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Role of interventional radiology in the management of complex pediatric surgical cases

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ABSTRACT

INTRODUCTION: Minimally-invasive techniques offered by interventional radiology (IR) are really helpful in the management of challenging surgical cases. The current report highlights a series of four complex pediatric surgical cases which were successfully managed by specific image-guided techniques.
CASE PRESENTATION: The first two cases in the present report were infants. One of them had a complicated type-1 choledochal cyst (obstructive jaundice and cholangitis) and was optimized with preoperative percutaneous transhepatic biliary drainage (PTBD) under fluoroscopic guidance. The other child had bilateral ureteropelvic junction obstruction and presented with urosepsis. Due to failure of retrograde stenting on one side, image-guided percutaneous nephrostomy and antegrade stenting were performed. The third and fourth cases had suffered blunt trauma to the abdomen. While one of them developed multiple pseudoaneurysms and arterioportal fistulae in the liver, the other had transection of the right posterior sectoral duct. Angioembolization of the pseudoaneurysms and embolization of the right posterior sectoral duct were performed for them under image-guidance respectively. The post-procedural course of all the above children was uneventful.
DISCUSSION: Image-guided minimally invasive procedures are associated with less post-procedural pain, early recovery, and better cosmetic outcomes. In specific scenarios, they may even obviate the need for surgical intervention, thereby reducing the overall morbidity.
CONCLUSION: Interventional radiology offers safe and effective alternatives to operative interventions. They are especially useful in the backdrop of significant morbidities like cholangitis, urosepsis, and trauma.

1. Introduction

Due to ongoing developments in imaging equipment and the availability of smaller access devices, the field of pediatric interventional radiology (IR) has evolved greatly over the last few decades [1]. At present, the scope of pediatric IR overlaps with nearly every sub-specialty offering care to children. These minimally-invasive approaches of IR offer several advantages including reduced post-procedural pain, shorter hospital stay, and better cosmetic outcomes. Another major advantage, with the IR procedure, is it can be easily repeated more than once. This becomes exceedingly helpful in the setting of dense post-operative adhesions when surgery is not advisable [2]. Herein, we describe four complex pediatric case scenarios, which were successfully managed by specific image-guided techniques. We aim to highlight distinct advantages of the techniques offered by pediatric IR in the management of these cases, thus avoiding futile and technically challenging interventions; especially in the backdrop of significant morbidities like cholangitis, urosepsis, and trauma. The present work has been reported in line with the SCARE 2020 Guidelines [3].

2. Case presentation

2.1. Case 1

A six-month-old boy was diagnosed with Type-1 choledochal cyst. The child was planned for surgery but had fever and passage of acholic loose stools at the time of admission. Laboratory investigations revealed conjugated hyperbilirubinemia (conjugated bilirubin = 8 mg/dl) and elevated liver enzymes. He also had low weight-for-age and poor growth. After initiating

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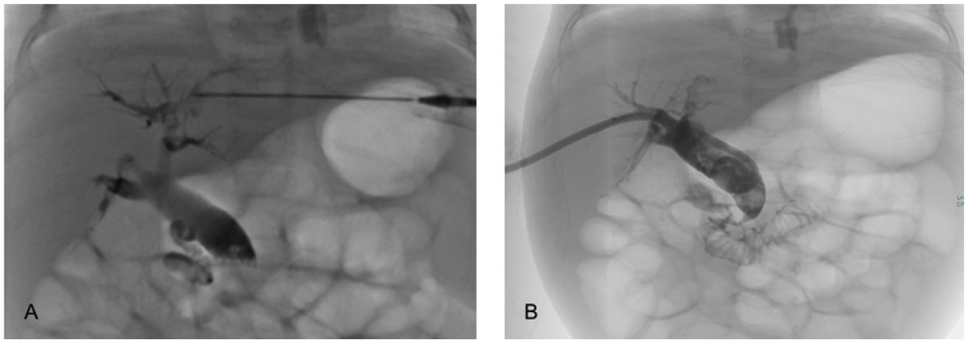

Fig. 1. Procedure of percutaneous cholangiogram and percutaneous transhepatic biliary drainage (PTBD). Under USG-guidance, access was taken into left hepatic duct and cholangiogram was performed (Fig. 1A). It revealed type I choledochal cyst. Subsequently, right posterior sectoral duct was punctured and tract was serially dilated. A stiff wire was navigated into duodenum, over which 8.5 F Dawson-Mueller drain was inserted. Fig. 1B shows check cholangiogram after PTBD.

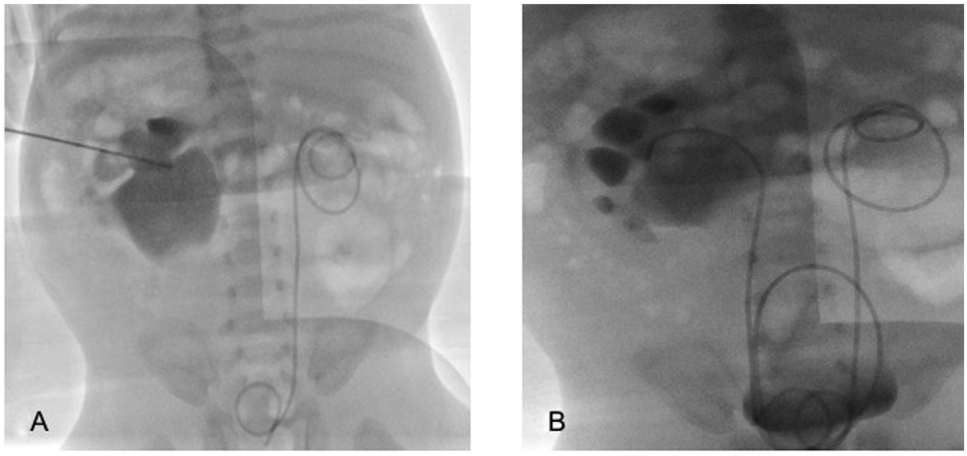

Fig. 2. Percutaneous nephrostomy and antegrade stenting. Left upper pole calyx was punctured under USG-guidance. Nephrostogram confirmed left ureteropelvic junction obstruction (Fig. 2A). Subsequently, guidewire was negotiated across the PUJ into the urinary bladder. DJ stent (3F × 16 cm) was passed over the guidewire and position was confirmed with plain abdominal X-ray (Fig. 2B).

broad-spectrum antibiotics and intravenous Vitamin K, the child underwent a percutaneous transhepatic cholangiogram (Fig. 1A) and percutaneous transhepatic biliary drainage (PTBD) procedure (Fig. 1B) under local anaesthesia. An 8.5 F Dawson-Mueller drain was placed in the dilated common bile duct (CBD). Subsequently, conservative therapy including nutritional build-up and intravenous antibiotics was continued for 10 days. Repeat liver function tests revealed a fall in serum conjugated bilirubin (2 mg/dL) and liver enzymes. The child underwent laparoscopic excision of the choledochal cyst with hepaticoduodenostomy. During the procedure, the external drain was removed. The postoperative course was uneventful and he was discharged on postoperative day (POD) 4. After 3 months of follow-up, he is healthy and gaining milestones as per chronological age.

2.2. Case 2

A one-month-old infant, who was antenatally diagnosed with bilateral hydronephrosis (left > right), presented to our center with features of urosepsis and poor oral intake. Laboratory investigations suggested deranged renal function test parameters. She was started on fluid-electrolyte optimization and broad-spectrum antibiotics. After five days of in-hospital management, she underwent cystoscopy and retrograde stenting (3F × 16 cm double J stent) of the right ureter. The left ureteric orifice could not be cannulated. One week later, a left-sided percutaneous nephrostomy with antegrade Double-J (3F × 16 cm) stenting was performed under ultrasound (USG)-guidance (Fig. 2A and B). The child was kept on antibiotic prophylaxis to avoid urinary tract infections (UTIs) following the procedure. She underwent bilateral open pyeloplasty (via the lumbotomy approach) after a span of 6 weeks. She had an uneventful postoperative course and was discharged in stable condition. After 10 weeks of follow-up, she is healthy and has no recurrence of UTI.

2.3. Case 3

An eleven-year-old boy presented to the emergency department with blunt trauma to the abdomen due to the accidental topple of a heavy vehicle over him while he was walking. Upon primary survey, he had features of hemorrhagic shock but responded well to balanced transfusion. Focused assessment with sonography in trauma (FAST) examination was positive for free fluid around the liver and pelvis. After resuscitation, his contrast-enhanced computed tomogram (CECT) revealed gross hemoperitoneum with grade-IV liver injury and non-enhancement of the right liver lobe. Associated findings of right renal grade-III injury, right adrenal hematoma, and right-sided mild pleural effusion were also observed. The child was started on conservative management. Re-evaluation after 48 h depicted persistent respiratory distress and abdominal distension due to pleural effusion and hemoperitoneum respectively. Although his vitals were stable, he required USG-guided drain insertion in the right paracolic gutter and pigtail insertion in the right hemithorax. The right lung showed complete expansion with the resolution of respiratory distress over the next 72 h, however, a persistent high-output bilious drainage (>300 mL/day) was observed from the abdominal drain over the next 2 weeks. A repeat

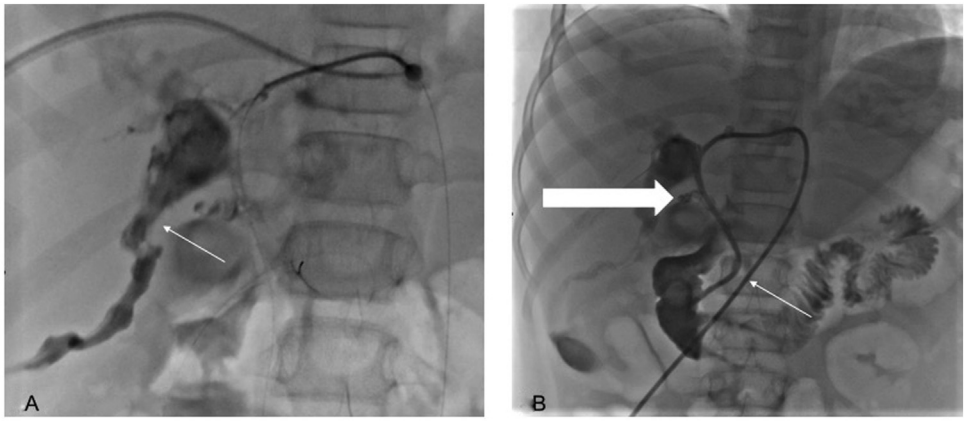

Fig. 3. Percutaneous transhepatic biliary drainage (PTBD) and embolization of the right posterior sectoral duct. Under general anaesthesia, the left hepatic duct was punctured. Cholangiogram confirmed active leak from the right posterior duct (Fig. 3A). Subsequently, the right posterior sectoral duct was embolized using coils and glue (solid arrow in Fig. 3B). 8.5 F external biliary drain was kept via left hepatic duct into the duodenum (thin arrow in Fig. 3B).

triple-phase CECT revealed right posterior sectoral duct injury. The child underwent a percutaneous transhepatic cholangiogram (Fig. 3A) confirming the site of the biliary leak. Subsequently, coil and glue embolization of the right posterior duct was performed (Fig. 3B). The external drain was kept in-situ and the child was discharged after 24 h of observation. The drain was removed after 3 weeks when the follow-up cholangiogram confirmed no leak. After 6 weeks of follow-up, the child is healthy and gaining milestones as per chronological age.

2.4. Case 4

An eight-year-old boy presented to the emergency department with blunt trauma to the abdomen due to the accidental collapse of a wall over the child. Upon primary survey, he had features of hemorrhagic shock but responded well to balanced transfusion. The FAST examination was positive for free fluid in the abdomen. After resuscitation, his contrast-enhanced computed tomogram (CECT) revealed gross hemoperitoneum with grade-III liver injury and multiple pseudoaneurysms involving the left and right hepatic arteries. Associated injuries included right second rib fracture, right ankle degloving injury, and contused lacerated wounds on the right ear lobe and right thigh. The child was started on conservative management, however, a hypotensive episode with fall in hematocrit was observed within the first 48 h. CT-angiogram (Fig. 4A) confirmed bleeding pseudoaneurysms and multiple hepatico-portal fistulae (largest 3 cm in diameter) in the liver. Therefore, anterior divisions of right and left hepatic arteries were selectively embolized using polyvinyl alcohol (PVA) particles and multiple coils. Postembolization angiogram revealed near-complete exclusion of the small aneurysms and heptico-portal fistulae (Fig. 4B). There were no post-procedural complications and the child was discharged uneventfully after feeding was established and adequate healing of the soft tissue injury was ensured. At present, he has completed 4 months of follow-up and is healthy.

3. Discussion

We have been following the minimally-invasive approach (laparoscopic or robotic-assisted laparoscopic) for excision of the choledochal cyst and hepaticoduodenostomy for more than seven years. Temporizing or bridge-procedures like percutaneous transhepatic biliary drainage (PTBD) or internal biliary stenting offers several advantages in children with complicated choledochal cysts; i.e. those with obstructive jaundice, cholangitis, or pancreatitis [4,5]. Firstly, they relieve the biliary obstruction and vent out the infected static bile, thereby providing a window period for optimizing the general condition of the child. Secondly, it is also believed by some, that these procedures might actually reduce the inflammation in the setting of cholangitis or pancreatitis [4]. Thus, they can reduce the chances of open conversion and increase the success rates of minimally-invasive approaches. In the first case of the present series, the infant had features of cholangitis and poor nutritional status. These reasons prompted us to go for preoperative biliary drainage in the form of PTBD. Cholangiogram performed during PTBD confirmed a near-complete obstruction to be responsible for his symptoms. With these bridge-procedures, a clinical improvement is usually observed between 1–3 weeks, after which the children can be operated. Although internal stenting via endoscopic retrograde cholangiopancreaticography (ERCP) is advantageous over PTBD, the non-availability of small-sized scopes is a major limitation with the former [4,6].

Bilateral ureteropelvic junction obstruction (UPJO) is a rare congenital anomaly, constituting <5% of all the UPJO cases [7]. Treatment of these cases is controversial. While some surgeons believe in concurrent pyeloplasty, others follow a successive approach of operating the poorer functioning side first [7,8]. In addition to the above two, few also believe in stenting the unoperated renal unit to prevent any further functional deterioration during the waiting time [7]. In complicated cases presenting as urosepsis or large mass causing respiratory distress, temporizing procedures such as percutaneous nephrostomy (PCN) and cystoscopy may be required for relieving the obstruction [7,9]. Shehab et al. have demonstrated significant improvement in the renal function and clinical condition of the patients with obstructive uropathy following ureteral stenting [9]. In the index case (case no 2), retrograde stenting was not successful on the more severely obstructed side. Hence, we resorted to antegrade stenting under fluoroscopic guidance. The approach of antegrade stenting is a safer alternative and has a success rate of >95% in obstructive ureteral pathologies [10]. In fact, van der Meer et al. were able to successfully stent all twenty-one ureters via the antegrade route in which the retrograde stenting had failed [10]. Thus, the antegrade approach under fluoroscopic guidance is less practiced but offers several advantages including more success rate, controlled stenting under vision, and fewer chances of infection.

The last two cases in our series were children who had suffered blunt abdominal trauma. The third child in our series developed both hepatic vascular and bile duct injury. Vascularity of the entire right lobe was compromised and transection of the right posterior sectoral duct resulted in high-output bilious drainage from the abdominal drain. In refractory high-output biliary leaks, con-

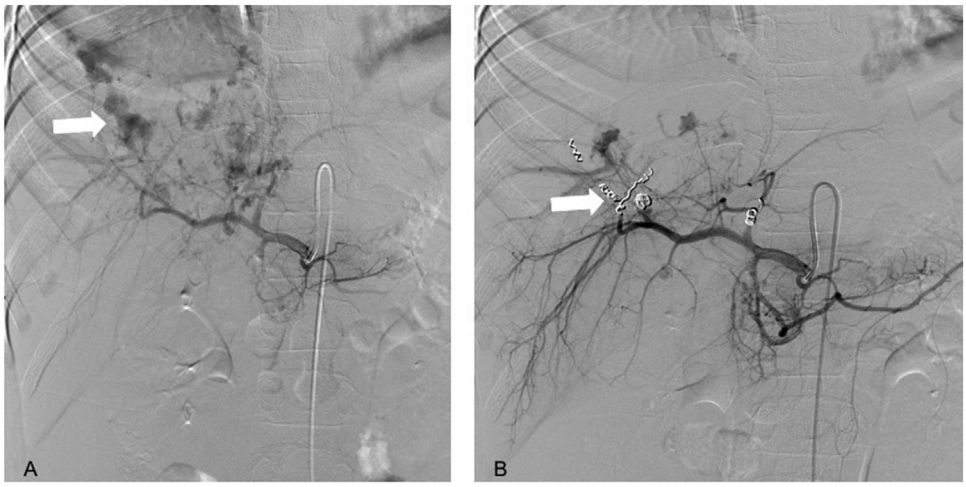

Fig. 4. Celiac artery angiogram and embolization of the anterior divisions of left and right hepatic arteries. Under local anaesthesia, left femoral artery was accessed using USG-guidance. Celiac artery angiogram revealed multiple pseudoaneurysms with hepaticoportal fistulae (solid arrow in Fig. 4A). Anterior divisions of left and right hepatic arteries were embolized using polyvinyl alcohol particles (PVA) and multiple coils. Post embolization angiogram (Fig. 4B) revealed complete exclusion of the small aneurysms and arterioportal fistulae.

ventional treatment options include ERCP with stenting or direct operative ductal repair/clipping [11]. However, both the procedures were not ideal for this child. Firstly, apart from the restricted availability of small-sized scopes and technical difficulties, it is unlikely that a major bile duct injury would have completely resolved on ERCP and stenting of the CBD. Secondly, it is difficult to perform an operative repair/clipping of the duct when we are anticipating significant omental adhesions and inflammation in the area due to trauma and parenchymal injury. Also, both the procedures are associated with their specific complications. Therefore, we had resorted to fluoroscopic-guided embolization of the sectoral duct using coils and glue. Various tissue sealants have been described for percutaneous transhepatic embolization of the bile duct leakage site. These include fibrin glue, n-butyl cyanoacrylate (NBCA), ethanol, etc. [12]. Vu et al. have described a similar technique to ours, using coils followed by NBCA in six patients of postoperative biliary fistulae [2]. The technique is a safer alternative to surgery with excellent results.

The fourth case also sustained a blunt abdominal trauma but the consequence was hepatic vascular injury in the form of multiple pseudoaneurysms and hepatico-portal fistulae. This development of pseudoaneurysms is very rare (<2%), yet it can be life-threatening [13]. As compared to traumatic splenic aneurysms, the incidence of rupture is higher in hepatic aneurysms. Therefore, some surgeons prefer to embolize these aneurysms prophylactically as delayed hemorrhage is often noticed once these patients are mobilized [13–15]. In the present case, the development of a hypotensive episode with a fall in hematocrit directed us to perform selective angioembolisation of the anterior divisions of the left and right hepatic arteries using multiple coils and PVA. Selective embolization of these branches ensure safe and early mobilization in these cases [15]. Common post-procedural complications reported in the literature include pain, fever, bleeding, etc. Some cases may also require more than sitting of the procedure before complete obliteration of the site of leak [2].

4. Conclusion

By virtue of the above cases, it is evident that minimally-invasive IR techniques can be really helpful in the management of complex pediatric surgical cases. These are safe and effective alternatives to operative interventions; especially in the backdrop of significant morbidities like cholangitis, urosepsis, and trauma.

Declaration of Competing Interest

None.

Funding

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Ethical approval

Not applicable.

Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

Author contribution

Study concept and design: Gursev Sandlas and Sachit Anand.
Data collection: Diptiman Roy, Gordhan Sanghani.
Data analysis and interpretation: Dhaval Darji and Preetha Joshi.
Drafting the manuscript: Sachit Anand and Gursev Sandlas.
Revision of manuscript: Diptiman Roy, Gordhan Sanghani, Dhaval Darji and Preetha Joshi.

Registration of research studies

Not Applicable.

Guarantor

Gursev Sandlas will act as the guarantor for the work.

Provenance and peer review

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