Outcomes of continous versus interrupted suturing techniques for biliary-enteric anastomosis after choledochal cyst excision in children

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Received: 10 November 2023
Revised: 29 November 2023
Accepted: 9 December 2023
Published: 31 January 2024

The Egyptian Journal of Surgery 2024, 43:131–138

Background
In this study, the biliary-enteric anastomosis following choledochal cyst excision was studied using continuous suture and interrupted suture procedures in a pediatric population.
Patients and methods
In this study, information on 57 children who received continuous suture choledochal cyst surgery at our facility between 2015 and 2020 was gathered retrospectively. The patients that were enrolled were divided into two groups: continuous suture (n=24) and interrupted suture (n=33).
Anastomotic leakage, anastomotic duration in minutes, hospital stay in days, and cost were all compared between these groups.
Results
The incidence of anastomotic leakage was higher in the interrupted suture group (4.17 vs. 6.6% for continuous suture and interrupted suture, respectively), but the difference was statistically insignificant (P=0.63). The groups did not differ regarding hospital stays (P=0.25). The mean time required to complete the anastomosis in the continuous suture group was 15.3±4.1 min, compared with 23.5±5.2 min in the interrupted suture group ($P<0.0001$). The costs were &z.euro;5 ±0.0 in the continuous suture group and &z.euro;30±6.4 in the interrupted suture group ($P<0.0001$).
Conclusion
The anastomotic leakage and hospital stay did not differ between the continuous suture and interrupted suture groups. In contrast, the continuous suture group had a considerable advantage over the interrupted suture group in terms of anastomotic duration and cost.

Keywords:
anastomosis, children, choledochal cyst, cost, leakage

Egyptian J Surgery 43:131–138

1110-1121

Introduction

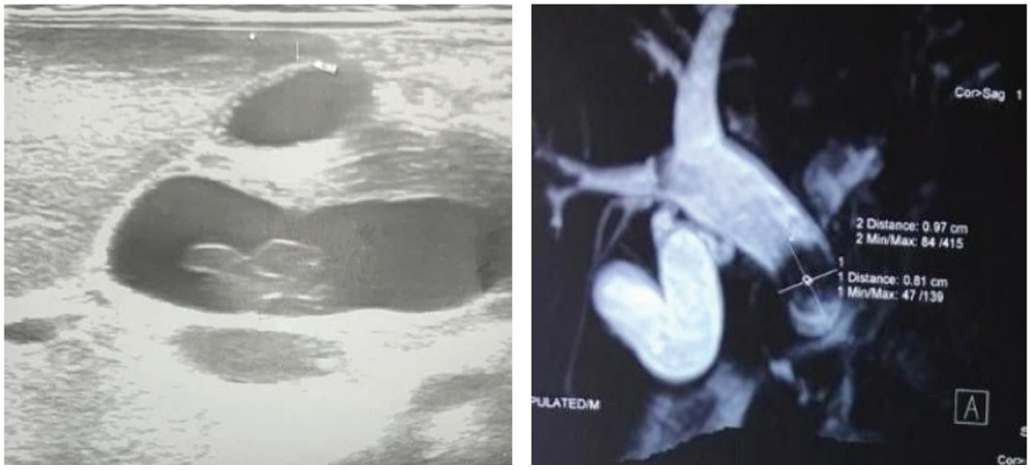
Choledochal cyst is a rare congenital anomaly that includes dilations of the biliary tracts, with an incidence ranging from one per 100 000–150 000 in Europe and America and one per 1000 to 13 000 in Japan [1,2], with a reported female-to-male ratio of â 3 : 1 [3]. Pediatric surgeons usually encounter this disease because 80% of these cases present before the age of 10 years [3–5]. The definitive treatment of choledochal cyst is complete removal of the entire cyst with restoration of the biliary and intestinal tracts [3,4,6,7].

The two main techniques of reconstruction are either hepaticoduodenostomy or hepaticojejunostomy, with several studies comparing the outcomes between them [8,9]. However, to the best of our knowledge, no study in the literature has compared the outcomes between the suture techniques (continuous suturing or interrupted suturing) used in reconstruction. This study compared both suture techniques used for biliary-enteric anastomosis in choledochal cyst surgery in the pediatric population.

Patients and methods

With institutional approval (IRB local approval number: 17300745, 28/3/2022), we reviewed 57 patients with choledochal cysts who underwent choledochal cyst excision with biliary-enteric reconstruction from 2015 to 2020 at the Pediatric Surgery Unit in our hospital. Written informed

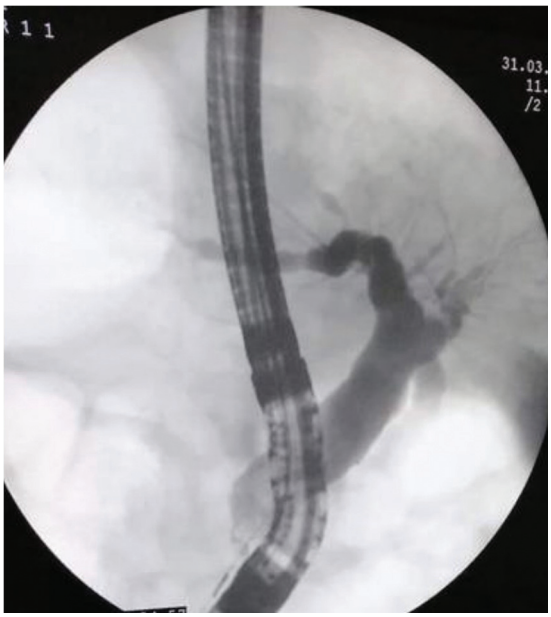
Figure 1



(a) An ultrasonography showing choledochal cyst type 1 with Fasciola seen in the common bile duct. (b) A magnetic resonant cholangiography showing type 1 choledochal cyst with stone in its distal end.

consent was obtained from the patient for publication of this manuscript and accompanying images. All patients initially underwent abdominal ultrasonography (US), and the diagnosis was confirmed with magnetic resonance cholangiopancreatography (MRCP) (Fig. 1a and b, respectively). Endoscopic retrograde cholangiopancreatography (ERCP) was conducted for one patient suspected of having a parasitic infestation (Fig. 2). All basic laboratory investigations were drawn with a mean preoperative total bilirubin level of 0.92 with a median of 0.6 (range, 0.2–4 mg/dl) and mean liver aspartate aminotransferase, alanine transaminase, and alkaline phosphatase levels of 44.11, 44.09, and 216.8, respectively. Table 1 shows the clinical profile of the patients included in the study.

Figure 2



ERCP demonstrating dilated common bile duct without distal obstruction (choledochal cyst). ERCP, endoscopic retrograde cholangiopancreatography.

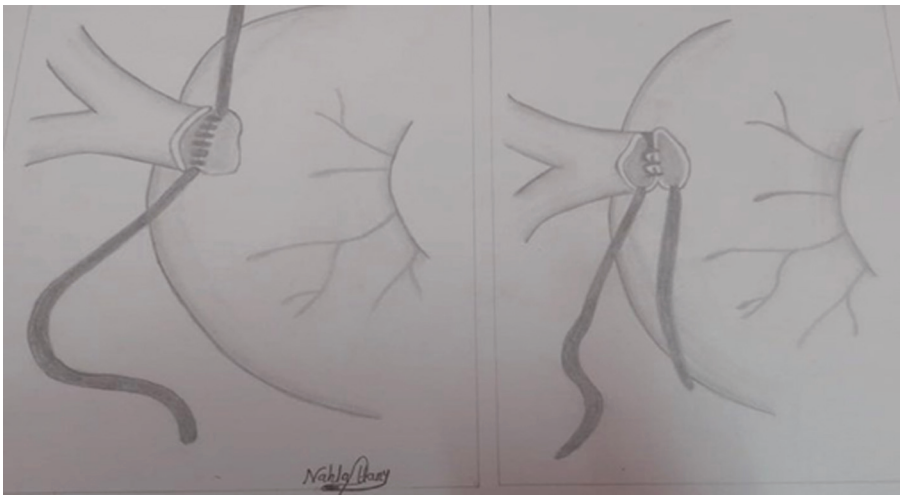
The medical records of 57 patients were retrospectively reviewed, and preoperative and postoperative variables were recorded. These included sex, age, weight,

Table 1 Clinical profiles of patients included in the study

Number of patients	57
Sex	*n* (%)
Male	20 (35.1)
Female	37 (64.9)
Age (years) (mean±SD)	6.01±3.6 (range, 40 days to 14 years)
Body weight (kg) (mean±SD)	24.18±13.92 (range, 4.5–62)
Presentation	*n* (%)
Abdominal pain	37 (64.9)
Mass	8 (10.5)
Jaundice	5 (8.77)
Triad	4 (7)
Perforated cyst	2 (3.5)
Incidental	1 (1.75)
Prenatal US	1 (1.75)
Pancreatitis	1 (1.75)
Diagnostic tool (MRCP)	57 (100)
Number of type 1 choledochal cyst	57 (100)
AST levels average	44.11
ALT levels average	44.09
ALP levels average	216.8
Total bilirubin levels (mg/dl) (mean, median)	0.92, 0.6 (range, 0.2–4)

ALP, alkaline phosphatase; ALT, alanine transaminase; AST, aspartate aminotransferase; MRCP, magnetic resonant cholangiography; US, ultrasonography.

Figure 3



Bilioenteric anastomosis using continuous suture technique (a) and interrupted suture technique (b).

presenting symptoms, type of choledochal cyst, diagnostic tools, preoperative liver enzymes, preoperative total bilirubin levels, anastomotic types (either hepaticoduodenostomy or Roux-en-Y hepaticojejunostomy), suture technique (either continuous or interrupted suture) (Fig. 3), anastomotic leakage, anastomotic duration in minutes, hospital stay in days, and cost of suturing material per case (calculated by the number of suture ampoules per case multiplied by the cost of one ampoule). We grouped all these variables according to the suture technique used into the continuous suture group (n=24) and interrupted suture group (n=33) and statistically compared all previous variables. The provisions of the Declaration of Helsinki were followed when conducting the study.

Operative techniques

All patients underwent surgery through a right subcostal incision, and our main goal was complete excision of the anomalous biliary tree, whenever possible. After complete cyst excision, an intraoperative decision was made by the surgeon on reconstruction of the biliary-enteric anastomosis, either hepaticoduodenostomy or hepaticojejunostomy, with continuous or interrupted suture. We used 5/0 polyglactin (Vicryl) in all cases. In all patients, we used an intraabdominal drain in the subhepatic pouch. All patients were transferred postoperatively to the intermediate care unit for 1 day and subsequently transferred to the wards. We recorded the number of patients who had biliary leakage through the intraabdominal drain during their hospital stay.

Statistical analysis

We used GraphPad Prism (9.0.2) (San Diego, California, USA) software for statistical analysis. Preoperative numerical variables were summarized as frequency counts, mean±SD, and/or medians and ranges. The normality tests used are the Shapiro–Wilk test and the Kolmogorov–Smirnov test. Numbers and percentages were used to express the categorical variables. The Mann–Whitney U test was used to compare numerical variables with skewed data and the unpaired t test with regularly distributed data. To compare categorical data, we utilized Fisher's exact test. P values less than 0.05 were considered statistically significant.

Results

The 57 patients included 20 (35.1%) boys and 37 (64.9%) girls, with a mean±SD age of 6.01±3.6 years (range, 40 days to 14 years) and a mean±SD body weight of 24.18±13.92 (range, 4.5–62 kg) at the time of surgery. All patients had type 1 choledochal cyst, and the presenting symptoms were variable, ranging from an accidental finding with abdominal US (one case) to abdominal pain, which is the most common presentation (37 cases) (Fig. 4).

We performed choledochal cyst excision on a total of 57 patients. The hepaticojejunostomy was conducted on 31 patients, while hepaticoduodenostomy was conducted on 26 patients. Twenty-four (42.1%) patients underwent biliary-enteric reconstruction using continuous suture, and 33 (57.9%) patients underwent reconstruction using interrupted suture.

Figure 4

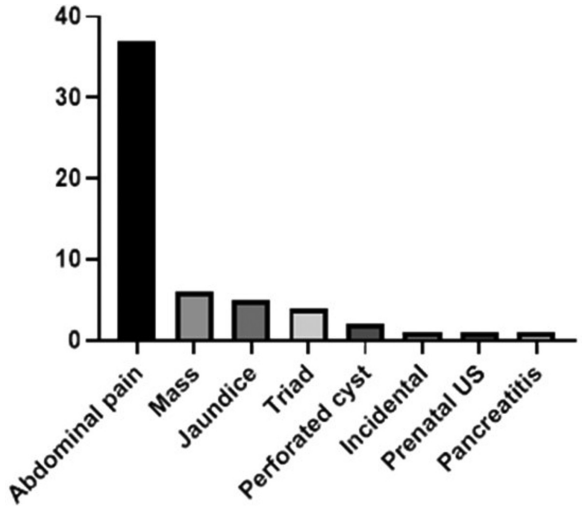
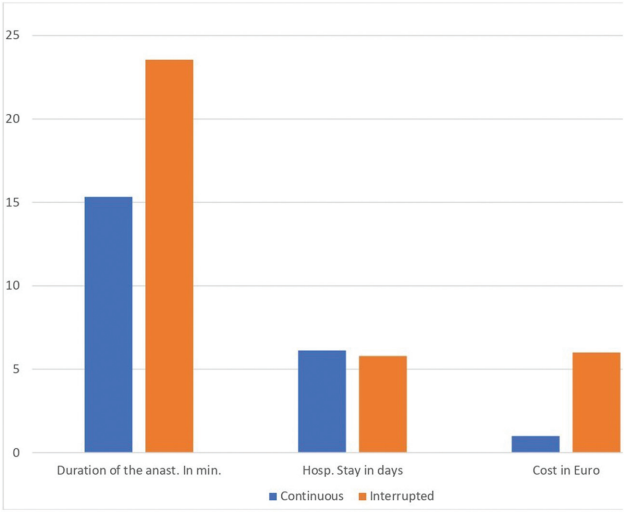


Diagram showing the frequency of presenting symptoms in our study.

Figure 5



Comparing the two study groups regarding anastomosis, duration, hospital stay, and cost.

Basic patient characteristics between both groups, including age, sex, weight, bilirubin levels, and liver enzyme levels, did not show a statistical difference.

The duration of biliary-enteric anastomosis in minutes was compared in both groups, and the mean±SD was 15.33±4.21 min in the continuous suture group, which was shorter than that in the interrupted suture group (mean±SD, 23.55±5.227, with a significant $P<0.0001$) (Fig. 5).

The hospital stay in days between both groups was insignificant, with a *P* value of 0.25. It was mean±SD 6.1±1.1 days in the continuous suture group and 5.8 ±0.78 in the interrupted suture group (Fig. 5).

A statistical analysis of the cost per case showed a significant difference. The average number of per-case ampoules used in the continuous suture group was one with a SD of 0, while it was 6±1.28 ampoules in the interrupted suture group, with a *P* value less than 0.0001. The mean cost was &z.euro;5±0.0 in the continuous suture group and &z.euro;30±6.4 in the interrupted suture group ($P<0.0001$) (Fig. 5).

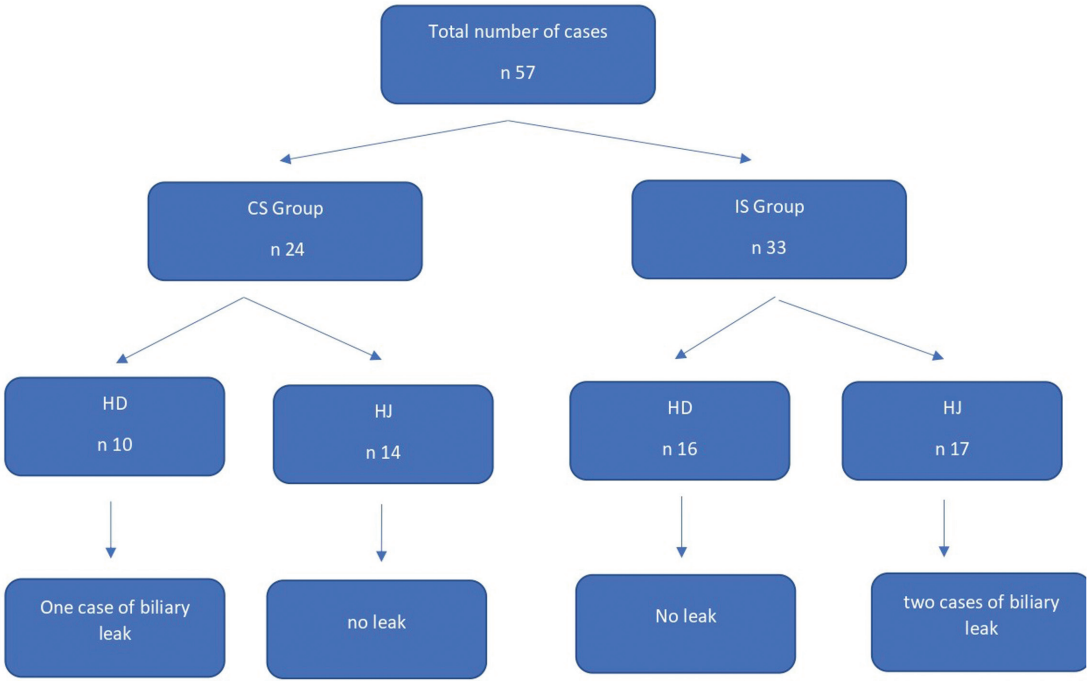
The leakage incidence in both groups was three, one (4.17%) in the continuous suture group and two (6.6%) in the interrupted suture group. The difference between both groups was statistically insignificant, with a *P* value of 0.63. Of the 57 cases, 31 patients underwent hepaticojejunostomy and 26 underwent hepaticoduodenostomy. There were two (6.45%) cases of anastomotic leakage in the hepaticojejunostomy group and one (3.85%) case in the hepaticoduodenostomy group. This difference was insignificant between both groups, with a *P* value more than 0.77 (Fig. 6). In the current study, the shortest duration of follow-up was 6 months, and the maximum period of follow-up was 1 year.

Discussion

Herein, we retrospectively analyzed 57 cases of bilioenteric anastomoses after choledochal cyst excision in children, mainly to assess the effect of suture technique on leakage, operative time, cost, and postoperative hospital stay in a tertiary referral center. Most cases of choledochal cysts are diagnosed during childhood, with an increasing incidence among adults in recent years. In adults, the most common presenting symptom is abdominal pain [10]. Two of the classic triad (abdominal pain, palpable abdominal mass, and jaundice) account for â 85% of the presenting symptoms in the pediatric population, mainly abdominal pain and jaundice [11]. Acholic stools, jaundice, and vomiting are the presenting symptoms in infants below 1 year of age. Rarely, complications are the presenting symptoms, pancreatitis, cholangitis, abnormal liver function tests, and portal hypertension, which may be caused by an anomalous pancreaticobiliary duct junction or stones or parasites obstructing the common bile duct (CBD) lumen [12–15].

The choledochal cyst may present with complications like malignancy. Jan *et al.* [15,16] reported a 10% incidence of malignancy in their series. Another

Figure 6



Incidence of biliary leakage in relation to the type of anastomosis and suture technique used.

complication is perforation. The incidence of perforation ranges from 5 to 10% [17]. Recently, incidental findings and prenatal diagnoses in the US have increased [18,19]. In our study, the pattern of presentation of symptoms is shown in Fig. 1, which is comparable with the literature. However, we see that prenatal diagnosis is made only in one (1.75%) case. This low proportion compared to that in the literature may be due to the unavailability of prenatal US in developing countries compared to those in developed countries. Moreover, we had zero malignancy cases in our study. Jan *et al.* [15] and Todani *et al.* [16] reported that the malignancy mainly occurs in adults or delayed teens. Interestingly, they found a case of choledochal cyst in our series that has distal obstruction with Fasciola and another case with distal CBD stone (Fig. 2a and b). We had two (3.5%) patients who presented with signs of biliary peritonitis secondary to perforated choledochal cyst. Kim *et al.* [17] identified perforated choledochal cyst in eight (8.7%) patients out of a total of 92 children who suffered from choledochal cyst.

The diagnosis of choledochal cyst is mainly made by imaging studies that delineate the anatomy of the biliary tree. In the current study, we initially performed abdominal US. It had a good sensitivity of 96.5% in the diagnosis of choledochal cyst in our study but did not help in the delineation of the biliary tree. The abdominal US can identify choledochal cyst and provide valuable comments on cyst location, liver condition, and portal structures. Despite this, it lacks the ability to identify anomalous pancreatobiliary duct junction or the cause of dilated CBD in about one-third of cases [19].

After performing US, we confirm the diagnosis with MRCP. The MRCP provided us with excellent delineation of the whole pancreaticobiliary tree with less invasive maneuvers and a lower cost [20]. We did not need to perform intraoperative cholangiography in any of our cases. The MRCP has the highest sensitivity among all radiology modalities, approaching 100% [21]. It poses an advantage over computed tomography as it does not expose the patient to ionizing radiation. Furthermore, MRCP is useful in identifying anomalous pancreatobiliary duct junction, cholangiocarcinoma, and choledocholithiasis [22]. The sensitivity of computed tomography cholangiography is only 64% in describing the pancreatic duct.

We performed ERCP on one patient in our series. The patient was diagnosed with a Fasciola infestation of the dilated CBD. Laboratory results matched Fasciola, and an antiparasitic regimen was prescribed to the patient. ERCP was ordered to confirm the choledochal cyst diagnosis and clearance of the dilated BD from any parasite. Despite being the highest diagnostic modality

for choledochal cyst, ERCP use has been limited in suspected cases of choledochal cyst due to its complications, including exposure to ionizing radiation, and its invasive nature. Moreover, ERCP-associated complications are common in cases of dilated ducts, long common pancreaticobiliary channels, or sphincter of Oddi dysfunction [22,23].

Alonso-Lej *et al.* [24] were the first to classify choledochal cyst in 1959. Presently, the most common classification used is the Todani classification and its modifications in 1977 and 2003 [16,25].

In our case series, all cases were type 1 according to the Todani classification and type 1 according to the Alonso-Lej classification.

The technique used for bilioenteric reconstruction in choledochal cyst was either hepaticoduodenostomy or hepaticojejunostomy. Many studies compared them. Santore *et al.* [26] proposed that hepaticoduodenostomy has a lower operative time and faster gastrointestinal function with a lower complication rate that requires reoperation. However, there was no significant difference in the biliary leakage rate. A meta-analysis was conducted by Narayanan *et al.* [9], whose results showed that hepaticoduodenostomy has more biliary gastric reflux and gastritis than hepaticojejunostomy. The analysis concluded that few good-quality studies compared hepaticoduodenostomy and hepaticojejunostomy. Thus, there is no recommendation to perform either technique based on the current literature.

In our series, 31 patients underwent hepaticojejunostomy and 26 underwent hepaticoduodenostomy. We found three cases of biliary leakage in both groups, with no significant difference ($P>0.7$). There were no other major complications, such as pancreatitis, bile gastric reflux, or anastomotic stricture, during our study.

The incidence of biliary leakage was 6.1% in the interrupted suture group and 3.8% in the continuous suture group, which may be explained by the theoretically watertight effect of continuous sutures. However, the *P* value was not significant. Kasahara *et al.* [27] reported similar results compared with the incidence of leakage between interrupted suture and continuous suture during end-to-end choledochocholedochostomy for orthotopic liver transplantation. However, they did not declare the difference between the two suture techniques in the hepaticojejunostomy group. However, other studies showed the same finding of higher leakage in the interrupted suture group after hepaticojejunostomy in liver transplant recipients [28].

Experimentally, interrupted suture and continuous suture anastomosis have equal anastomotic bursting pressure and breaking strength in a rat model, according to Jiborn *et al.* [29]. Conversely, Harder has a different finding: in an interrupted anastomosis, the suture is placed at a right angle. A continuous anastomosis is extremely different, the suture filaments run diagonally over the anastomosis. By filling and therefore expanding the anastomosis, the crosswise running filaments are capable of sealing themselves because the tension is better distributed on the circumference [30]. Thus, the question that should be raised is, 'Which suture technique (interrupted suture vs. continuous suture) is better regarding the incidence of leakage after biliary-enteric anastomosis?' This can only be answered through a randomized, controlled comparative study. Surgeons know well how operative time is a very important factor in patient recovery and its effect on the complication rate. Daley *et al.* [31] studied over 100 000 operative cases, and the results revealed that a longer duration of the operation correlates with higher complications and higher risks for the patients. Thus, it is highly recommended for every surgeon to choose the operative technique that has a shorter duration among other techniques if the outcomes and complication rates are comparable. In this series, continuous anastomosis has a shorter duration in contrast to interrupted sutures, with no added complications or risks. The shorter operative time in the continuous suture group seems to be due to the fewer knots the surgeon has to tie and the shorter time needed for handling excessive instruments in the interrupted suture group.

Guo *et al.* [32] studied the factors that affect the operative time in choledochal cyst surgery in the pediatric population. He found that the morphological subtype and presence of cholangitis affected the operative time. It is shown that the cystic form of choledochal cyst is associated with more displacement in the biliary tracts and biliary vasculature and subsequently needs more time during dissection, while cholangitis is associated with more adhesion and fibrosis. Moreover, it seems that continuous suture is more cost-effective compared with interrupted suture.

Study limitations

It is a retrospective study, so it is recommended to perform a randomized controlled trial to provide more evidence for our results.

This study has a defect regarding the long-term outcomes, mainly anastomotic stricture; we did not detect any cases of anastomotic stricture in our study until the time of writing the manuscript. However, a longer follow-up period of more than 5 years is required to validate the results.

Conclusion

To the best of our knowledge, this retrospective study is the first to demonstrate that the continuous suture and interrupted suture techniques did not differ regarding anastomotic leakage and hospital stay in the pediatric population. In contrast, the continuous suture group had a considerable advantage over the interrupted suture group in terms of anastomotic duration and expenditure. Our argument is that while these findings should be confirmed by prospective, multicenter trials, our findings provide evidence in favor of continuous sutures for bilioenteric anastomosis after choledochal cyst excision.

Acknowledgements

Author contributions: T.A.S. wrote the manuscript, data design, the main surgeon who operated the patients and follow up of the patient. S.M.A. reviewed the manuscript, data interpretations, the surgeon assistant in some cases, and follow up of the patient. A.M., the surgeon assistant in some cases and follow up of the patient. M.S.A. data analysis, the surgeon assistant in some cases, and follow up of the patient. A.S.M. the surgeon assistant in some cases and follow up of the patient. H.M.A.M. the anesthesia physician. A.B. the surgeon assistant in some cases and follow up of the patient.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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