

Original Article

Retrospective analysis of laparoscopic versus open treatment of annular pancreas in pediatric patient

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Abstract: *Background:* Annular pancreas is a rare congenital abnormality in the pediatric patient population. This study was to retrospectively evaluate the clinical efficacy and postoperative complications of laparoscopic or open duodenoduodenostomy for annular pancreas in pediatric patients. *Methods:* Total 7 pediatric patients who received laparoscopic duodenoduodenostomy and 9 cases undergoing open operation for annular pancreas were reviewed as the laparoscopic and control group, respectively. The demographic and clinical data including age, gender, body weight, premature birth and comorbidity were documented. *Results:* Pediatric patients in the laparoscopic and control groups were well matched with respect to the demographics and clinical data at admission (all $P > 0.05$). All surgeries were successfully performed and no laparoscopic procedures were converted to open surgery. The mean duration of laparoscopic surgery was 122.9 ± 22.7 min compared with 78.9 ± 10.2 min for open operation ($P < 0.001$). Patients in laparoscopic group had earlier removal of gastrointestinal decompression tube or Jejunal nutrient canal (3.8 ± 0.8 d vs. 6.3 ± 1.6 d, respectively, $P = 0.03$) than the control cases. The mean length of hospital stay after laparoscopic procedure was 12.3 ± 1.9 d, 2 days shorter than that after open operation ($P = 0.011$). No difference in postoperative complications was observed between the two groups ($P = 0.608$). *Conclusions:* Laparoscopic duodenoduodenostomy could be used as a safe and available treatment for annular pancreas in pediatric patients due to the earlier achievement of parenteral nutritional support and shorter hospital stay compared with the open procedure.

Keywords: Annular pancreas, laparoscopy, duodenoduodenostomy, pediatric patient

Introduction

Annular pancreas is a rare congenital abnormality in the pediatric patient population, with an incidence rate of approximately 1 to 3 cases per 20000 person-years [1, 2]. This abnormality results from the malrotation of ventral pancreatic bud during the embryonic development [3], and is usually characterized by the pancreatic tissue partially or completely surrounding the descendent duodenum [4]. Intestinal obstruction and the delayed gastric emptying are the most common complications following this abnormality, so patients with annular pancreas commonly present bilious vomiting [5, 6].

Annular pancreas is always treated by surgical procedures in symptomatic pediatric cases, which generally include duodenal by-pass operation via duodenoduodenostomy, gastrojeju-

nostomy with vagotomy, side-to-side duodenal-jejunal bypass, or very rarely, pancreatic resection [5, 6]. With the advent of laparoscopy, intensive care medicine, and postoperative nutritional support over the last decades, laparoscopic bypass procedure for the treatment of annular pancreas has become popularized [7, 8].

Although several case series have demonstrated the safety and efficiency of laparoscopic duodenoduodenostomy for the treatment of annular pancreas [9-11], data focusing on the clinical therapeutic effect and postoperative complications after laparoscopic versus open operation remain rare in Chinese population.

Hence, this study reviewed a total of 16 pediatric patients with annular pancreas who underwent laparoscopic or open duodenoduodenos-

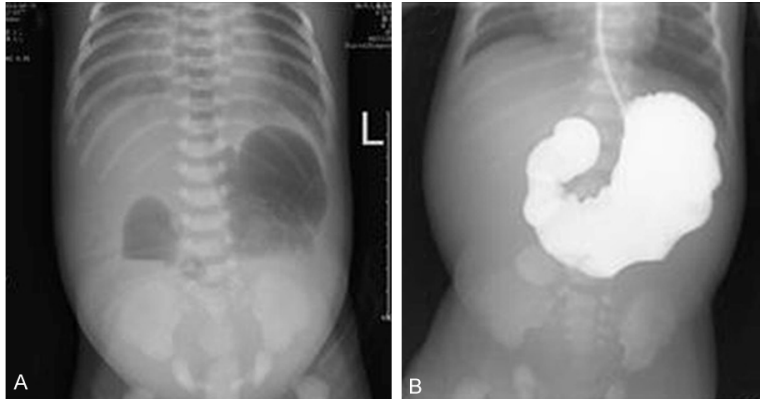


Figure 1. Plain abdominal radiograph presented double bubble sign (A); and the upper gastrointestinal barium radiography indicated obstruction of duodenum (B).

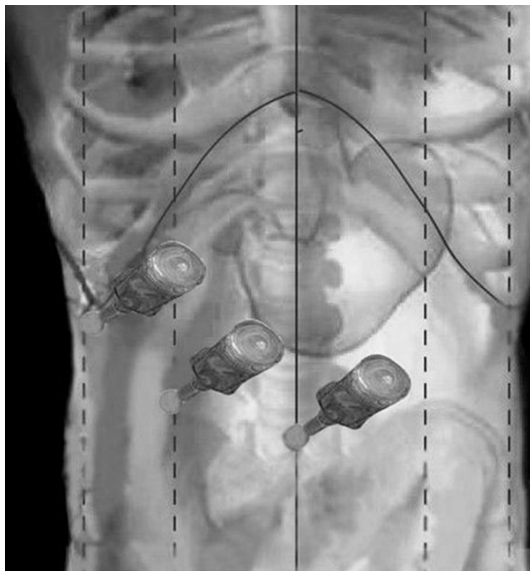


Figure 2. The location of three 5-mm trocars.

tomy to compare the clinical efficacy and post-operative complications.

Materials and methods

Patients

Total 7 pediatric patients with annular pancreas who received laparoscopic duodenoduodenostomy (diamond shaped anastomosis) at Xuzhou Children's Hospital from August 2011 to April 2016, were reviewed in the laparoscopic group of this retrospective study. The inclusion criteria were: (1) a clinical diagnosis of annular pancreas; (2) body weight of > 2 kg; (3)

no obvious pulmonary infection, (4) no congenital heart disease or severe deformity of other organs.

All the patients were evaluated by the same experienced pediatric urologist. The demographic and clinical data including age, gender, body weight, premature birth and comorbidity were documented. There were 4 boys and 3 girls, with a median age of 5 d. The antenatal examinations revealed 4 patients with duodenectasis (suspected deformity of the digestive tract),

among whom 3 cases were accompanied with polyhydramnios. Plain abdominal radiograph of the 7 patients at erect position typically presented double bubble sign (**Figure 1A**). The upper gastrointestinal barium radiography indicated the obstruction of duodenum (**Figure 1B**), and malrotation of intestine was confirmed in 2 cases during the laparoscopic operation.

Besides, 9 pediatric patients were randomly selected as the control group by a random digits table from all pediatric patients who homochronously received open operation for annular pancreas in the same departments of this hospital.

Surgical procedures

All the surgical procedures were performed by same surgeon with several years of experiences. For laparoscopic group, patient was placed in a supine position with the head elevated and the foot in a low-set. A bolster was placed under the right side of body. After trachea cannula and general anesthesia, a 5-mm trocar was inserted to establish pneumoperitoneum using the open Hassan method [12], and the intra-abdominal pressure of 8-10 mmHg was maintained throughout the operation. After the placement of a 30° laparoscope, two 5-mm trocars were inserted into the peritoneal cavity, one at the anterior axillary line below right costal margin and the other one at the right mid-abdomen (**Figure 2**). An ultrasound-knife was used for laparoscopic dissociation of hepatic flexure of colon ligaments, and the colon was pushed in the hypogastric region to expose the

Laparoscopic procedure for annular pancreas

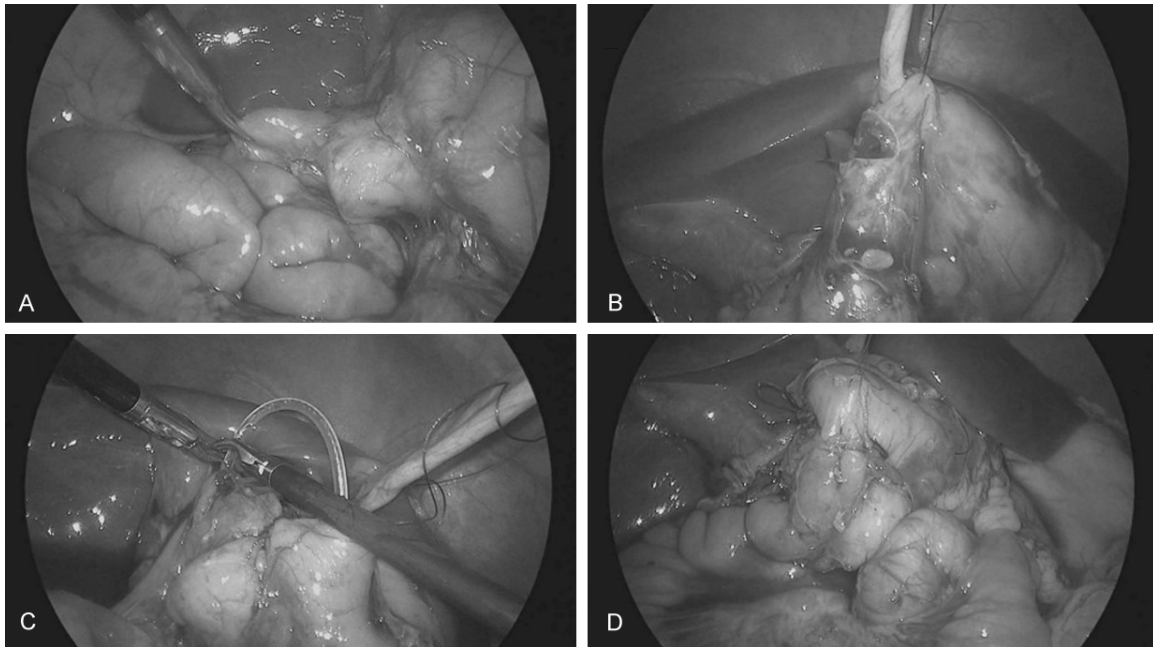


Figure 3. The procedure of laparoscopic duodenoduodenostomy: the pancreatic tissue compressing the descending duodenum (A); the suspended traction of the proximal duodenum by using a 2-0 suture to facilitate the anastomosis (B); the placement of a Jejunal nutrient canal before the anastomosis of anterior wall (C); and the accomplishment of anastomosis (D).

pancreatic tissue surrounding the descending duodenum (**Figure 3A**). In order to minimize the postoperative tension of the anastomotic stoma, surrounding adhesions of the proximal dilated and distal deflated duodenum were completely dissociated. The anastomosis was performed using duodenal by-pass operation (diamond shaped anastomosis) for the re-patency of duodenum: for the proximal dilated duodenum, a 1.5 cm transection was made on the duodenal wall at 1 cm away from the pancreatic tissue, and a 1.5 mm longitudinal incision was made on the anterior wall below the pancreatic tissue; the anterior-posterior walls of proximal and distal duodenum were sutured using 5-0 PDS (Ethicon Inc., Johnson & Johnson Co., Somerville, NJ, USA) or unabsorbable 2-0 coated braided polyester (TiCron™, Covidien) sutures. In order to fully expose the duodenum, suspended traction of proximal duodenum could be conducted (**Figure 3B**). If the inferior margin of the right hepatic lobes was low in some cases and covered the duodenum, suspended traction of the liver by using a 2-0 suture from the xiphoid process inside the peritoneal cavity to sew up the ligamentum teres hepatis and outside below right costal margin would facilitate the anastomosis. Finally, a Jejunal nutrient canal or a gastrointestinal decompression tube was placed over the anas-

tomotic stoma into proximal jejunum before the anastomosis of anterior wall (**Figure 3C, 3D**). In addition, two cases with malrotation of intestine also received Ladd's procedure.

As to the control group of patients, traditional open operation was performed. The incision was made at the right upper quadrant, and the anastomosis was the same as laparoscopic group using diamond shaped anastomosis.

Postoperative management

Patients with the placement of gastrointestinal decompression tubes were fasting postoperatively for 3-5 d according to the gastrointestinal functional rehabilitation, during which time total intravenous nutrition was given. The tube was clamped one day before the removal of the tube; if vomiting and abdominal distention occurred, the tube was removed next day, and patients were given a small quantity of sugar water and then gradually to breast milk. For patients with Jejunal nutrient canals, enteral nutrition was given at 24 h after the surgery.

Statistics analysis

Continuous variables are presented as mean $\pm$ standard deviation (SD) and were compared by t test, whereas categorical variables are pre-

Table 1. Characteristics of pediatric patients with annular pancreas

Characteristics	Laparoscopic group (n = 7)	Control group (n = 9)	P-value
Gender (boy/girl)	4/3	5/4	0.671
Mean age, d*	4.40 ± 4.56	4.22 ± 3.11	0.932
Body weight, kg	3.77 ± 1.05	3.03 ± 0.35	0.118
Premature infant, n			0.635
Yes	2	3	
No	5	6	
Comorbidity			
Malrotation of intestine	2	4	0.451

*Two non-neonatus in laparoscopic group were excluded from the analysis. A *t* test was used to compare two groups of continuous variables, and *chi*-square test for categorical variables.

sented as count (percentage) and were compared by χ^2 test. All statistical analyses were performed using the standard statistical package of SPSS version 19.0 (SPSS Inc., Chicago, IL, USA). A *P*-value of ≤ 0.05 was regarded as statistically significant.

Results

As shown in **Table 1**, pediatric patients in the laparoscopic and control groups were well matched with respect to the demographics and clinical data at admission, with no significant differences in terms of the gender, age, body weight, premature infant and the incidence of concomitant malrotation of intestine (all *P* > 0.05).

Table 2 shows perioperative finding and postoperative complications. All surgeries were successfully performed and no laparoscopic procedures were converted to open surgery. The mean duration of laparoscopic surgery was 122.9 ± 22.7 min compared with 78.9 ± 10.2 min for open operation (*P* < 0.001). Patients in laparoscopic group had earlier removal of gastrointestinal decompression tube or Jejunal nutrient canal (3.8 ± 0.8 d vs. 6.3 ± 1.6 d, respectively, *P* = 0.03) than the control cases. The mean length of hospital stay after laparoscopic procedure was 12.3 ± 1.9 d, 2 days shorter than that after open operation (*P* = 0.011). No difference in postoperative complications was observed between the two groups (*P* = 0.608).

Among the two laparoscopic patients who were given Jejunal nutrition, blood transfusion dur-

ing operations, one case still had intermittent vomiting, with yellowish green bile-like vomits. Then upper gastrointestinal barium radiography was performed at postoperative 11 d, prompting the contrast media was blocked at the anastomotic stoma. But it was unobstructed when the patient was placed in a prone position, hence the angulation at the anastomotic stoma was suspected. The enteral nutrition was continued with oral feeding if the distal intestinal canal was revealed with no obvious obstruction by visualization via Jejunal nutrient canal at postoperative 12 d. At postoperative 14 d, the tube was removed under the gradual disappear of vomiting. Finally the patient was discharged from hospital 24 d after the surgery.

Discussion

This study represented an experience with the performance of laparoscopic procedure of annular pancreas via diamond shaped anastomosis in pediatric patients. In this study, the outcomes and postoperative complications between laparoscopic and open repair were compared. The results showed that patients receiving laparoscopic procedure had longer operative duration, early removal of gastrointestinal decompression tube/Jejunal nutrient canal and shorter hospital stay than those undergoing open operation.

Previously Mustafawi and Hassan retrospectively reviewed 77 children born with congenital duodenal obstruction (CDO), among whom 30 cases were caused by annular pancreas [13]. In another retrospective review of 22 patients with annular pancreas who were treated with surgical repair, 80% cases had the obstruction at the distal end of the common bile duct opening, and 20% had it at the proximal end [14]. Hence, clinical examination findings of annular pancreas vary according to the compression location and the extent of pancreatic tissue over the duodenum. In fact, only 1/3 symptomatic cases require surgical treatment and most cases with annular pancreas are symptomless in their lifetime [15]. The pathophysiology is pancreatic tissue partially or completely surrounding the descendent duodenum, and patients commonly present bilious vomiting due to the intestinal obstruction and the

Table 2. Perioperative findings and postoperative complications

Variables	Laparoscopic group (n = 7)	Control group (n = 9)	P-value
Operative duration, min	122.9 ± 22.7	78.9 ± 10.2	< 0.001
Removal of gastrointestinal decompression tube/Jejunal nutrient canal, d*	3.8 ± 0.8	6.3 ± 1.6	0.03
Length of hospital stay, d*	12.3 ± 1.9	14.4 ± 0.9	0.011
Postoperative complications, n			0.608
Adhesive intestinal obstruction	2	1	
Wound infection	0	1	

*One case with angulation at the anastomotic stoma after surgery was excluded from the analysis. A *t* test was used to compare two groups of continuous variables, and *chi*-square test for categorical variables. A *P* value of ≤ 0.05 was regarded as statistically significant.

delayed gastric emptying. In our laparoscopic cases, 2 cases had delayed visiting because of the absence of severe vomiting but slow weight gain. However, the diagnosis was determined based on abdominal radiograph at erect view of double bubble sign, barium meal examination of obstruction below the descending part and CT image of pancreatic tissue surrounding the descending part.

Now duodenum bypass procedure has been recognized the preferred treatment of annular pancreas, especially duodenoduodenostomy (diamond shaped anastomosis) [5, 16]. With the advent and development of laparoscopy, most cases of laparoscopic procedure for duodenal obstruction or annular pancreas were considered safe and feasible [9, 17-19], except that Jensen *et al.* reported a higher conversion rate from laparoscopic to open surgery [10]. In the present study, the results showed that it took more time to accomplish laparoscopic duodenoduodenostomy than open procedure ($P < 0.002$), and the auxiliary incision and suture might accounted for the extra time spent on laparoscopic procedure; and this might be associated with the complication after surgery. Jensen *et al.* reported the operative duration of laparoscopic surgery was 145 min (91-308 min), much longer than that of the present study (122.9 ± 22.7) [10]. As one case who were given Jejunal nutrition developed angulation at the anastomotic stoma, the removal of the canal and the discharge from hospital were obviously delayed. After the exclusion of this case from the outcome analysis, postoperative parenteral nutritional support was achieved earlier in laparoscopic group than open group, and the hospital stay was also significantly shorter compared with cases

receiving open procedure. In addition, no laparoscopic cases were converted to open procedure, significantly lower than that (35%) of Jensen *et al.* [10].

We further summarized our key techniques of laparoscopic procedure including: (1) the surrounding adhesions of the duodenum should be fully dissociated in order to minify the postoperative tension of the anastomotic stoma, as the anastomotic stoma tension was associated with the looseness of the distal duodenum; (2) the suspended traction of proximal duodenum or the liver with 2-0 suture would enlarge the operative field of vision, facilitating the anastomosis; (3) the application of a Jejunal nutrient canal or a gastrointestinal decompression tube before the anastomosis of anterior wall; (4) the appropriate selection of the sutures, such as 5-0 PDS suture for the cases with not very hypertrophic proximal duodenum and 2-0 coated braided polyester sutures for obviously hypertrophic proximal duodenum, because the larger suture needle would reduce the operative difficulty and shorten the procedure time.

Several limitations have been noted in our study, including the retrospective study, the insufficient sample size and the short length of follow-up. Hence, further studies with a larger sample size and longer follow-up from multiple institutions were necessary to elucidate the effect of laparoscopic duodenoduodenostomy versus open surgery for the treatment of annular pancreas in pediatric patients.

Conclusions

Laparoscopic duodenoduodenostomy could be used as a safe and available treatment for annular pancreas in pediatric patients due to

the earlier achievement of parenteral nutritional support and shorter hospital stay compared with open procedure.

Acknowledgements

Informed consent was obtained from all individual participants included in the study.

Disclosure of conflict of interest

None.

Authors' contribution

YY, SL, CF and JW carried out the studies, and drafted the manuscript. ZQ, HC, FS, XZ and HZ carried out the design of the study and performed the statistical analysis. All authors read and approved the final manuscript.

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