (shock bowel),
pancreatic shock, and perirenal hemorrhage of the right kidney
were noted.

A clinical dilemma was reached: continue non-operative man-
agement in the pediatric intensive care unit (PICU), consult inter-
ventional radiology regarding endovascular options, or proceed to
the operating room (OR) for an abdominal exploration. Although
initially responsive to fluid administration, her vitals became
increasingly unstable with ongoing resuscitation necessitating
operative intervention. In the operative suite, additional IV access
was obtained above the diaphragm. The abdomen and chest were
prepped and draped. A midline laparotomy was performed with
immediate eruption of massive hemoperitoneum upon entry. All
four quadrants of the abdomen were tightly packed with laparot-
omy pads then systematically investigated. A large amount of blood
was noted welling up from the retrohepatic area of the liver.
Additionally, a large right Zone II hematoma was noted that
extended from the liver to the pelvic brim. However, this hematoma
was not expanding, and therefore not explored. The lesser sac was
entered through the gastrocolic ligament where blood was evacu-
ated and a superficial laceration to neck and body of the pancreas
was noted. Small splenic and hepatic lacerations were also noted.
Evaluation of the bowel demonstrated a superficial sigmoid colon
contusion and shock bowel of the entire small intestine. The
abdomen was tightly packed taking care to compress the liver
against the spine as well as place packs in the lesser sac, and along
the retroperitoneum. Due to the amount of packing and the severity
of shock bowel present, a large, rudimentary negative pressure
vacuum dressing (VACPAC) was placed.

At this point, the patient was in fulminant disseminated intra-
vascular coagulopathy (DIC) and bleeding from all orifices (mouth,
nares, nasogastric tube, rectum), IV sites, as well as the VACPAC. She
was taken to the PICU for continued critical care management and
resuscitation, mainly, rewarming, correction of her coagulopathy
and ongoing acidosis. Over the course of her resuscitation, she
would receive 31 units of pRBCs, 35 units of fresh frozen plasma
(FFP), 22 units of platelets, 4 units of cryoprecipitate, and 4 doses of
recombinant factor VIIa (90 mcg/kg/dose). For several hours post-
operatively she continued to have bloody VACPAC drainage that
made maintenance of abdominal containment difficult. The
VACPAC was continually modified by adding sponges drained by
suction tubing with overlying 3M™ Ioban™ 2 antimicrobial drapes
(3M, St. Paul, MN, USA) to the edges of the previously placed
dressing as needed to maintain negative pressure. This resulted in a
large VACPAC draining from multiple sites as seen in Fig. 2.

With resuscitation, her body temperature normalized, acidosis
resolved and coagulation profile corrected. We attempted to wait
until post-injury day (PID) 2 to return to the OR for a second look,
however, evidence of abdominal compartment syndrome required
re-exploration on PID 1. The abdominal packing was removed; no
further bleeding was seen at the spleen and the retroperitoneal
hematoma did not have any evidence of expansion. There was still
bleeding observed from the retrohepatic area of the liver. The liver
was repacked tightly and a new VACPAC dressing was placed. Upon
returning to the OR on PID 2 and removal of the packing, only
bleeding at the liver edge was noted and easily controlled with
cauterization. Over the course of the next 2 weeks, the VACPAC was
intermittently changed until PID 14 when the abdomen was closed.
No additional bleeding was noted at the liver or spleen. Slight
saponification was noted within the lesser sac; however, no sig-
ificant injury of the pancreas was seen. A closed suction drain was
placed within the lesser sac and brought out percutaneously. The sigmoid colon contusion was stable and the shock bowel had resolved without evidence of necrosis. The fascia was closed primarily with interrupted absorbable monofilament suture and the skin closed using staples.

The patient required critical care management of ongoing medical problems and remained in the PICU for 35 days. She was ventilator dependent for just over 3 weeks, which was felt to be due primarily to the massive amount of blood products that she received during her resuscitation. Only conventional ventilation was required with gradual improvement of her respiratory status and eventual extubation. Acute kidney injury was identified postoperatively with the peak of serum creatinine of 3.3 mg/dL on PID 7. Treatment included judicious fluid management and vigilance of medication dosing. Parenteral nutrition was implemented on PID 2 and continued until the patient was tolerating full goal enteral feeds on PID 29. In order to prime the gut, enteral glutamine (0.5 g/kg/day) was given via nasogastric (NG) tube from PID 6–PID 12. Enteral feeds with a mixture of Peptamen Junior® (Nestlé HealthCare Nutrition, Inc., Florham Park, NJ, USA) and Peptamen AF® (Nestlé HealthCare Nutrition, Inc., Florham Park, NJ, USA) were started on PID 13 and initially given through a nasojejunal (NJ) tube, bypassing the injured pancreas. With time, the amylase- and lipase-rich drain output decreased to less than 5 ml per day. Follow-up abdominal ultrasound (US) was performed and demonstrated no evidence of intra-abdominal fluid collection, and the drain was removed on PID 41. Enteral nutrition was transitioned to the NG route and oral feeds initiated on PID 34. The child was discharged from the hospital receiving nocturnal NG supplemental nutrition with ad-lib oral feeding during the day.

Social workers were present at the initial evaluation in the ED. They were instrumental in elucidating suspected non-accidental trauma and appropriately involved law enforcement officials. During the child’s stay, the Suspected Child Abuse and Neglect (SCAN) team played an important role ensuring that the child had a safe home and environment in which to return. Physical, occupational, and speech therapists were consulted within the first week of the child’s hospital course and continued to treat her throughout her in-patient hospital stay and then at home on an outpatient basis. Although, the Physical Medicine and Rehabilitation (PM&R) team was consulted and found the child to be an appropriate candidate for inpatient rehabilitation, she was discharged to home on PID 55 with outpatient therapy. A timeline of events is seen in Fig. 3.

2. Discussion

The majority of blunt liver trauma in children can be managed non-operatively [9], however, in an unstable patient, damage control management with hepatic packing and temporary abdominal closure is well described [6,10–12]. In the presence of coagulopathy, acidosis, and hypothermia, this has been found to be a life saving maneuver and is now considered the standard of care. The liver can be packed against the retroperitoneum using laparotomy pads with the abdomen closed in a temporary fashion. The patient is then transported to the intensive care unit where aggressive re-warming, coagulation factor repletion, and correction of the acidosis are performed. Once the child has stabilized, he/she is taken back to the operating room for re-exploration. If feasible, the packing is removed and the abdomen closed. Often the packing needs to be replaced due to continued bleeding. This should be repeated until the bleeding stops or the patient is stable enough to undergo a formal operation when indicated to obtain hemostasis. Of the first series of pediatric patients described by Stylianos in 1998 to have undergone damage control hepatic packing, 82% were able to have their packing removed within 72 h [11]. Markley et al. described children at their institution that underwent damage control procedures and found that they had temporary abdominal closure for a mean of 8 days (range 3–21 days) [13].

Injuries of the vena cava carry a high mortality rate, with as many as 50% of the patients dying at the scene and 20–60% of those patients lucky enough to make it to a hospital ultimately succumbing to their injury [3]. In these patients, death most often occurs due uncontrollable intraoperative hemorrhage [5,14]. The trauma literature contains multiple studies that describe different approaches for repair of these injuries [2,3,5–8,14–16]. Major retrohepatic vascular injuries are rare but not unknown in pediatric patients. In 1991 Moulton described a series of children with such injuries [16] and compared their treatment of primary cava repair using an atriocaval shunt after laparotomy to those with a sternotomy first approach. Their study included children treated
between 1984 and 1990. Early in their cohort they would perform a laparotomy, and place an atrio caval shunt once this type of injury was recognized, then primarily repair the injury. This resulted in an abysmal survival rate of 14%. In 1987, when this injury was suspected, they would first perform a sternotomy with placement of an atrio caval shunt. They would then proceed with the laparotomy to repair the injury with an improved survival rate of 80%, however, with a significant amount of morbidity.

There are several reports of non-operative management of retrohepatic vena cava injuries in both the adult and pediatric populations [3,9,17–20]. The common clinical finding in the patients described was stabilization of their vital signs after resuscitation without additional indications for surgical intervention. This approach could not have been taken in our reported case. Although she initially responded to resuscitation, she decompensated to the point that surgical intervention was required. Due to a delay in arrival to the hospital and a delay in recognition that the injuries were sustained as a result of NAT, she was already hypothermic, acidic, and coagulopathic by the time she arrived to the OR. With the findings on the CT scan as well as a large retrohepatic hematoma, it was felt that the injury must be due to a retrohepatic IVC injury and any attempt at repair in her condition would lead to exsanguination. Therefore, perihematomal packing and temporary abdominal closure was employed. However, this was only the beginning of her surgical intervention, as over the course of the next several hours her VAC-PAC would require continual modification by the surgical team to maintain abdominal domain. This was felt to be the best course of action until the abdomen is closed [22]. Meeting nutrition requirements is extremely difficult and only partially ameliorates the hypermetabolic state characterized by a host of metabolic changes that are directly proportional to the degree of injury and lead to muscle proteolysis, acute protein malnutrition, and impairment of the immune system. The large open wound associated with an open abdomen acts a catabolic drain with those patients representing one of the sickest and most impaired and catabolic of all surgical patients [21]. The proinflammatory cascade contributing to this hypermetabolic state continues until the abdomen is closed [22]. Meeting nutrition requirements is extremely difficult and only partially ameliorates the hypermetabolic state and prevention of muscle protein loss. In the case of this child, it was made even more difficult by an acute kidney injury.

Throughout her entire PICU stay (35 days), the patient received an average of 85.5% of ordered nutrition (71–75 kcal/kg), or 60–64 kcal/kg. As resuscitation needs to be completed prior to provision of nutrition, if the first 48 h of the patients PICU stay are excluded, her average intake was actually 90.7% or 64–68 kcal/kg. Estimated weight at admission was 15 kg. Weight peaked at 22.9 kg (PID 2) and was 15.7 kg upon discharge from the PICU, representing an average weight gain of 20 g/day. Prealbumin and albumin were respectively 12.9 mg/dL and 2.9 g/dL on PID 4 (with a C-reactive protein of >9.0) and then 37.8 mg/dL and 3.9 g/dL upon discharge from the PICU. Both weight trends and labs were indicative of adequate provision of nutrition support during her prolonged hospitalization. Although the child was discharged from the hospital with ad lib oral feeding during the day and nocturnal NG supplemental nutrition, by PID 110 she was growing normally without NG supplementation or residual gastrointestinal complaints.

3. Conclusion

The initial exploration and hepatic packing was a life saving maneuver, however, her ultimate recovery was the result of a multidisciplinary approach to care, including the trauma and PICU teams, trauma dietitian, social workers, physical and occupational therapists, speech therapists, dedicated nurses, child life specialists and ancillary staff. This case report highlights several important points: first, beware of trauma masquerading as a medical code. Non-accidental trauma should always be in the differential in a young child who presents unresponsive to the emergency department. Second, although non-operative management is frequently appropriate in the stable pediatric patient with blunt abdominal trauma, surgeons should not have tunnel vision in this respect. This standard doesn’t always apply to each individual patient situation, and delay of timely operative intervention in those patients who require it can be disastrous. Finally, as demonstrated by this case, the damage control surgical approach remains a good strategy in certain cases of pediatric trauma.

References