ENDOLUMINAL SURGERY

Comparison of pediatric choledochal cyst excisions with open procedures, laparoscopic procedures and robot-assisted procedures: a retrospective study

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Abstract

Background The main treatment of choledochal cysts is the complete resection of the cyst with Roux-en-Y hepaticojejunostomy, which includes open procedures, laparoscopic procedures, and robot-assisted procedures using a da Vinci surgical system. The aim of this current study was to investigate the safety and effectiveness of these three different surgical methods in pediatric choledochal cyst excisions.

Methods Between January 2015 and December 2018, patients with choledochal cysts treated with open procedures, laparoscopic procedures, or robot-assisted procedures were retrospectively analyzed. The data collected included demographic information of all patients, type and size of cyst, operative details, and postoperative outcomes.

Results A total of 371 episodes of patients were enrolled which consist of the open procedures group ($n = 226$), laparoscopic procedures group ($n = 104$), and robot-assisted procedures group ($n = 41$). The operation time was significantly longer in the laparoscopic procedures group (212.79 ± 34.94) than open procedures group (115.88 ± 13.50) and robot-assisted procedures group (180.61 ± 14.07) ($p < 0.001$). The volume of intraoperative bleeding were higher in the open procedures group (40.12 ± 55.51) than in the laparoscopic procedures group (21.73 ± 11.44) and robot-assisted procedures group (21.34 ± 9.42), while there was no significant difference between the latter groups. The time to taking water, time to starting liquid diet, and the average length of postoperative hospital stay were similar between the laparoscopic and robot-assisted procedures group, which are shorter than the open procedures group with significant differences. There was no signifcant difference in complications among the three groups.

Conclusion Choledochal cyst excision with robotic-assisted procedures had identical surgical effects as open procedures and had lower technical requirements. But it had higher medical cost and better cosmetic effects. Open procedures had largely positive surgical outcomes with fewest complications but poor cosmetic effects. Laparoscopic procedures were the most technique-demanding approaches with positive cosmetic and economic effect. The incidence of complications of laparoscopic procedures decreased with the learning curve.

Keyword Pediatric · choledochal cyst excision · open procedures · laparoscopic procedures · Robot-assisted procedures

Choledochal cysts (CCs) are rare entities characterized by congenital biliary tract dilatation leading to symptoms of abdominal pain, jaundice, and tumors. Its incidence in European countries and in the USA is 5–15 cases per million people [1–3], while it is more common in Asian countries,

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such as China, Korea, and Japan, with an incidence up to 1000 cases per million people [4–6].

Choledochal cysts can be discovered early during the antenatal period using prenatal sonography or during late childhood or early adulthood. About 80% of choledochal cysts are diagnosed in childhood before the age of ten years old [7, 8]. Imaging tests such as B-mode ultrasound, CT, and MRCP can assist in the diagnosis. Choledochal cysts have a high likelihood of progressing to severe hepatobiliary complications such as cholangitis, pancreatitis, perforation of the cyst, and even canceration [9]. Due to the abovementioned dangers involved, prompt treatment is essential.

The main treatment of choledochal cysts is the complete resection of the cyst with a Roux-en-Y hepaticojejunostomy, which traditionally has been performed as an open procedure [10]. Laparoscopic surgery is also an option as in pediatric cases, it has been performed extensively for various conditions and has been applied in choledochal cyst excision as well. In 1995, Farello et al. performed the first laparoscopic choledochal cyst resection with a Roux-en-Y hepaticoenterostomy in a 6-year-old girl [11]. Over the last decade, with the advent of laparoscopy, several authors have reported on the feasibility and benefits of laparoscopic choledochal cyst excisions [12–15]. However, laparoscopic approaches have not gained widespread popularity, mainly because these are technically-demanding procedures. Meanwhile, robotic surgery has been proposed as another adjunct for pediatric minimal surgery for hepatobiliary diseases, including operations treating choledochal cysts [16]. Woo et al. reported on the first robotic laparoscope-assisted type I choledochocystectomy for a 5-year-old child patient in 2006 [17]. Subsequently, there were related reports [6, 16, 18]. However, there still is a lack of data and large sample cases comparing the three surgical methods for pediatric choledochal cyst excisions. Therefore, we conducted a retrospective study to investigate the safety and effectiveness of these three different surgical methods: open procedures, laparoscopic procedures, and robot-assisted procedures using a da Vinci surgical system in pediatric choledochal cyst excisions.

Methods

Study population

This retrospective cohort study was approved by the West China Hospital of Sichuan University ethics committee. Owing to the retrospective nature of this study, the committee waived the need for patient consent. Between January 2015 and December 2018, patients with choledochal cysts and who were treated with open procedures, laparoscopic procedures or robot-assisted procedures with da Vinci surgical system were retrospectively analyzed. During the study period, all children with clinical symptoms or abdominal ultrasonography showing suspicion of choledochal cysts were diagnosed using computed tomography or magnetic resonance cholangiography. The surgical approach (open, laparoscopic or robotic procedure) was chosen according to the patient's parent's individual needs, such as operation cost, cosmetic effect, and operation time. Of course, children under 8 kg were not recommended to robot-assist surgery. The patients were divided into three groups according to the three different surgical methods: the open procedures group (OG), laparoscopic procedures group (LG), and robot-assisted procedures group (RG).

Open procedures

After endotracheal intubation under general anesthesia, an arterial catheter and a peripheral intravenous catheter are additionally used. A right subcostal incision of about 4-6 cm in length is made through which the gallbladder and choledochal cyst are excised. The choledochal cyst is opened to depress the cyst and remove any calculi. The cyst is transected 0.5–1.0 cm beneath the normal common hepatic duct to create a trumpet-shaped terminal. The cyst is dissected from its proximal to distal end. When the narrow, distal part of the cyst is exposed, it is clipped with double thread ligation and the entire cyst is removed. The jejunum is transected at a point 20 cm from the Treitz ligament and an end-to-side jejunojejunostomy is then created at a level 35 cm distal to the hepaticojejunostomy using the interrupted suture technique with 5–0 absorbable sutures. The Roux limp of the jejunum is pulled to the hepatic hilum in a retrocolic manner, and a hepaticojejunostomy is created in an end-to-side fashion using the interrupted suture technique with 4–0 absorbable sutures. A drainage catheter is then placed around the liver portal.

Laparoscopic procedures

After endotracheal intubation under general anesthesia, an arterial catheter and a peripheral intravenous catheter are additionally used. The patients are placed in the supine position. A Roux-en-Y jejunojejunal anastomosis is performed extracorporeally by prolapsing the jejunum through a 1.5 cm incision below umbilicus. Exploration through this incision is made to identify the Treitz ligament and for the subsequent anastomosis and anti-reflux valve. Finally, sealing of the blind end of the loop is performed. A 12 mm trocar is placed in the incision and then insufflation to 8–10 mm Hg is conducted. Three additional 5 mm trocars are inserted into the right subcostal region along the midclavicular line, the paraumbilical area of the right rectus abdomini, and the top left rectus abdomini. After general exploration of the abdominal cavity, the left hepatic lobe is suspended to allow

perfect visualization of the hepatic hilar region. Under the guidance of a laparoscope, a monopolar electrocautery hook is used to dissect the choledochal cyst and the gallbladder. The cyst is dissected down to the distal tapered end of the common bile duct and it is then ligated. The upper part of the cyst is further dissected up to the common hepatic duct and then removed at this level. The jejunum is brought up to the hepatic duct via the retrocolic route. An end-to-side anastomosis between the hepatic duct and the Roux-en-Y limb is conducted laparoscopically using a continuous hand suture method with 4–0 absorbable sutures. A drainage catheter is then placed around the liver portal.

Robotic procedures

After endotracheal intubation under general anesthesia, an arterial catheter and a peripheral intravenous catheter are additionally used. The patient should be put close to the bedside with their head elevated 15° with a slight tilt to the left 15°. Intestinal anastomosis is performed extracorporeally and a camera port is placed at this incision below umbilicus as the laparoscopic approaches. The 8 mm operating port I is placed in the left upper quadrant with a 5–8 cm length incision (Fig. 1). For infants the location is close to left anterior axillary line. The 8 mm operating port II is placed 5-8 cm right of the umbilicus and the 5 mm port for assistance is between Port I and the umbilical port. Traction sutures are performed at the
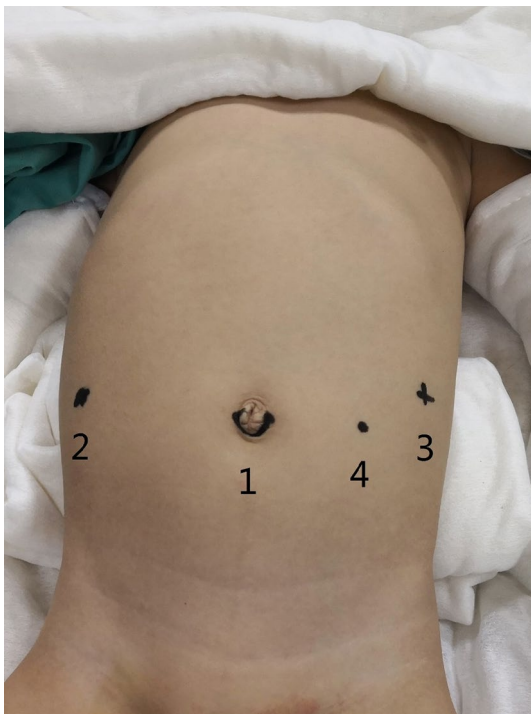

Fig. 1 Port placement in robot-assisted surgery for choledochal cysts: 1. Camera port. 2. Port I. 3. Port II. 4. Assistant port

base of ligament teres and at middle portion of gallbladder for better exposure of the cyst and hilum. An electric hook is used to free and then transect the cyst after double ligation. After the openings of the hepatic duct and cystic duct are identified, the cyst is completed removed. The opening site of the hepatic duct can be described as oval-shaped with a higher left side and a lower right side (Fig. 2A). The biliary loop is lifted up through the avascular region of the transverse colon's right mesentery. An end-to-side choledochojejunostomy is made 0.5 cm away from the blind end using a 4–0 Stratafix. Singer-layer continuous sutures are made from left to right and from back to front (Fig. 2B). The mesentery defect and biliary loop are then promptly repaired. Finally, the Gallbladder is removed and spilled bile is cleaned. A drainage catheter is then placed around the liver portal.

Postoperative progress

An oral diet was started on the third day after surgery in all groups upon evidence of a return of bowel motility. Water was given first, then followed by a liquid and a soft diet. Patient discharge was considered upon all diets being able to be undertaken without any discomfort, abdominal pain, or other complications.

Data collection

The data collected included: demographic information of all patients, type and size of cyst, operative details and outcomes such as operation time, volume of blood loss, intraoperative blood transfusion, postoperative feeding of solids, weight, adjusted morphine sulphate equivalent usage, postoperative hospital stay, and postoperative complications.

Statistical analyses

Data were entered into the database by one author and checked by one of the other authors. Statistical analysis was performed using SPSS version 23.0. A Chi-square test was used for analyzing categorical data among the three different groups. Continuous variables were recorded as the mean ± SD. Among-group comparisons were made using ANOVA. If there was any statistical significance, then between-group comparisons were made by performing Dunnett-t test. For each analysis, a p value of < 0.05 was considered statistically significant.

Results

A total of 382 patients with choledochal cyst excisions were treated with open procedures, laparoscopic procedures, and robot-assisted procedures at our institution over a 4-year
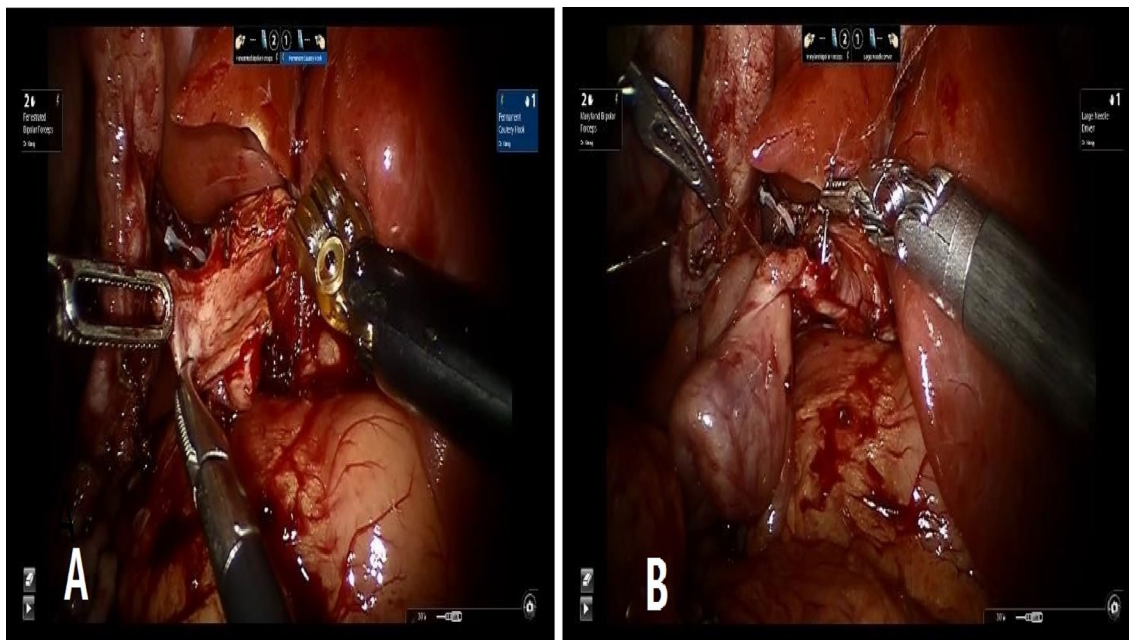
Fig. 2 Intraoperative photographs: **A** choledochal cyst dissected and resected at the level of common hepatic duct. **B** hepaticojejunostomy with robotic instruments

period (Fig. 3). The median follow-up time in open procedures group, laparoscopic procedures group, and robot-assisted procedures group were, respectively, 38.5 months, 36 months, and 20 months. And the total median follow-up time was 35 months. According to the retrospective study, missing data elements were identified in 11 records which were excluded accordingly. Therefore, a total of 371 cases

of patients with choledochal cysts were collected for final analysis.

Characteristics and outcomes of the study population are described in Table 1. The male to female ratio was 1:3.32. The median age of the patient was 34 months with a mean weight of 14.56 kg. The age and weight of the patients were significantly older and heavier in the robot-assisted

Fig. 3 Study flow of pediatric choledochal cyst excision
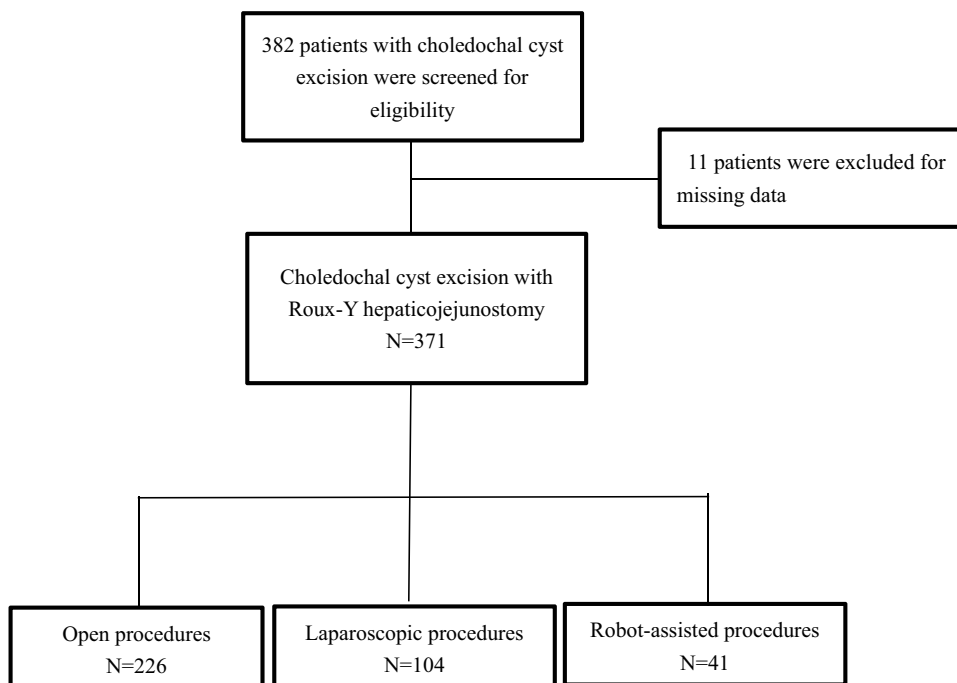
procedures group, compared to the open procedures group and laparoscopic procedures group ($p < 0.05$). At the same time, there was no significant difference between these two latter groups. The most common symptoms were abdominal pain, vomiting, and jaundice (67.92%, 44.47%, and 29.65%, respectively). A palpable abdominal mass and abdominal distension were observed in 9.16% and 9.43% of the patients, respectively. There were no significant differences in type and diameter of cyst among the three groups.

Intraoperative data are summarized in Table 2. The operation and times were significantly longer in the laparoscopic procedures group (212.79 ± 34.94) than the open procedures group (115.88 ± 13.50) and robot-assisted procedures group (180.61 ± 14.07) ($p < 0.001$). Total amounts of intraoperative fluid input were significantly higher in the laparoscopic procedures group (525.58 ± 87.05) than the open procedures group (312.43 ± 59.00) and robot-assisted procedures group (404.02 ± 39.12). The volume of intraoperative bleeding was higher in the open procedures group (40.12 ± 55.51) than in the laparoscopic procedures group (21.73 ± 11.44) and robot-assisted procedures group (21.34 ± 9.42), while there

was no significant difference between the two latter groups. Additionally, there were no statistical differences in the rate of red blood cell transfusion among the three groups. Six patients who had arranged for laparoscopic surgery were converted to open surgery and no case required conversion to laparotomy in robot-assisted procedures.

Postoperative outcomes and complications are shown in Table 3. The time to begin taking water, the time to starting a liquid diet, and the average length of postoperative hospital stay were similar between the laparoscopic procedures group and robot-assisted procedures group, which were both significantly shorter than the open procedures group. As regards to postoperative hospital parameters, postoperative pain medication usage was significantly lower in the minimally invasive groups than in the open procedures group ($p < 0.001$), where the mean weight-adjusted morphine sulphate equivalent usage was 0.94 ± 0.18 mg/kg for the open procedures group, 0.29 ± 0.15 mg/kg for the laparoscopic procedures group, and 0.30 ± 0.13 mg/kg for the robot-assisted procedures group. No significant differences in postoperative pain medication use were noted among the minimally invasive

Table 1 Patient Characteristics According to Surgical Approach

Group	OG n (%) N = 226	LG n (%) N = 104	RG n (%) N = 41	p-value
Sex				
Male	52(23.01%)	25(24.04%)	10(24.39%)	0.800
Female	174(76.99%)	79(75.96%)	31(75.61%)	
Age (month)[a]	33.5 (17.75–60.00)	28.00 (8.75–53.00)	48.00 (30.50–77.50)	0.005
Weight (Kg)[b]	14.48 (8.05)	13.06 (6.06)	18.74 (11.44)	0.001
Abdominal pain	158 (69.91%)	64 (61.54%)	30 (73.17%)	0.324
Vomiting	99 (43.81%)	41 (39.42%)	25 (60.98%)	0.060
Distension	25 (11.06%)	8 (7.69%)	2 (4.88%)	0.357
Jaundice	61 (26.99%)	38 (36.54%)	11 (26.83%)	0.101
Palpable mass	20 (8.85%)	10 (9.62%)	4 (9.76%)	0.746
WBC count (/mm3)[b]	9.02 (3.44)	8.88 (3.43)	9.84 (3.93)	0.305
Neutrophils (%)[b]	42.90 (18.32)	42.35 (18.98)	41.36 (18.50)	0.878
ALT (IU/L)[b]	126.46 (163.06)	122.42 (177.67)	130.44 (133.08)	0.961
AST (IU/L)[b]	146.77 (215.27)	139.50 (235.23)	165.63 (192.55)	0.811
TBIL (umol/l)[b]	41.47 (60.44)	41.00 (59.55)	61.00 (75.02)	0.160
DBIL (umol/l)[b]	31.71 (50.74)	31.40 (50.28)	49.33 (62.96)	0.123
IBIL (umol/l)[b]	9.65 (19.47)	9.56 (20.09)	11.44 (12.29)	0.847
Cyst type				
I	189 (83.63%)	90 (86.54%)	33 (80.49%)	0.640
II	1 (0.44%)	0 (0.00%)	(0.00%)	
IV	36 (15.93%)	14 (13.46%)	8 (19.51%)	
Diameter of cyst (cm)[b]	3.95 (2.14)	3.78 (2.39)	3.18 (1.65)	0.111

[a]Median, interquartile range;

[b]mean, standard deviation

OG open procedures group, *LG* laparoscopic procedures group, *RG* robot-assisted procedures group, *WBC* white blood cell count, *ALT* alanine transferase, *AST* aspartic aminotransferase, *TBIL* total bilirubin, *DBIL* direct bilirubin, *IBIL* indirect bilirubin

Table 2 Intraoperative outcomes according to surgical approach

Group	OG n (%) N=226	LG n (%) N=104	RG n (%) N=41	p-value
Operation time (min)[b]	115.88 (13.50)	212.79 (34.94)	180.61 (14.07)	<0.001
Anesthesia time (min)[b]	139.09 (19.03)	256.88 (39.14)	204.51 (17.77)	<0.001
Total fluid input (ml)[b]	312.43 (59.00)	525.58 (87.05)	404.02 (39.12)	<0.001
Total Urine output (mL)[b]	83.96 (11.55)	125.09 (19.93)	97.24 (7.81)	<0.001
Intraoperative bleeding (mL)[b]	40.12 (55.51)	21.73 (11.44)	21.34 (9.42)	<0.001
Transfusion rate, n (%)	4 (1.73%)	4 (3.85%)	0 (0.00%)	0.292
Conversion to open surgery, n (%)	–	6 (5.77%)	0 (0.00%)	

[a]Median, interquartile range

[b]mean, standard deviation

OG open procedures group, *LG* laparoscopic procedures group *RG* robot-assisted procedures group

Table 3 Postoperative outcomes and complications according to surgical approach

Group	OG n (%) N=226	LG n (%) N=104	RG n (%) N=41	p-value
Time to taking water (days)[b]	4.07 (0.38)	3.08 (0.38)	3.00 (0.31)	<0.001
Time to starting solids diet (days)[b]	4.78 (0.43)	3.86 (0.34)	3.74 (0.16)	<0.001
MS equiv. used (mg/kg)[b]	0.94 (0.18)	0.29 (0.15)	0.30 (0.13)	<0.001
Total complication	7 (3.10%)	9 (8.65%)	2 (4.88%)	0.064
Bleeding at hepaticojejunostomy	1 (0.44%)	1 (0.96%)	1 (2.44%)	
Bile leakage, n (%)	0 (0.00%)	2 (1.92%)	0 (0.00%)	
Wound infection	2 (0.88%)	0 (0.00%)	0 (0.00%)	
Respiratory tract infection	0 (0.00%)	0 (0.00%)	0 (0.00%)	
Residual cyst	0 (0.00%)	1 (0.96%)	0 (0.00%)	
Biliary stones	0 (0.00%)	1 (0.96%)	0 (0.00%)	
Pancreatitis	1 (0.44%)	0 (0.00%)	0 (0.00%)	
Intestinal obstruction, n (%)	3 (1.33%)	1 (0.96%)	1 (2.44%)	
Stricture of hepaticojejunostomy, n (%)	0 (0.00%)	3 (2.88%)	0 (0.00%)	
Reoperation, n (%)	2 (0.88%)	5 (4.81%)	1 (2.44%)	0.074
Hospital stay (days)[b]	10.28 (2.23)	7.56 (1.08)	7.55 (1.00)	<0.001
Hospitalization expenses (RMB)[b]	28,460 (2615)	35,430 (1847)	62,320 (3798)	<0.001

[a]Median, interquartile range;

[b]mean, standard deviation

OG open procedures group, *LG* laparoscopic procedures group, *RG* robot-assisted procedures group *MS* equiv, morphine sulphate equivalents

groups ($p=0.561$). The number of complications was higher in the laparoscopic procedures group ($n=9$, 8.65%) than the open procedures group ($n=7$, 3.10%) and robot-assisted procedures group ($n=2$, 4.88%) without a significant difference. The 7 complications in open procedures group consisted of 1 bleeding at the hepaticojejunostomy, 2 wound infections, 1 pancreatitis and 3 cases of intestinal obstruction. Two patients underwent reoperation. One patient with bleeding at the hepaticojejunostomy and one patient with a case of intestinal obstruction received an exploratory laparotomy. The 9 complications in laparoscopic procedures group consisted of 1 bleeding at the hepaticojejunostomy, 2 bile leakages, 1 residual cyst, 1 biliary stone, 1 intestinal

obstruction and 3 cases of stricture of the hepaticojejunostomy. 5 patients underwent reoperation. One patient with bleeding at the hepaticojejunostomy received an exploratory laparotomy. One patient with biliary stone received choledochojejunotomy and lithotomy. Three patients with stricture of the hepaticojejunostomy received a reoperation of choledochojejunostomy. Two patient with minor bile leakage was treated using a short conservative medical treatment without any problems. The 2 complications in robot-assisted procedures group consisted of 1 bleeding at the hepaticojejunostomy and 1 case of intestinal obstruction. One patient with bleeding at the hepaticojejunostomy received a reoperation with laparotomy. All 8 patients were eventually discharged

and made uneventful recoveries after the operation. The hospitalization expenses in open procedures group, laparoscopic procedures group, and robot-assisted procedures group were, respectively, $28{,}460 \pm 2615$ RMB, $35{,}430 \pm 1847$ RMB, and $62{,}320 \pm 3798$ RMB, which showed signifcant differences ($p < 0.001$). The healed incisions of the three different procedures were, respectively, presented in Fig. 4a–c.

Discussion

Currently the main surgical methods for treating choledochal cysts through an excision with Roux-en-Y hepaticojejunostomy include open procedures, laparoscopic procedures, and robotic-assisted procedures using the da Vinci surgical system. The laparoscopic approaches and robotic-assisted approaches have the advantage of being minimally invasive with cosmetically enhanced recovery and providing better vision of the deep anatomic structures compared with the open approaches [12]. However, there is still a serious lack of data and large sample cases comparing the safety and effectiveness of these three surgical methods for pediatric choledochal cyst excisions.

In our study, patients in the robot-assisted procedures group were significantly older than those in the open procedures group and laparoscopic procedures group. We believe that this is the result of our strategy of not recommending robot-assisted procedures in young patients with choledochal cyst, because currently bulky robotic surgical systems and evolving techniques for choledochal cyst treatments would limit the application of robot-assisted surgery in very young patients due to their small size. However, we believe that technical refinement and further miniaturization of robotic systems in the future could reduce this limiting effect of patient size in pediatric choledochal cyst surgery.

The comparison of the three groups in our study showed that the mean total operation time for laparoscopic operation group ($212.79 \pm 34.94$ min) and robot-assisted procedures group (180.61 ± 14.07 min) appeared to be longer than open procedures group (115.88 ± 13.50 min). Laparoscopic operations required the longest operation time and the open procedures required the shortest operation time, and this result was comparable to that found in other previously reported literature [19–22].

Six patients who had been arranged to undergo laparoscopic surgery were later converted to open surgery in our study. Kim et al. reported one case was converted to open conversion in their early cases and Alizai et al. reported five cases of open conversion due to technical problems with the robot-assisted procedure [18, 21]. In our study, no case required conversion to laparotomy in robot-assisted procedures, whereas other authors reported a higher conversion rate due to technical problems.

The total complications rate of our patients was 5.3%, which is comparable to that of the previously reported literature [20, 23]. The rate of complications in the laparoscopic procedures group were higher than those in the open procedures group and the robot-assisted procedures group, but there was no significant difference found among the three groups.

The rate of complications and operation time in the laparoscopic procedures group was higher than the other two groups which may have been caused by a small abdominal space, complicated structures around the hepatic portal (the hepatic artery and the portal vein are behind the common bile duct), and the existence of abnormal blood vessels in laparoscopic procedures [19]. Laparoscopic hepaticojejunostomies are especially technically demanding and there is a steep learning curve in the initial stages. However, with the development of surgical skills and experience, the risk of conversion and postoperative complications has significantly decreased. Meanwhile, robotic surgery undoubtedly provides technical advantages over conventional laparoscopy [24]. It includes 3D imaging, tremor filters, and articulated instruments [25]. With this advanced equipment, robotic surgery is superior to conventional laparoscopic surgery due to its

Fig. 4 The postoperative photos of each group: **A** The healed incision of open procedure. **B** The healed incision of laparoscopic procedure. **C** The healed incision of robot-assisted procedure
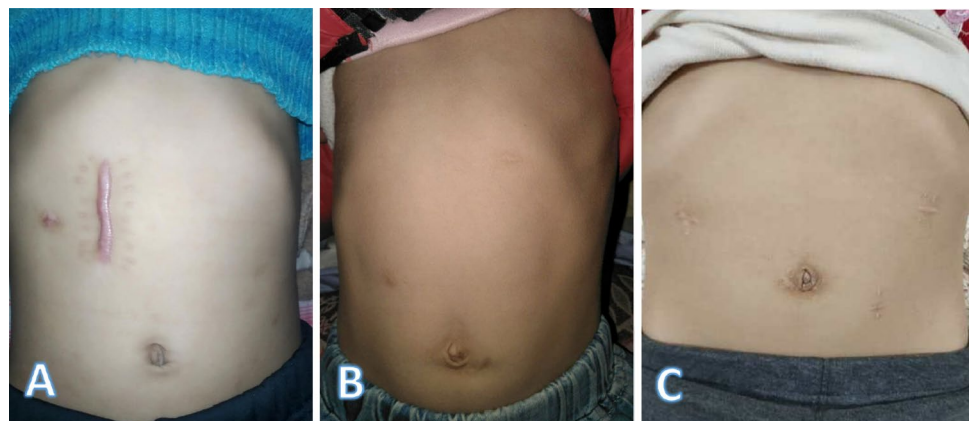
significant improvements in visibility and manipulation [26, 27]. Markar SR et al. conducted a systematic review which demonstrated there was a significantly reduced incidence of anastomotic stricture in the robotic Roux-en-Y gastric bypass compared when with the laparoscopic group [28]. The causes as to why robot-assisted procedures take longer than open procedures were chiefly related to the technical aspects of initial setup, docking time, and the time taken to exchange instruments during the procedure. Of course, robot-assisted procedures also has its limitations. The cost of robot-assisted procedures is higher because an extra 30–40 thousand RMB is needed. In addition to this, beginners to this procedure who deal with making knots and tissue pulling are prone to use excessive force, potentially causing adverse consequences. Consequently, the tactile feedback needs to be improved.

The total amount of intraoperative fluid input and output in the laparoscopic procedures group was higher than that in the open procedures group and the robot-assisted procedures group because of the longer operation time in the laparoscopic procedures group. Laparoscopic operations and robot-assisted approaches result in less intraoperative blood loss, less postoperative recovery time, shorter postoperative hospital stays, and lower postoperative pain medication use, which may be due to its minimally invasive nature.

However, there are several limitations in our study. First, the study is a retrospective study in a single center. Second, the different time intervals of enrollment of the three groups of patients may impact the results even though the postoperative management and discharging indexes are the same.

Conclusion

Choledochal cyst excisions with robotic-assisted procedures had identical surgical effects with open procedures while also having lower technical requirements and better cosmetic effects. At the same time, it had higher medical cost which can be a barrier to its application. Open procedures had positive surgical outcomes with the fewest complications but poor cosmetic effects. Laparoscopic procedures were the most technically-demanding approaches, but had both positive cosmetic and economic effects. The incidence of complications of laparoscopic procedures decreased with the learning curve.

Compliance with ethical standards

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