Biliary Reconstruction by Isolated Jejunal Interposition Loop: Our Experience after Excision of Choledochal Cyst

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Background: Choledochal cyst is a fairly common hepatobiliary condition in pediatric surgical practice. For the most common type (type I), it is well established that the total excision of the cyst with an wide biliary-enteric anastomosis is key for long-term good result. Multiple options remain for biliary-enteric reconstruction after excision. Jejunal interposition loop reconstruction is thought to be the most physiologic.

Materials and Methods: We have retrospectively reviewed the data of patients of type I choledochal cysts which were operated between January 2010 and September 2018 and undergone jejunal interposition loop reconstruction. Clinical presentation, investigations, operative procedure morbidity and complications were reviewed.

Results: There were 33 patients, with a male-to-female ratio of 1:3 and a mean age of 4.63 years (mean ± standard deviation [SD] = 4.63 ± 2.98 years). The follow-up period ranged from 3 to 81 months (mean ± SD = 36.30 ± 19.24 months). There was no stricture or cholangitis. Reoperation required in one due to leak at biliary-enteric anastomosis leading to biliary peritonitis. One each had pancreatitis and prolonged ileus. Two bile leaks stopped spontaneously. Operative time and postoperative hospital stay were 228.78 ± 40.43 min (mean ± SD) and 8.96 ± 3.63 days (mean ± SD), respectively.

Conclusion: Jejunal interposition loop reconstruction is safe and reproducible with acceptable morbidity. However, if this procedure is abandoned, the long-term benefits may remain ever elusive.

Keywords: Choledochal cyst, jejunal interposition loop, physiologic reconstruction, short- and intermediate-term outcome

INTRODUCTION

Choledochal cyst is a fairly common hepatobiliary condition in our pediatric surgery practice. Here, we have studied one of the less frequently practiced but accepted methods of reconstruction for biliary-enteric drainage after complete excision of choledochal cyst that is the jejunal interposition loop reconstruction which is said to be more physiological.[6] We have modified in the sense that we did not put any valve mechanism at the duodenal end of the interposition.

MATERIALS AND METHODS

We have retrospectively reviewed the operative, inpatient, outpatient department, and follow-up data of children undergoing jejunal interposition loop reconstruction for the period of January 2010–September 2018 with reference to clinical presentation, investigative protocols, operative management, and intermediate- and short-term outcome in a single institute and single unit. We have included only children with type I choledochal cysts and a residual type I cyst in a child who was previously operated elsewhere. Patients with at least two follow-up
visits or at least 1-year follow-up (whichever is longer) were included considering a significant attrition rate in follow-up. Other types of choledochal cysts were excluded from this study. Statistical calculation of numbers, percentage, average/mean and standard deviation (SD) were used to express the data.

**Results**

We had total 45 children who had undergone surgery for choledochal cyst in this time period in the unit of which 33 had undergone jejunal interposition loop reconstruction and also fulfilled the inclusion criteria [Table 1]. The male-to-female ratio was 1:3. The mean age was 4.63 years (mean ± SD = 4.63 ± 2.98 years). None were detected antenatally. Pain abdomen was the most common mode of presentation, followed by lump in the abdomen. We had seen the classic triad of pain, lump, and jaundice in two (6%) children. One infant presented with jaundice, hepatomegaly, ascites, and acholic stool with features of hepatic failure [Table 2].

All had undergone ultrasonography abdomen (USG) [Figure 1a], liver function test (LFT), and serum amylase and required essential blood tests including coagulation profile, serum electrolytes, urea, creatinine, complete blood count, and hemoglobin estimation apart from other investigations for anesthesia fitness. Magnetic resonance cholangiopancreatography was done in all except two infants in whom technical problems were there to do it [Figure 1b and c]. Two patients had contrast-enhanced computed tomography abdomen done from outside before coming to us. Preoperative hepatobiliary scan with Tc-99m mebrofenin (HPB scan) was done in two children [Table 3 and Figure 1d]. Postoperatively, the children were followed up at regular interval. The usual schedule was 1st year at 3 monthly intervals after the first follow-up visit at 1 month, then 6 monthly for 2 years, and then yearly. Apart from history and clinical examination (each visit), HPB scan (at 3 months and then when indicated), USG abdomen (at 3 months and then yearly or earlier if indicated clinically), and LFTs (at each visit) were done. Prophylactic antibiotics were used postoperatively up to 1 month, and ursodeoxycholic acid was used from diagnosis to 6 months postoperatively. We had performed complete resection of all the cysts up to the confluence of the hepatic ducts (hilum) above. A wide stoma was created for anastomosis at hilum with an extension of lateral cut in the ducts. Lower down the cyst was dissected and excised in completion taking care not to injure pancreatic duct. Copious irrigation was done with normal saline both at proximal ducts and through the lower end when there was an opening to wash out debris. A jejunal loop of approximately 3.5–7 cm, length of which varied with size of children, was selected 15–20 cm from the duodenojejunal junction, so as there was no tension in the anastomosis and pedicle of the interposition loop. It was then brought out through an avascular window in the transverse mesocolon along with its supplying mesentery and depending on the size of the diameter of ducts at hepatic duct confluence (hilum), anastomosed end to end or end to side, in an isoperistaltic manner. The lower end was anastomosed with the vertical part of the duodenal C-loop, and no valve mechanism was created at this duodenal end unlike the original Chicago-Beijing procedure[1] [Figure 2]. The window on transverse mesocolon was closed with sutures taking special care not to twist the mesentery of the interposition loop. The upper end of the loop was fixed with few stitches to the liver. Jejunal continuity was established by anastomosis. The residual cyst which was previously operated outside had a cystoduodenostomy which was dismantled the area of the duodenum closed the cyst.

![Figure 1: (a) USG picture of cystic variant. (b and c) MRCP showing a fusiform (b) and cystic (c) type I choledochal cyst. (d) Preoperative Tc-99m mebrofenin hepatobiliary scan showing a photopenic area near hilum which takes up of tracer in delayed film (1 h) looking to be dilated extrahepatic biliary tree and shows prolonged hold up (up to 4 h) but delayed excretion to intestine is present (2 h) in same patient as in a thus suggestive of choledochal cyst. USG: Ultrasonography, MRCP: Magnetic resonance cholangiopancreatography](image)
completely excised up to hilum and interposition loop fashioned in similar manner and lower anastomosis done at fresh vertical part of c-loop of the duodenum. Our operative time was 228.78 ± 40.43 min (mean ± SD). Days to feed and postoperative hospital stay were 6.03 ± 1.97 days (mean ± SD) and 8.96 ± 3.63 days (mean ± SD), respectively. The most common immediate postoperative complication was prolonged bile drainage in abdominal drain in three patients (>72 h), in which two of them stopped spontaneously. One required

Table 1: Patients in brief

| Patient serial | Age (years) | Sex | Presenting features | Surgery time (min) | Days to feed | Postoperative hospital stay (days) | Complications (perioperative) | Delayed complications | Follow-up period (months) |
|----------------|-------------|-----|---------------------|-------------------|-------------|----------------------------------|-----------------------------|------------------------|-------------------------|
| 1              | 10          | Female | Pain abdomen      | 170               | 5           | 7                                | No                          | No                     | 49                      |
| 2              | 5.50        | Male   | Pain abdomen, lump | 230               | 6           | 8                                | No                          | No                     | 72                      |
| 3              | 7           | Male   | Lump with jaundice and pain abdomen | 165               | 5           | 8                                | Wound infection-conservative management | No                     | 81                      |
| 4              | 4           | Female | Lump abdomen      | 200               | 5           | 7                                | No                          | No                     | 75                      |
| 5              | 2.50        | Female | Pain abdomen      | 240               | 6           | 8                                | No                          | No                     | 68                      |
| 6              | 2           | Female | Jaundice and lump abdomen | 180               | 5           | 7                                | No                          | No                     | 58                      |
| 7              | 11          | Female | Lump, pain abdomen | 310               | 10          | 15                               | Prolonged ileus             | No                     | 38                      |
| 8              | 4           | Female | Pain abdomen      | 225               | 5           | 8                                | No                          | No                     | 50                      |
| 9              | 6           | Female | Pain abdomen, jaundice | 275               | 5           | 8                                | No                          | No                     | 46                      |
| 10             | 1.83        | Female | Lump abdomen      | 180               | 6           | 9                                | No                          | No                     | 49                      |
| 11             | 11          | Female | Pain abdomen      | 230               | 5           | 7                                | No                          | No                     | 36                      |
| 12             | 1.50        | Male   | Jaundice          | 190               | 5           | 7                                | No                          | No                     | 34                      |
| 13             | 2           | Female | Jaundice and lump abdomen | 290               | 9           | 15                               | Prolonged bile leak, stopped spontaneously | No                     | 39                      |
| 14             | 7           | Female | Pain abdomen      | 200               | 5           | 8                                | No                          | No                     | 29                      |
| 15             | 3           | Female | Pain abdomen, jaundice | 220               | 5           | 7                                | No                          | No                     | 36                      |
| 16             | 2.25        | Male   | Pain abdomen      | 180               | 5           | 7                                | No                          | No                     | 38                      |
| 17             | 3.5         | Female | pain abdomen      | 180               | 6           | 8                                | No                          | No                     | 40                      |
| 18             | 1           | Female | jaundice, pain abdomen | 240               | 8           | 15                               | Prolonged bile leak stopped spontaneously | No                     | 37                      |
| 19             | 5           | Female | Lump, pain abdomen | 320               | 5           | 8                                | No                          | No                     | 28                      |
| 20             | 9           | Female | Lump abdomen      | 180               | 5           | 7                                | No                          | No                     | 30                      |
| 21             | 4           | Male   | Pain, jaundice, lump abdomen | 260               | 5           | 7                                | No                          | No                     | 27                      |
| 22             | 2           | Female | Lump, jaundice    | 240               | 6           | 9                                | Hypertrophic scar           | No                     | 35                      |
| 23             | 10          | Female | Pain, jaundice    | 240               | 5           | 7                                | No                          | No                     | 37                      |
| 24             | 2.5         | Male   | Jaundice, lump abdomen | 180               | 6           | 8                                | No                          | No                     | 36                      |
| 25             | 2.66        | Female | Pain abdomen, lump | 240               | 6           | 8                                | No                          | No                     | 25                      |
| 26             | 6           | Female | Lump abdomen      | 220               | 5           | 7                                | No                          | No                     | 22                      |
| 27             | 6           | Female | Pain abdomen      | 270               | 5           | 7                                | No                          | No                     | 20                      |
| 28             | 3.5         | Female | Presented with pancreatitis/pain abdomen | 250               | 6           | 12                               | Pancreatitis 1 month postoperative, resolved conservatively | No                     | 16                      |
| 29             | 2           | Female | Pain abdomen, vomiting | 260               | 7           | 9                                | No                          | No                     | 12                      |
| 30             | 4           | Male   | Pain abdomen      | 260               | 6           | 8                                | Prolonged bile leak, peritonitis Required surgery, lavage and drainage | No                     | 14                      |
| 31             | 0.16        | Female | Jaundice, hepatomegaly, acholic stool | 270               | 15          | 25                               | Failure to thrive, Cirrhosis liver 12 then lost to follow-up | No                     | 16                      |
| 32             | 4           | Female | Lump abdomen      | 245               | 6           | 8                                | No                          | No                     | 6                       |
| 33             | 7           | Female | Pain and lump abdomen | 210               | 5           | 7                                | No                          | No                     | 3                       |
re-exploration and peritoneal lavage and drainage. This patient was an infant with failure to thrive and deranged liver function and required prolonged nutritional support postoperatively. She had cirrhosis on histopathology of liver biopsy. She was lost to follow-up after 1 year from surgery. One other patient had prolonged ileus requiring parenteral nutritional support. One patient who had presented with pancreatitis had a postoperative single episode of pancreatitis 1 month after surgery which was managed conservatively, no further episode since then with a follow-up period of 10 months. Wound infection occurred in one, and one patient developed hypertrophic scar. We did not have any case of postoperative stricture, cholangitis, gastritis, or malignancy in this group in the follow-up period which ranged from 3 to 81 months (mean ± SD = 36.30 ± 19.24 months) [Table 4].

**Discussion**

Standard treatment of type I choledochal cyst is a complete excision of the cyst with reconstruction of biliary-enteric drainage. Various methods are used for the reconstruction, namely Roux-en-y hepaticojejunostomy (RYHJ), hepaticoduodenostomy (HD), interposition of appendix, or isolated jejunal loop.[2] Stricture of the biliary-enteric anastomotic site is a complication that is possible in all of these types of reconstruction and is likely the most important factor in intermediate to long-term outcome.[3] However, each of these procedures has some advantages and disadvantages over others. Of the accepted methods of reconstruction of biliary-enteric drainage, the authors feel that a physiologic drainage of bile in the duodenum without any long-term potential adverse effect is of utmost importance in children. RYHJ was used to be the most popular method until recent years when HD superseded it as most popular reconstruction. One of the reasons being its easy reproducibility by surgeons both in open and laparoscopic techniques.[4] Roux-en-y loop of the jejunum diverts bile away from the duodenum where it should be mixing with pancreatic juices and acid chyme from the stomach, thus having potential for malabsorption and acid peptic diseases.[5] One study showed that these children actually do catch up in growth after surgery in spite of a Roux loop, but overall evidence is scarce.[6] The standard 40-cm Roux loop may actually become redundant and cause stasis-stone-cholangitis sequence. There had been studies that reduced the length of the Roux loop to that suit the size of the child to address these problems.[7] The most disturbing fact about HD is the consistently reported high incidence of duodenogastric regurgitation (DGR) and the fact that there are changes in gastric epithelium due to that which is known to predispose to malignancy.[8-10] Shimotakahara et al. suggested that if the size of the dilated ducts is more than 10 mm, there is a high chance of duodenal contents refluxing into the intrahepatic bile ducts (including activated pancreatic juice) which may damage biliary epithelium and predispose to malignancy.[2,4,11] However, the actual risk of malignancy

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**Table 2: Clinical presentations**

| Presentations       | Number of patients (%) |
|---------------------|------------------------|
| Pain abdomen        | 22 (66.67)             |
| Lump abdomen        | 16 (48.48)             |
| Jaundice            | 12 (36.36)             |
| Pancreatitis        | 1 (3.03)               |
| Classic triad       | 2 (6.06)               |
| Acholic stool, ascites | 1 (3.03)          |
| Antenatal           | 0                      |

**Table 3: Investigations**

| Investigations          | Number of patients Preoperative | Number of patients Postoperative and follow-up |
|-------------------------|---------------------------------|-----------------------------------------------|
| MRCP                    | 31                              | 0                                             |
| USG abdomen*            | 33                              | 33                                            |
| HPB scan*               | 2                               | 33                                            |
| CECT abdomen            | 2                               | 0                                             |
| LFT*                    | 33                              | 33                                            |
| Serum amylase**         | 33                              | 7                                             |

MRCP: Magnetic resonance cholangiopancreatography, USG: Ultrasonography, HPB scan: Tc-99m mebrofenin hepatobiliary scintiscan, CECT: Contrast-enhanced computed tomography, LFT: Liver function test

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**Figure 2:** Salient operative steps in short. (a) Jejunal loop selected. (b) The loop is isolated on its pedicle (at least two arcades) and brought up in supracolic compartment through window in transverse mesocolon. (c) Upper anastomosis completed between confluence (hilar) and interposition loop. (d) Lower interposition loop to duodenal anastomosis completed.
is yet not established and likely to take more time before any conclusion could be reached.[12] The basic handicap in comparing the jejunal interposition loop reconstruction is that it is rarely practiced nowadays or rarely reported in the contemporary English literature. It has gone out of favor due to the following probable reasons – it is time-consuming and relatively complex procedure with multiple anastomosis and probably due to overwhelming popularity of laparoscopic HD in the current era in spite of the fact that laparoscopic HD is still fraught with lack of standardization (as observed by Stringer).[13] DGR has been reported in jejunal interposition procedure as well; however, we believe that the actual length of the jejunal conduit with its isoperistaltic nature and lower anastomosis done at the vertical part of the duodenum away from the pylorus helps in minimizing the DGR and also retrograde spill of duodenal content into the biliary tree. In our study, the postoperative hepatobiliary scintiscan (Tc-99m mebrofenin) did not show any notable tracer activity in the stomach except in one although the child was asymptomatic [Figure 3a]. Good drainage in postoperative HPB scan is seen in most (32 out of 33) patients [Figure 3b]. Although we had seen delayed transition/hold up of bile (>1 h) in one patient [Figure 3a], there were no clinical symptoms, no altered LFT, or morphological stricture in imaging (USG abdomen) at follow-up. Although bile leak occurred in three patients (9%), only one required reoperation (3%). This skewed percentage of leak can also be due to the small size of patient population and might actually decrease for a larger series. The absence of cholangitis in follow-up in this group probably contributed due to the following factors: (I) wide hilar anastomosis, (II) we did not address the cysts with intrahepatic component and stricture/narrowing at intrahepatic part of ducts, (III) relatively small sample size, and (IV) follow-up period being short to intermediate. Our operative time was more compared to HD and hepaticojejunostomy in most of the available literature beyond 2010 [Table 5].[2,5,14,15] Operative time may depend on various factors other than the mode of biliary-enteric reconstruction. In a retrospective multicenter study from hepaticojejunostomy, Guo et al. from China showed that previous biliary tract infection, cholecystitis, and cystic type of choledochal cyst were statistically significant for more operative time.[16] That kind of analysis was beyond scope of this study.

Postoperative hospital stay in our situation depends a lot on socioeconomic factors other than the surgical factors itself, although we do not have the data or analysis regarding that we believe we have an acceptable postoperative hospital stay albeit it is consistently more compared to HD [Table 5].

**Table 4: Morbidity**

| Time to full feeds (days), mean±SD | Hospital stay (days), mean±SD | Bile leak, n (%) | Cholangitis, n (%) | Reflux gastritis, n (%) | Stricture/stone, n (%) | Cirrhosis liver, n (%) | Re-operation, n (%) | Wound infection, n (%) | Hypertrophic scar, n (%) |
|----------------------------------|-------------------------------|-----------------|-------------------|-----------------------|-----------------------|----------------------|----------------------|----------------------|------------------------|
| 6.03±1.97                       | 8.96±3.63                     | 3 (9)           | 0                 | 0                     | 0                     | 1 (3)                | 1 (3)                | 1 (3)                | 1 (3)                  |

SD: Standard deviation

**Figure 3:** Follow-up Tc-99m mebrofenin hepatobiliary scintiscan. (a) Postoperative scan showing gastric bile reflux (S) and delayed but adequate clearance in an asymptomatic child with normal liver function test (b) Postoperative scan showing good bile excretion and early clearance from the loop into the duodenum, no gastric bile reflux. *L*: Interposition loop, *D*: Duodenum, *S*: Stomach

**Conclusion**

Thus, we believe that jejunal interposition is a safe, reproducible, physiologic technique for biliary-enteric reconstruction after complete excision of choledochal cyst, especially in children, with acceptable complication rates and morbidity. At present, its superiority compared to other acceptable methods, especially HD, cannot be established; however, unless tried and tested by many and the patients being followed up even after adulthood, the question of actual benefit cannot be established or emphasized more.
Table 5: Few studies to compare with beyond 2010

| Author year of study | Type of study | Method of reconstruction | Number of patients (n) | Laparoscopic method (n) | Age at operation (years) Mean±SD | Operative time (min) Mean±SD | Hospital stay (days) Mean±SD | Follow-up time (years/months), range (years) Mean±SD |
|----------------------|--------------|-------------------------|-----------------------|-------------------------|---------------------------------|-------------------------------|-----------------------------|---------------------------------------------------|
| Hussam S Hassan 2016 | Retrospective | HD                      | 32                    | NA                      | 95±5.1                          | 5.34±2.65                     | 54.6±6.42 months             |
| Liem 2012            | Retrospective | HD                      | 238                   | 398                     | 3.96                            | 164±51                        | 6.4±0.3                     | 2.1±0.12 years                                   |
| Santore 2011         | Retrospective | HD                      | 39                    | 6                       | 5.5                             | 235                           | 7.1±6                       | 3 months-6 years                                 |
| Current study        | Retrospective | Jejunal interposition   | 33                    | 0                       | 4.63±2.98                      | 228.78±40.43                  | 8.96±3.63                   | 36.30±19.24 months                              |

HD: Hepaticoduodenostomy, HJ: Roux-en-y Hepaticojejunostomy, NA: Not available, SD: Standard deviation

Financial support and sponsorship
Nil.

Conflicts of interest
There are no conflicts of interest.

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