Original Article

Outcome of Biliary-enteric Reconstruction with Hepaticoduodenostomy Following Choledochal Cyst Resection: A Prospective Study

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Abstract

Background: The two most commonly performed methods of biliary-enteric reconstruction following choledochal cyst resection are Roux-en-Y hepaticojejunostomy (HJ) and hepaticoduodenostomy (HD). There is a lack of consensus regarding the better technique between them. This study aimed to evaluate the outcomes, efficacy and early complications of HD as a mode of biliary reconstruction after surgical resection of a choledochal cyst. **Materials and Methods:** This was a multi-institutional prospective study carried out in high-volume tertiary care teaching institutes from January 2010 to December 2022. All children managed with HD following choledochal cyst resection were analysed for their early complications and outcomes. **Results:** A total of 74 patients were included in this study. There were 59 (79.73%) females and 15 (20.27%) males. Thirty-nine (52.70%) patients had jaundice at the time of presentation. Magnetic resonance cholangiopancreatography was performed in 57 (77.03%) patients following ultrasonography. Intraoperatively, malrotation was present in 2 (2.70%) patients. In our study, operating time ranged from 60 to 195 min (mean: 118 min). Hospital stays ranged from 8 to 17 days (mean: 11.5 days). The post-operative biliary leak was seen in 7 (9.50%) patients, out of which 6 (8.11%) minor leaks were managed conservatively. Roux-en-Y HJ was performed on 1 (1.35%) patient with a major leak. In our series, 4 (5.40%) patients developed cholangitis; post-operative haemorrhagic nasogastric aspirate 5 (6.76%), post-operative pancreatitis 3 (4.05%) and wound infection 4 (5.40%) were observed and managed conservatively. None of the patients in our study developed an anastomotic stricture, bile gastritis and adhesive small bowel obstruction. **Conclusion:** Resection of choledochal cyst with HD reconstruction is safe and feasible with short operative time. HD is a viable option for operative management of choledochal cyst with low complication rates and faster recovery.

Keywords: Biliary-enteric reconstruction, choledochal cyst, complications, good outcome, hepaticoduodenostomy, meta-analysis

Introduction

The two most commonly performed methods of biliary-enteric reconstruction following choledochal cyst resection are Roux-en-Y hepaticojejunostomy (HJ) and hepaticoduodenostomy (HD).[1,2] Roux-en-Y HJ was the favoured reconstructive procedure after resection of choledochal cysts due to the low incidence of associated 'ascending cholangitis'.[3] The cause of ascending cholangitis in HD was assumed to be the reflux of duodenal content through the anastomosis into the intrahepatic bile ducts.[3] This reflux of the duodenal contents containing activated pancreatic enzymes may damage the biliary mucosa, and predispose to hilar bile duct carcinoma. Furthermore, there is a high incidence of endoscopy-proven bilious gastritis due to duodenogastric reflux following HD.[4]

Few articles suggest HD to be more physiologically and technically easier.[3-5] In this prospective study, authors

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analysed the outcomes, efficacy and early complications in 74 patients who underwent HD reconstruction after resection of a choledochal cyst. In addition, a meta-analysis of recent studies on HD for choledochal cyst resection is contemplated. The study aimed to evaluate the outcomes, efficacy and early complications of HD as a mode of biliary reconstruction after surgical resection of a choledochal cyst.

Materials and Methods

This was a multi-institutional prospective study carried out in the paediatric surgery departments of two high-volume tertiary care teaching institutes over 13 years from January 2010 to December 2022. All paediatric patients <16 years of age with HD following choledochal cyst resection were included in this study. Clinical details including age, sex, clinical presentation, history, baseline blood investigations including liver function tests, radiological evaluation, operative management, and hospital stay, were analyzed. Abdominal ultrasound, computerised tomography and magnetic resonance cholangiopancreatography (MRCP) were performed in patients as per radiological assessment. Choledochal cysts were classified according to Todani's modification of the Alonso-Lej classification, which is based on the site of the cyst or dilatation.[3,5]

Statistical analysis

All the medical records were carefully recorded in Excel sheets and the information obtained was analysed according to the objectives of the study using the SPSS Statistics for Windows, version x.0 (SPSS Inc., Chicago, Ill., USA).

The results obtained were reported in tables; relevant figures were included.

Surgical technique

The children included in the study were preoperatively optimised and those who presented with cholangitis were initially treated conservatively with broad-spectrum antibiotics for at least 6 weeks (cooling off period). A detailed pre-operative radiological evaluation of the anatomy around the Calot's triangle was performed.

All patients were managed with open technique. A right subcostal incision was given in all patients in supine position. The gall bladder was initially dissected up to Calot's triangle. The choledochal cyst was mobilised all around and its lower end was ligated and disconnected. The proximal limit of dissection was just distal to the confluence of both hepatic ducts. It was followed by a resection of the cyst. Lilly's procedure (excising the mucosa of the posterior cyst wall completely) was performed when the posterior wall of the cyst was densely adhered to the portal vein.

Hepaticoduodenostomy procedure

The duodenum was Kocherized, and completely mobilised to bring it close to the hepatic hilum without any tension (extensive Kocher manoeuvre). It was opened at the junction of the first and second parts in the superolateral wall, approximately 3 cm from the pylorus. A wide anastomosis was done in a single-layer fashion with the application of stay sutures at the corners of the duodenotomy incision [Figure 1]. The posterior wall of the duodenum was sutured to the posterior wall of the common hepatic duct (CHD) followed by the respective anterior walls using interrupted row of sutures (polyglycolic acid 5-0/ polydioxanone 5-0). The duodenum was anchored to the liver at the porta to avoid tension on the anastomosis. The abdomen was closed over a drainage tube, and a Ryle's tube was placed in the stomach. Postoperatively, the patients were started on feeds on the 5th or 6th post-operative day when Ryle's tube output dwindled. The intra-abdominal drain was removed. A major leak was defined as drainage of >400 mL/day or persistent output of >50 mL/day for longer than 2 weeks. The patients were discharged on successive days. The follow-up practice included assessment of clinical symptoms, liver function tests and abdominal ultrasound at 3 months and then yearly for all patients.

Results

A total of 74 patients were included in this study. There were 59 (79.73%) females and 15 (20.27%) males (female:male = 3.93:1). The age of presentation ranged from 1 month to 15 years, with a mean of 30.66 + 31.31 months. Type I was the most common (70, 94.59%) type. Age distribution and the type of cyst are presented in Table 1. Thirty-nine (52.70%) patients had jaundice, while 29 (39.19%) patients had abdominal pain at the time of presentation. One patient presented with a huge lump in the abdomen due to the presence of a large cyst [Figure 2]. Other clinical characteristics

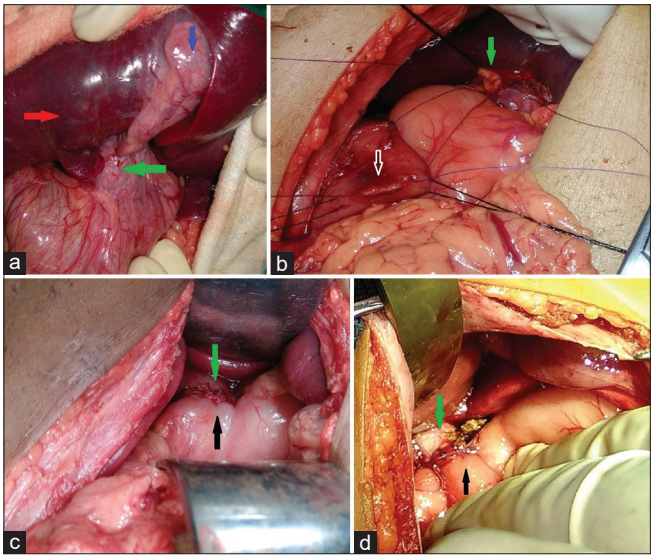


Figure 1: Intraoperative photographs show (a) a choledochal cyst (green arrow) and gall bladder (blue arrow) after mobilisation of the liver (red arrow); photograph post-cyst excision shows (b) completely mobilised duodenum and creation of duodenotomy (second part of the duodenum, white arrow); a wide anastomosis being performed in a single-layer fashion with the application of stay sutures at the margins of the duodenotomy and proximal common hepatic duct (common hepatic duct, green arrow) (c and d) completed hepaticoduodenostomy anastomosis; suture line is visible with common hepatic duct (green arrows) above and duodenum (black arrows) below

are presented in Table 2. All the 74 patients underwent HD, following primary cyst excision.

The diagnosis was made by screening ultrasonography or computerised tomography abdomen in 17 (22.97%) patients, while MRCP was performed in 57 (77.03%) patients following ultrasonography [Figure 3]. Anomalous pancreaticobiliary duct junction (APBDJ) was diagnosed in 4 (5.40%) patients in our series. One of the patients had pre-operative ERCP for management of pancreatitis.

Intraoperatively, malrotation was confirmed in 2 (2.70%) patients and Ladd's procedure was performed on them. One (1.35%) patient each had a pus-filled cyst and multiple calculi in the cyst. There was one patient with calculus in Hartmann's pouch with compression over the CHD (Mirizzi syndrome). In patients with intrapancreatic involvement of the cyst, care was taken to prevent any injury to the pancreatic duct by keeping the plane of dissection away from the head of the pancreas. Ductal and vascular anomalies are briefly summarised in Table 2.

There were 2 (2.70%) patients with complete involvement of CHD, i.e., right and left hepatic ducts inserted into cyst. In one of these patients, both the ducts were separately anastomosed to the duodenum, while in another patient, both the ducts were first anastomosed side to side, and then, a single HD was completed. Nine (12.16%) patients had either markedly inflamed cysts or posterior wall adherent to the cyst. This led to a difficult dissection of the cyst wall. Intraoperative

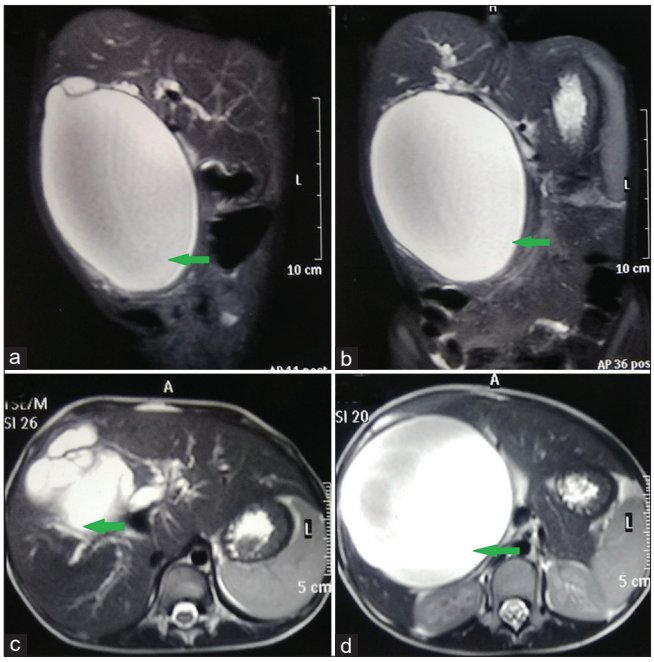


Figure 2: Magnetic resonance cholangiopancreatography coronal sections images show (a and b) large, well-defined thin-walled cystic mass in the right subhepatic region with minimal intrahepatic biliary radical dilatation suggestive of a large choledochal cyst (green arrow). Axial section images of the same patient show (c) smooth saccular extrahepatic biliary tree dilatation (green arrow) with dilated intrahepatic bile ducts (d) large, well-defined cyst in right subhepatic space (green arrow)

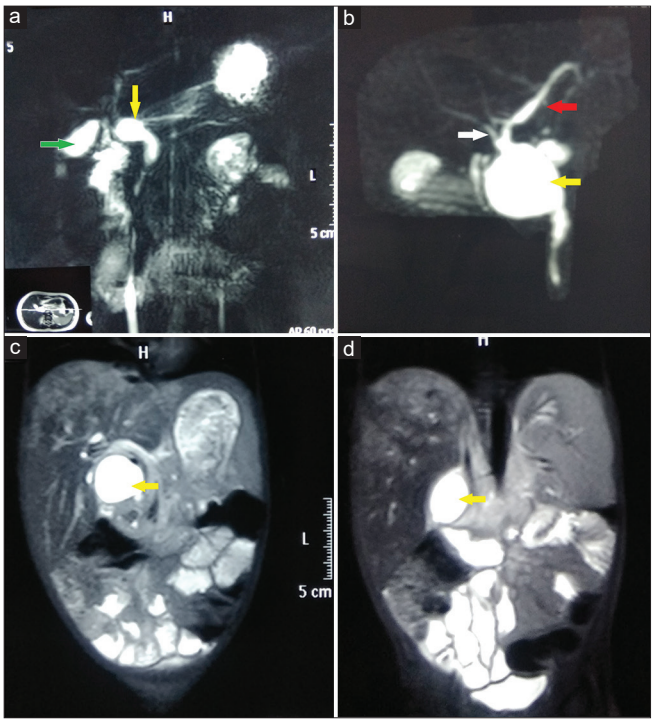


Figure 3: Magnetic resonance cholangiopancreatography coronal section images show. (a) Smooth extrahepatic biliary tree dilatation suggestive of choledochal cyst (yellow arrow) with dilated gall bladder (green arrow) without intrahepatic duct dilatation and contrast filling of the duodenum. (b) Smooth cystic extrahepatic biliary tree dilatation suggestive of choledochal cyst (cystic subtype, yellow arrow) with mild intrahepatic left duct dilatation (red arrow); junction of right and left hepatic duct is unremarkable (white arrow). Magnetic resonance cholangiopancreatography coronal section images show. (c) Cystic subtype choledochal cyst (yellow arrow) and (d) Fusiform subtype choledochal cyst (yellow arrow)

Table 1: Demographic details of the patients in our study

Age	Male, *n* (%)	Female, *n* (%)	Type I, *n* (%)	Type IVA, *n* (%)	Type IVB, *n* (%)	Total, *n* (%)
<2 months	2 (2.7)	6 (8.11)	8 (10.81)	-	-	8 (10.81)
2–<6 months	3 (4.05)	7 (9.46)	10 (13.51)	-	-	10 (13.51)
6 months–<1 year	2 (2.7)	6 (8.11)	7 (9.46)	1 (1.35)	-	8 (10.81)
1–<5 years	6 (8.11)	25 (33.78)	30 (40.54)	1 (1.35)	-	31 (41.89)
5–<10 years	2 (2.7)	15 (20.27)	15 (20.27)	1 (1.35)	1 (1.35)	17 (22.97)
Total	15 (20.27)	59 (79.73)	70 (94.59)	3 (4.05)	1 (1.35)	74 (100)

Table 2: Clinical, pre-operative, intraoperative and post-operative details of the patients in our study (*n*=74)

Demographic details	Frequency (%)
Clinical presentation	
Jaundice	39 (52.70)
Mild (serum bilirubin <5 mg %)	16 (21.62)
Moderate (serum bilirubin <10 mg %)	13 (17.57)
Severe (serum bilirubin >10 mg %)	10 (13.51)
Pain abdomen	29 (39.19)
Severe anaemia (Hb <8 g %)	15 (20.27)
Lump abdomen	16 (21.62)
Acute pancreatitis (long common channel)	2 (2.70)
Charcot's triad	8 (10.81)
Liver parenchymal disease	1 (1.35)
Pre-operative diagnosis	
Ultrasonography/CT abdomen	17 (22.97)
MRCP (following ultrasonography)	57 (77.03)
Intraoperative findings	
Malrotation of gut	2 (2.70)
Intrapancreatic cyst	1 (1.35)
Phrygian cap	1 (1.35)
Low insertion of the long cystic duct	2 (2.70)
Complete involvement of CHD	2 (2.70)
Choledocholithiasis	1 (1.35)
Pus-filled choledochal cyst	1 (1.35)
Mirizzi syndrome	2 (2.70)
Difficulties during cyst resection	9 (12.16)
Intraoperative complications	
Portal vein injury (repaired)	1 (1.35)
CHD injury (anastomosis at hepatic hilum)	1 (1.35)
Right hepatic duct injury (repaired)	1 (1.35)
Post-operative complications	
Bile leak	7 (9.50)
Minor (conservative)	6 (8.11)
Major (conversion to HJ)	1 (1.35)
Cholangitis	4 (5.40)
Post-operative haemorrhagic NG aspirate	5 (6.76)
Post-operative pancreatitis	3 (4.05)
Wound infection	4 (5.40)
Bile gastritis	0
Anastomotic stricture	0
Adhesive small bowel obstruction	0

NG: Nasogastric, MRCP: Magnetic resonance cholangiopancreatography, CT: Computerised tomography, CHD: Common hepatic duct, HJ: Hepaticojejunostomy, Hb: Haemoglobin

complications (3, 4.05%) are presented in Table 2. There was one patient with portal vein injury during difficult dissection at the adherent posterior wall of the cyst, which was repaired intraoperatively.

Operating time ranged from 60 to 195 min (mean: 118 min). Hospital stays ranged from 8 to 17 days (mean: 11.5 days), excluding the patient with a major leak.

Out of 74 patients, 23 (31.08%) developed post-operative complications. The post-operative biliary leak was seen in 7 (9.50%) patients, out of which 6 (8.11%) were managed conservatively with nil per oral for 1 week, total parenteral nutrition, supportive care and an abdominal drain *in situ*. The bile leak remained initially between 150 and 250 mL. The leak gradually reduced and stopped over a 2–4-week period.

One (1.35%) patient with a major leak required re-exploration (reoperation), and Roux-en-Y HJ was performed with the repair of the duodenum. In our study, cholangitis 4 (5.40%), post-operative haemorrhagic nasogastric aspirate 5 (6.76%), post-operative pancreatitis 3 (4.05%) and wound infection 4 (5.40%) were observed and managed with conservative treatment. The post-operative pancreatitis was managed successfully with conservative treatment in all three patients. There was no patient with an anastomotic stricture. Adhesive small bowel obstruction was not seen in any of our patients during follow-up. All the patients were asymptomatic with normal liver function tests and ultrasonography on post-operative follow-up of 2–10 years.

Discussion

The main findings of the study were that females constitute majority (4/5th) of the patients and type I was present in 94.59% of patients. More than half of the patients (52.70%) presented with jaundice. There were 2.70% of patients with complete involvement of CHD and 12.16% of patients with markedly inflamed cysts (posterior wall adherent to the cyst). Out of 74 patients who underwent HD, 31.08% developed post-operative complications. The post-operative biliary leak was seen in 9.50% of patients, and only 1.35% (one) of patient developed a major leak which precipitated re-exploration and Roux-en-Y HJ with the repair of the duodenum. All other patients with post-operative cholangitis (5.40%), post-operative haemorrhagic nasogastric aspirate (6.76%), post-operative pancreatitis (4.05%) and wound infection (5.40%) were managed conservatively. We neither had post-operative anastomotic stricture nor adhesive small bowel obstruction in any of our patients during follow-up of 2–10 years.

A choledochal cyst involves cystic dilation of various parts of the biliary tree that share the potential for obstructive complications of the common bile duct (CBD), pancreatic duct and finally malignant degeneration.[1] It occurs more frequently in Asian than in Western countries; its incidence ranges from 1 in 13,000 in Japan.[1-6]

Choledochal cysts are more common in females than males and may range from 2.4:1 to 8:1.[6,7] The same incidence was observed in our series also with female predominance (approximately 4:1). In infancy, painless jaundice is the common presentation, while intermittent abdominal pain with or without associated jaundice is seen in older children. Charcot's triad of jaundice, right upper quadrant mass and abdominal pain was 10.81% in our study.[6] The diagnosis of a choledochal cyst is made on abdominal ultrasound and confirmed by either contrast-enhanced

computed tomography or MRCP (preferably).[1] MRCP is non-invasive and gives evidence about the extent of the cyst, abnormalities within the biliary tree and the presence or absence of the APBDJ. APBDJ may be present in 30% to 70% of choledochal cysts.[8] It is an anomalous anatomical variation in which the junction of the CBD and pancreatic duct occurs at a distance of more than 15 mm from the papilla of Vater.[8] This convergence exposes the biliary epithelium to alkaline pancreatic enzymes, creating a hostile environment that may precipitate the formation of a choledochal cyst.[8]

Complete resection has been established as a standard management practice for choledochal cysts over the last 50 years. Its advantages are the prevention of both post-operative cholangitis and the development of carcinoma arising from the cyst wall.[1,2] There is a paucity of consensus with regard to the technique of biliary-enteric reconstruction following choledochal cyst resection. Both Roux-en-Y HJ and HD have their own merits and demerits. Conventionally, Roux-en-Y HJ was favoured by most surgeons for biliary-enteric reconstruction as it was thought to be relatively protective against so-called 'ascending cholangitis'.[3] Ascending cholangitis presents with symptoms of abdominal pain, fever and leucocytosis. Many series and meta-analyses have reported ascending cholangitis associated with Roux-en-Y anastomosis, particularly in the setting of anastomotic stenosis or intestinal stasis distal to the Y-junction.[1,2] Other demerits of HJ are (i) the presence of two or three anastomotic closures and high chances of anastomotic leakage, (ii) high incidence of intestinal obstruction due to operative manipulation performed below the transverse mesocolon and mobilisation of jejunum through it, (iii) intestinal stasis favouring the development of cholangitis, (iv) decreased secretion of bile salts and possible impact on fat malabsorption and diarrhoea and (v) peptic ulcer.[3]

HD was earlier alleged to be associated with ascending cholangitis because of the reflux of duodenal content into the biliary ducts, although the contents of the duodenum are relatively sterile. In the setting of an absence of any obstruction to the flow of bile and patent anastomotic stoma with free flow of bile, ascending cholangitis is usually never seen.[3,9] Bernhard (1950) gave the concept that suppurative cholangitis is not an 'ascending' infection but truly a 'descending' infection because of obstruction to the egress of bile from the liver.[9] Furthermore, in experimental studies on dogs with wide choledocho (bilio)-colic anastomosis, cholangitis was conspicuously absent in the absence of anastomotic stricture.[9] In all these dogs, anastomosis was done with an unprepared transverse colon, and regurgitation of colonic contents into the biliary tree did not result in cholangitis. Furthermore, the presence of reflux of barium into the biliary tree may be a favourable sign, signifying the absence of anastomotic stricture.[9]

As per Todani *et al*., the manifestation of cholangitis in patients with HD is due to anastomotic stenosis, preventing the free flow of bile to drain into the duodenum.[3] They also performed wide anastomotic stoma to prevent cholangitis by making an adequate incision along the lateral wall of both the transacted hepatic ducts in patients with intrahepatic involvement by the cyst or coexisting stenosis of the hepatic duct.[3] They also recommend liver biopsy from the middle portion of the left lobe to prevent tissues with localised fibrosis present at the periphery of the liver.[3]

Another concern regarding HD was malignancy involving the hepatic hilum. A case of hilar cholangiocarcinoma was reported approximately two decades after cyst excision and HD.[10] Most cases of intrahepatic or cholangiocarcinoma in post-operative cases of the choledochal cyst were seen with HJ associated with anastomotic stricture and recurrent cholangitis.[11] Thus, an association of a single case of malignancy with HD should not be generalised and disrepute it. The development of cholangiocarcinoma after excision of the choledochal cyst requires long-term follow-up before qualifying any association with the types of biliary-enteric reconstruction.

We perform an extensive Kocher manoeuvre in order to allow complete duodenal mobilisation with anatomy allowing a tension-free HD anastomosis. The HD anastomosis was constructed at the junction of the first and second parts of the duodenum. This is >3 cm distal to the pylorus and should not significantly affect the pyloric function or gastric emptying. This concept is also explained by Santore *et al*.[1] Most surgeons perform a single layer of interrupted sutures, while double rows of sutures on the posterior wall have been described by Patil *et al*.[12]

HD is a simple procedure with single anastomosis and lesser chances of leakage. It requires less operative time and allows faster recovery of bowel function. Furthermore, there is the maintenance of a normal physiologic state with HD, as bile flows in the intestinal tract through the duodenum.[3] There is no manipulation below the infracolic (transverse mesocolon) abdominal compartment resulting in the absence of complications (adhesive bowel obstruction and internal herniation) associated with bowel manipulation seen with HJ.[2,13] In the presence of post-operative anastomotic strictures or biliary calculi, HD allows favourable endoscopic access (both diagnostic and therapeutic) to the anastomosis.[12]

The average operative time in our study was less as compared to the other studies, while hospital stay was slightly longer than in most series.[1,12] Although faster recovery of bowel functions has been described by various authors, we have followed the protocol of nil per oral for 5 days and started feeds gradually.[2] This was one of the reasons for the relatively long hospital stays of our patients.

Patil *et al*.[12] over a period of 25 years performed primary cyst excision and HD in patients with choledochal cyst; the biliary leak was seen in 2 (8%) of their patients, similar (9.50%) to our large series.[12] Most of the bile leaks were seen early in our study, due to an early learning curve. It may range from 0% to 5% with HD as per meta-analysis of studies on HD.[1,14] Post-operative biliary leak rates between HJ and HD were similar as per a recent meta-analysis comparing HJ versus HD.[8]

Table 3: Meta-analysis of 15 studies (including present study) using hepaticoduodenostomy for biliary enteric continuity following choledochal cyst resection; year of publication, type of study, frequency of cohort (both HD and HJ) and the post-operative complication rates along with mortality rates are presented

Characteristics	Study							
	Todani *et al.*, 1995[11]	Shimotakahara *et al.*, 2005[4]	Takada *et al.*, 2005[10]	Mukhopadhyay *et al.*, 2011[5]	Santore *et al.*, 2011[1]	Liem *et al.*, 2012[15]	Yeung *et al.*, 2015[14]	Patil *et al.*, 2015[12]
Study type (prospective/retrospective)	Retrospective	Retrospective	Prospective	Retrospective	Retrospective	Retrospective	Retrospective	Retrospective
Total cases (operated)	97	40	8	79	59	400	31	54
Procedures	HD=67 HJ=30	HD=12 HJ=28	HD=3 HJ=5	HD=53 HJ=18 Other=6	HD=39 HJ=20	HD=238 HJ=168	HD=11 HJ=20	HD=54
Anastomotic (bile) leak	-	-	-	1 (HD)	4 (2 HD, 2 HJ)	8 (4 HD, 4 HJ)	1 (HJ)	2 (HD)
Minor (conservative)				1	3	7		2
Major (conversion to HJ)					1	1		
Post-operative haemorrhagic NG aspirate/bleeding	-	-	-	-	-	1 (HJ)	-	-
Post-operative fluid collection/abscess	-	-	-	-	-	2 (1 HD, 1 HJ)	-	-
Pancreatic fistula	-	-	-	-	-	4 (2 HD, 2 HJ)	-	-
Post-operative cholangitis	-	-	-	-	1 (HJ)	6 (5 HD, 1 HJ)	1 (HJ)	-
Temporary liver dysfunction	-	1 (HD)	-	-	-	-	-	-
Post-operative pancreatitis	-	-	-	-	-	-	-	-
Bile gastritis	-	4 (HD)	3 (HD)	3 (HD)	-	8 (HD)	-	-
Wound infection	-	-	-	-	-	-	-	-
Anastomotic stricture/stenosis	10 (4 HD, 6 HJ)	-	-	3 (1 HD, 2 HJ)	2 (1 HJ, 1 HD)	3 (HD)	4 (HJ)	1 (HD)
Intestinal obstruction	-	2 (HJ)	-	-	-	-	-	-
Ileus	-	-	-	-	-	-	-	-
Post-operative complications (morbidity) (%)	10/97 (10.31)	7/40 (17.5)	3/8 (37.5)	7/79 (8.86)	7/59 (11.86)	32/400 (8)	6/31 (19.35)	3/54 (5.56)
Mortality (%)	-	-	-	1 (HJ) 1/79 (1.27)	-	-	-	-

Characteristics	Jacob *et al.*, 2017[13]	Saxena *et al.*, 2017[18]	Guzman *et al.*, 2019[19]	Gezer *et al.*, 2019[20]	Deep *et al.*, 2021[7]	Balanescu *et al.*, 2022[21]	Present study (all HD)
Study type (prospective/retrospective)	Retrospective	Retrospective	Retrospective	Retrospective	Retrospective	Retrospective	Prospective
Total cases (operated)	70	31	122	31	16	16	74
Procedures	HD=35 HJ=35	HD=31	HD=68 HJ=54	HD=10 HJ=15	HD=9 HJ=7	HD=8 HJ=8	HD=74
Anastomotic (bile) leak	4 (1 HD,3 HJ)	1 (HD)	6 (3 HD, 3 HJ)	2 (HJ)	1 (HJ)	1 (HD lap)	7 (HD)
Minor (conservative)	4			2	0	1	6
Major (conversion to HJ)				0	1	0	1
Post-operative haemorrhagic NG aspirate/bleeding	-	-	1 (HD)	-	-	-	5 (HD)
Post-operative fluid collection/abscess	1 (HJ)	-	-		-	-	
Pancreatic fistula	-	-	-		-	-	
Post-operative cholangitis	4 (HJ)	-	5 (HD)	-	-	-	4 (HD)
Temporary liver dysfunction	-	-	-	-	-	-	-

Contd...

Table 3: Contd...

Characteristics	Study						
	Jacob *et al*., 2017[13]	Saxena *et al*., 2017[18]	Guzman *et al*., 2019[19]	Gezer *et al*., 2019[20]	Deep *et al*., 2021[7]	Balanescu *et al*., 2022[21]	Present study (all HD)
Post-operative pancreatitis	7 (3 HD, 4 HJ)	-	1 (HD)	-	-	1 (HJ)	3 (HD)
Bile gastritis		-	-	1 (HD)	-	-	-
Wound infection	2 (1 HD, 1 HJ)	-	-	-	2 (1 HD, 1 HJ)	-	4 (HD)
Anastomotic stricture/stenosis	-	-	-	1 (HJ)	-	-	-
Intestinal obstruction	3 (HJ)	-	1 (HJ)	1 (HJ)	-	-	-
Ileus	-	-	5 (1 HD,4 HJ)	1 (HJ)	-	-	-
Post-operative complications (morbidity) (%)	21/70 (30)	1/31 (3.26)	19/122 (15.57)	6/25 (24)	3/16 (18.75)	2/16 (12.5)	23/74 (31.08)
Mortality (%)		-	2 (HD)	-	-	1 (HJ)	-
			2/122 (1.64)			1/16 (6.25)	

HD: Hepaticoduodenostomy, HJ: Hepaticojejunostomy, NG: Nasogastric

The post-operative haemorrhagic nasogastric aspirate was present in 6.76% of our patients suggestive of bleeding. All patients responded to proton-pump inhibitors. Post-operative cholangitis was seen in 4 out of 19 (21.05%) patients with HD in one series.[3] It was less (5.40%) in the present study. Most of the patients responded to antibiotics without any demonstrable hepatic dysfunction.[3] It was not seen in other series.[1] A meta-analysis revealed cholangitis in 2.47% of patients with HD, which was not significantly higher (statistically) than HJ.[2]

Shimotakahara *et al*. observed complications of bile reflux gastritis (duodenogastric reflux) in 4 of 12 (33.33%) with HD, and none with HJ patients in their series.[4] Chemical and endoscopic evidence of duodenogastric reflux was present in all three patients with HD without any clinical symptoms in other series.[10] The presence of bile gastritis was seen in 3.8% of patients.[15] A recent meta-analysis showed approximately 6% incidence of symptomatic gastritis with HD.[2] Another meta-analysis comparing HJ versus HD favoured HJ over HD vis-à-vis biliary reflux rates.[8] The absence of this complication in the present study may be ascribed to our technique of HD reconstruction.

The post-operative pancreatitis managed in three patients in our series was purported to be due to the presence of APBDJ. Studies reveal that the incidence of acute pancreatitis in paediatric choledochal cysts may be as high as 70.6%.[16] Post-operative pancreatitis (clinico-radiological) findings were seen in 9.7% of patients with the presence of pre-operative pancreatitis.[17]

Post-operative anastomotic stricture (stenosis) with HD was not seen in our study, while it was present in 2.6% of patients in one series.[1] The rates of the anastomotic stricture with HJ are higher than HD as per the meta-analysis of the surgical techniques.[14] Our results were similar to other series in the literature.[14,18]

HJ has a higher (5.12%) chance of post-operative intestinal obstruction compared to the HD group (0%).[2] HD produces fewer complications requiring reoperation. The reoperation rate with HD was 1.35% (1/74) in our study. The reoperation rate due to postoperative biliary leak as per previous studies [Table 3] was 0.47% (3/638). The overall reoperation rate reported by a systemic review and meta-analysis was 1.21%.[2] The reoperation was performed for a major leak for which Roux-en-Y HJ was performed. Roux-en-Y HJ remains the gold standard for major leaks or failure of HD.

An attempt at meta-analysis of important studies published in the last 4 decades using HD for biliary enteric continuity following choledochal cyst resection is shown in Table 3.[1,4,5,10-15,17-21] In our prospective study, minor complications (9) such as minor wound infection (4) and post-operative haemorrhagic nasogastric aspirate (5) were also recorded, while most series were retrospective and rarely mention these minor complications.[1,4,5,10-15,17-21] The percentage of the rest of the complications (18.92%, 14/74) was similar to the rest of the studies published in the literature. As per our meta-analysis

Table 4: Comparative evaluation of post-operative complication rates along with mortality rates of hepaticoduodenostomy and hepaticojejunostomy for choledochal cyst described in earlier table [Table 3]

Complications	Procedures			
	HD (712), *n* (%)	HJ (408), *n* (%)	Others (8), *n* (%)	Total (1128), *n* (%)
Anastomotic (bile) leak	22 (3.09)	16 (3.92)	-	38 (3.37)
Post-operative haemorrhagic NG aspirate/bleeding	6 (0.84)	1 (0.24)	-	7 (0.62)
Post-operative fluid collection/abscess	1 (0.14)	2 (0.49)	-	3 (0.26)
Pancreatic fistula	2 (0.28)	2 (0.49)	-	4 (0.35)
Post-operative cholangitis	14 (1.97)	7 (1.71)	-	21 (1.86)
Temporary liver dysfunction	1 (0.14)	-	-	1 (0.09)
Post-operative pancreatitis	7 (0.98)	5 (1.22)	-	12 (1.06)
Bile gastritis	19 (2.67)	-	-	19 (1.68)
Wound infection	6 (0.84)	2 (0.49)	-	8 (0.71)
Anastomotic stricture/stenosis	10 (1.40)	14 (3.43)	-	24 (2.13)
Intestinal obstruction	-	7 (1.71)	-	7 (0.62)
Ileus	1 (0.14)	5 (1.22)	-	6 (0.53)
Total post-operative complications	89 (12.5)	61 (14.95)	-	150 (13.3)
Mortality	2 (0.28)	2 (0.49)	-	4 (0.35)

HD: Hepaticoduodenostomy, HJ: Hepaticojejunostomy, NG: Nasogastric

described in Table 4, the percentage of overall post-operative complications was slightly higher with HJ (14.95%) than HD (12.5%).[1,4,5,10-15,17-21] Post-operative bile gastritis was seen exclusively with HD (2.67%), while post-operative intestinal obstruction was seen solely with HJ (1.71%). Comparative evaluation of post-operative complications with HD and HJ is elaborated in Table 4. HD was superior to HJ in terms of anastomotic stricture/stenosis with complication rate of 1.40% and 3.43%, respectively.

Mortality may occur in patients with major anastomotic leaks or cholangitis.[5,19] Mortality was not seen in our series similar to other series reported in the past.[3,12,20] We are doing hepaticoduodenostomies for all of our patients with choledochal cysts since 2008 (AG) and 2017 (RG). This is a large series compared to other studies published over the last two decades.[18,20,21] We have not encountered any major complications, except for a patient with a major biliary leak (during early learning curve) which required HJ.

Conclusion

Resection of choledochal cyst with HD reconstruction is simple and feasible with short operative time. The technique is a safe and effective procedure in experienced hands. The early complication rates in our study were low. The study highlights the absence of severe post-operative complications such as anastomotic stricture, bile gastritis and adhesive small bowel obstruction with HD. Post-operative biliary leak is an important complication seen with HD and is usually minor.

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Conflicts of interest

There are no conflicts of interest.

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