Traumatic bile leaks from blunt liver injury in children: A multidisciplinary and minimally invasive approach to management

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Abstract

Background: Selective non-operative management (NOM) of hemodynamically stable pediatric patients with blunt hepatic trauma is the standard of care. Traumatic bile leaks (TBL) are a potential complication following liver injury. The use of endoscopic retrograde cholangiopancreatography (ERCP) in the diagnosis and treatment of TBL is described in adults, but limited in the pediatric literature. We report our experience with a multidisciplinary and minimally invasive approach to the management of TBL.

Methods: This was an IRB-approved 13-year retrospective review (January 1999–December 2012) of an institutional pediatric trauma registry; 294 patients (≤17 years old) sustained blunt hepatic injury. Those with TBL were identified. Patient demographics, mechanism of injury, management strategy and outcomes were reviewed.

Results: Eleven patients were identified with TBL. Hepatobiliary iminodiacetic scan (HIDA) was diagnostic. Combinations of peri-hepatic drain placement, ERCP with biliary stenting and/or sphincterotomy were performed with successful resolution of TBL in all cases. No child required surgical repair or reconstruction of the leak. Cholangitis developed in one child. There were no long-term complications.

Conclusions: A multidisciplinary and minimally invasive approach employing peri-hepatic external drainage catheters and ERCP with sphincterotomy and stenting of the ampulla is a safe and effective management strategy for TBL in children.

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were reviewed to evaluate the patient demographics, mechanism of injury, management strategy, outcomes, and complications. Grades of injuries were determined by CT scan and in accordance with the Association for the Surgery of Trauma (AAST) guidelines [12]. Successful non-operative management of TBL was defined as no required hepatobiliary surgery during the index stay [3]. TBL was diagnosed by the appearance of bile in peri-hepatic drains or by hepatobiliary iminodiacetic acid (HIDA) scan. Combinations of image-guided or operatively (laparoscopic or open) placed peri-hepatic drains, and ERCP with biliary stenting and/or sphincterotomy, were used in the management of all patients with TBL.

The choice of sphincterotomy and/or stent placement was the decision of the pediatric endoscopist, although sphincterotomy with stent placement has become our preferred approach as our experience with these techniques has grown. Those with symptomatic or tense biliary ascites received peri-hepatic drain placement to relieve pain or discomfort. The choice of laparoscopic versus image-guided placed peri-hepatic drains was based on the attending pediatric surgeon’s clinical judgment. Laparoscopically placed drains provided additional opportunity for evaluation of other potential injuries, peritoneal lavage, and direct visual placement. Resolution of bile leak was determined when external catheter drainage diminished and became non-bilious or when repeat ERCP demonstrated no further evidence of bile leak.

2. Results

Eleven patients with TBLs (3.7%) were identified following pediatric blunt liver injury. Of these eleven, seven were male (64%). The median age at presentation was 11 years (range, 3–16 years). The mechanism of injury varied among patients, but all sustained either crush or direct impact injuries to the upper abdomen. There was one patient with a grade II liver injury, five with grade III liver injuries, and five with grade IV liver injuries. The median injury severity score (ISS) was 17.5 (range, 9–38). In 82% of the patients, liver injury was the only abdominal solid organ injury present. At initial presentation, ten patients were hemodynamically stable and subsequently managed successfully non-operatively.

One patient with a grade IV injury sustained following a motor vehicle accident (MVA) was hemodynamically unstable at presentation to another hospital. An exploratory laparotomy with hepatic packing was performed, and he was transferred to our institution. Re-exploration 72 hours later demonstrated continued liver bleeding and bile-stained tissues, which were addressed with argon beam coagulation and operative drain placement. Biliary drain output persisted and an ERCP with sphincterotomy was performed on postoperative day (POD) 17, with subsequent resolution of the bile leak within 2 weeks. Another patient suffered a grade IV liver laceration, pancreatic transection, and renal artery dissection following an all-terrain vehicle (ATV) accident. Following a period of stability, she developed progressive abdominal distension and physiologic instability. She underwent diagnostic laparoscopy with drainage of ascites, peritoneal lavage, and placement of peri-hepatic drains that subsequently drained bile.

Bile leaks were diagnosed at a median time of 5 days (range, 3–7 days) after initial trauma. The development of new symptoms, including increasing abdominal pain, distention, nausea, and vomiting, prompted suspicion in the majority of cases. This led to hepatobiliary iminodiacetic acid (HIDA) scanning by nuclear medicine in nine of the eleven patients, which proved to be diagnostic of biliary leak in all nine cases (Fig. 1). In the remaining patients, none had symptoms concerning for TBL and no HIDA scans were performed. In the two patients described above, a bile leak was diagnosed from operatively placed peri-hepatic drains. Intrapерitoneal drains were placed laparoscopically or using image-guided techniques in six additional patients to treat symptomatic biliary ascites. ERCP was performed at a median time of 8 days (range, 3–17 days) after initial trauma. This procedure confirmed bile leaks in all patients, of which nine were intrahepatic and two were extrhepatic. During ERCP, sphincterotomy and/or stent placement was performed in all patients.

Following ERCP, all bile leaks resolved with a median time to resolution of 13 days (range, 3–64 days). The drains were subsequently removed at a median of 23 days (range, 6–78 days). Indwelling biliary stents were endoscopically removed at a median of 60 days (range, 12–438 days). TBL resolution was confirmed with radiographic visualization during ERCP stent removal. Two patients developed complications related to their interventions. One patient was lost to follow up and developed cholangitis secondary to retained biliary stent, which was subsequently removed on day 438. Another patient developed a small pneumothorax and pleural effusion after an image-guided drain placement, which required a drainage catheter and resolved. No child suffered from any long-term complications. Median length of stay was 10 days (range, 5–31).

3. Discussion

Selective NOM of hemodynamically stable pediatric patients with blunt hepatic injury has emerged as the accepted standard of care [1–5]. Advances in critical care and patient selection have contributed to success rates exceeding 90%, with success observed even in Grade V liver injuries [2,3,8,13]. TBLs are a potential complication of selective NOM of traumatic blunt hepatic injury, occurring almost

Fig. 1. A, HIDA scan demonstrating bile leak (arrow indicates bile leak). B, ERCP demonstrating bile leak (arrow indicates bile leak).
exclusively in higher-grade injuries (≥ grade III), which pose significant morbidity [2,7,8,14–16].

Our incidence of TBL of 3.7% was consistent with pediatric literature reports of 4% [6]. Traumatic biliary tract laceration, parenchymal disruption, ductal ischemia, delayed rupture of subcapsular bile collections, or persistent leak following hepatorrhaphy or resection during laparotomy are all implicated in the various etiologies for bile leaks [8,10]. In our experience, the majority of biliary leaks were found to be intrahepatic, which has been supported by other reports [8,17]. The true incidence may even be higher, as there is evidence to suggest that many intrahepatic tears form contained bilomas that may be clinically insignificant and evade diagnosis [18].

With selective NOM, a high index of suspicion must be maintained in patients who develop symptoms such as nausea, increasing pain, and abdominal distention after an initial period of clinical improvement following blunt liver injury [9]. In our series, the earliest symptoms developed in the third day following initial injury. The median time to diagnosis was 5 days after the initial trauma (range, 3–7 days), consistent with that observed in several other small series [8,14,18,19]. The development of the aforementioned symptoms should prompt hepatobiliary nuclear scanning (HIDA), as CT imaging has inadequate sensitivity for detecting biliary tract disruption [14,19]. HIDA scans are equally noninvasive but have a high sensitivity in diagnosing TBLs [4,18]. In our series, HIDA scan was the initial diagnostic modality used to investigate suspicion of TBL when peripheric drains were not present and was diagnostic in each of the cases it was utilized.

Drain placement, whether image-guided, laparoscopic, or during laparotomy, has been employed as both a diagnostic and therapeutic intervention for biliary leaks [6,8]. Eight of the eleven patients (73%) in our series had drains as placed as adjuncts in the diagnosis or management of their TBLs, while the remaining three were treated with ERCP alone. Drainage may also alleviate symptoms from the mass effect of bilomas, as well as decrease the risk of superinfection [6]. Properly placed catheters can convert a bile leak into a controlled fistula, and may even be sufficient to resolve some leaks [4–6,9]. Still, drainage may prove to be poorly tolerated or insufficient for resolution of TBL [2,4,6,7,14]. In both circumstances, ERCP provides additional therapeutic interventions for treatment.

ERCP can provide detailed visualization of the ductal system to localize the biliary leak. ERCP provides a minimally invasive means for performing an endoscopic sphincterotomy or placing a stent across the ampulla. This is postulated to relieve the pressure gradient across the site of the lesion and allow for healing by diverting the biliary flow freely through the ampulla, rather than transmitting pressure along the biliary tree [7,8,14]. In our series, endoscopic sphincterotomy was performed in nine patients (82%), stent placement was performed in nine (82%) patients, and both interventions were performed simultaneously in seven (64%) patients.

Sphincterotomy alone has failed in some series and is postulated to be secondary to subsequent edema compressing the sphincter and preventing biliary drainage [17,20]. Simultaneous endoscopic placement of stents has been reported by other groups to improve decompression of the biliary tree and leak resolution [9,20]. Endoprosthetic stents are safe and effective, but do require an additional procedure for removal [9,10,14]. Early in our experience we performed sphincterotomy alone, but transitioned to combining this procedure with stent placement in concordance with increasing literature supporting this dual approach, in addition to external biliary drainage in most patients [3,8–11,14].

The pediatric literature describing the use of ERCP in managing pediatric TBLs has been limited to case reports and a few small series [4,7,8,15–17,19]. Of the series, Ulitsky et al. presented seven cases, Castagnetti et al. presented five cases, and Almaramhi et al. presented five cases that had sustained blunt abdominal trauma with resultant TBLs, and were treated with combinations of ERCP, stenting, and external drainage procedures [4,8,17]. These series notably contained

**Fig. 2.** Algorithm for management of pediatric TBL following blunt liver injury.
a high proportion of patients who required initial laparotomy (63%, 40%, and 100%, respectively), typically due to hemodynamic instability upon presentation. In contrast, only one patient in our series (grade IV liver injury) underwent an initial laparotomy for hemodynamic upon presentation. In contrast, only one patient within our series 40%, and 100%, respectively, typically due to hemodynamic instability. The low rate of laparotomy among our TBL patients provides a contrasting experience to previous series, particularly with comparable severity of liver injury.

Our median time to resolution of TBL was 13 days (range 3–64 days), which is comparable to other series [17]. Although the time to resolution could not be accurately quantified in the three patients without peri-hepatic drains, resolution of TBLs was confirmed in all three during repeat ERCP for indwelling biliary stent removal at 48, 55, and 60 days, respectively. In an adult study using ERCP techniques, Anand et al. noted resolution of TBLs at an average of 47 days, with all leaks resolving by 7 months [10]. Indwelling stent duration of 3–8 weeks has been suggested, based on symptomatology and available follow-up imaging [8]. Our median time until stent removal was 60 days, and none of these patients required further biliary intervention following stent removal.

Strict follow-up is required for removal of indwelling biliary stents. We encountered cholangitis in one patient who was lost to follow up 1 year after stent placement. This resolved with stent removal and antibiotics, and he did not suffer any long-term complications. While complications such as pancreatitis, stent migration or clogging, and biliary strictures have been described, ERCP does not appear to contribute significant long-term morbidity and is a safe and effective approach for the management of TBLs [4,8–10,14,17].

This study is limited by its retrospective nature and the long interval studied which encompassed evolving treatment strategies and varying surgeon and endoscopist preferences; as such, not all patients experienced uniform management decisions. We have, however, outlined our preferred management algorithm in Fig. 2. Furthermore, this study does not address whether sphincterotomy or stent placement, in combination or isolation, is superior for resolution of bile leaks. This is controversial and limited in the pediatric literature.

To our knowledge, we report the largest series of pediatric patients with TBLs following blunt hepatic injury that resolved after ERCP. TBLs should be suspected when patients develop increased abdominal pain, distention, or nausea after initial clinical improvement. Symptoms may arise several days after injury, and hepatobiliary scanning is diagnostic. A strategy employing peri-hepatic external drainage catheters and ERCP with sphincterotomy and stenting of the ampulla provides a safe and effective multidisciplinary and minimally invasive approach for addressing pediatric trauma patients with evidence of biliary leak.

References


