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ORIGINAL ARTICLE

Gastroduodenal perforation in the pediatric population: a retrospective analysis of 20 cases

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Abstract

Objective The aim of this study was to investigate the pathogenesis, symptoms and individualized surgical management in pediatrics with gastroduodenal perforation (GDP).

Methods Patients diagnosed with GDP from January 2013 to December 2016 in our hospital were collected and divided into gastric perforation (GP) group and duodenal perforation (DP) group. Demographics, clinical events, etiological factors, symptoms, the time from symptom onset to operation, intraoperative findings and surgical procedures were analyzed. Follow-ups including ulcer, perforations occurrence, and digestive symptoms were carried out by out-patient review or telephones.

Results A total of 20 patients aged from 3 months to 14 years were enrolled in this study. The average age, main clinical presentations, size of perforations and operating time between two groups had no difference. The male to female ratio in DP group was higher than GP ($P < 0.05$). The high risk factor for DP was the use of dexamethasone, and for GP was *HP* infection. The most common site of perforation in DP group was duodenal bulb, and in GP group was pylorus area. Simple suture is the main management for both DP and GP, but distal gastrectomy combined with gastrojejunal Roux-en-Y anastomosis may be an alternative procedure for large perforation with diameter > 2 cm. The length of hospital days in GP group is shorter than DP group ($P < 0.05$). For follow-up, no patients had digestive symptoms.

Conclusions The general condition had no difference between GP and DP patients. But the risk factors and surgical repair differ depending on the patient's fundamental illness and the complexity of the perforation.

Keywords Gastroduodenal perforation · Peptic ulcer · Laparoscopy-assisted simple suture · *H. pylori*

Introduction

Gastroduodenal perforation is a well-known cause of acute abdomen in adults with the main symptoms of severe abdominal pain intensified by movement, nausea, vomiting and hematemesis, but it is uncommon in children [1]. Due to the serious pathology that could lead to the diffuse peritonitis and eventually lead to shock as a life-threatening condition, the management of GDP is emergency operation. Despite widespread use of endoscopy, laparoscopic exploration should be considered as the main effective diagnostic and therapeutic method for GDP in adults and children [2, 3]. Surgical repair is an undisputed intervention for GDP but the pathogenesis and outcomes in pediatrics are quite different from adult patients with sparse literature in pediatrics. In this study, we investigate risk factors, characteristic symptoms, and individualized surgical management in children with GDP.

Methods

This is a retrospective study of patients who experienced GDP from January 2013 to December 2016 at Wuhan Children's Hospital. The study complied with the Declaration of

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Helsinki and was approved by the Review Board of Ethics Committee of Wuhan Children's Hospital (Number: WCH-20170497). During hospitalization, the children's caregivers were informed about the study and they provided written consent.

All GDP patients were divided into GP group and DP group based on the anatomical region of the perforation. The clinical characteristics including symptoms, family history, timing of onset of illness, risk factors, radiological studies, surgical procedure, intrasurgical observations on pathology, hospital stay and postoperative outcomes were collected and compared between the two groups.

All patients received surgery including traditional simple suture and laparoscopic-assisted simple suture, the location of perforation, operation time, complications were recorded. Patients were followed up for 6 months to 2 years to assess for ulcer and perforation recurrence as well as any gastrointestinal symptoms.

Statistical analysis was performed using IBM SPSS19.0, continuous variable were analyzed using the Student's *t* test. Discrete variables were analyzed using the x^2 test. Statistical difference was defined as a *P* value of < 0.05.

Results

A total of 20 patients aged from 3 month to 14 years (average = 6.6 years) were enrolled in this study, with 11 patients suffering from DP and other 9 patients suffering from GP. Demographic data and preoperative characteristics are presented in Table 1. The average age in DP group was 5.49 ± 1.62 years, in GP group was 7.97 ± 1.53 years, which had no difference ($P > 0.05$). The male to female ratio in DP group (11:0) was higher than GP group (6:3). The family history of peptic ulcer disease in DP group (18.2%) was lower than that of GP group (44.4%). The main clinical presentation in both groups was abdominal pain, abdominal distention and vomiting. The duration of symptoms before operation between the groups had no difference ($P > 0.05$). Free air detected by X-ray in DP group was 72.7% and in GP group was 88.9%. The most common risk factor for DP was the use of dexamethasone and for GP was the infection of *H. pylori*. Other risk factors or comorbidities including blunt trauma, Bochdalek hernia, heterotopic pancreas, Meckel's diverticulum and rotavirus were also noted in pediatric patients.

Table 1 Preoperative characteristics

Patient	Sex/age (years)	Family history of PUD	Duration of preoperative acute symptoms/main clinical presentations	X-ray (free air)	Preoperative risk factors or comorbidities
DP					
1	M/2.8	−	1 day/AD, vomiting	−	Blunt trauma
2	M/0.3	−	3 days/AD, turbid ascites	+	Bochdalek's hernia
3	M/0.8	−	3 days/massive hematochezia	−	Heterotopic pancreas
4	M/2.6	−	3 days/AD, vomiting	+	–
5	M/1.3	−	4 days/hyperpyrexia, wheal, AD, melena, shock	+	Acute urticaria, dexamethasone
6	M/1.2	−	3d/vomiting, melanemesis, hematochezia	+	Meckel's diverticulum
7	M/ 14	−	12 h/AP (lower right abdomen)	+	Retrobulbar neuritis, dexamethasone
8	M/12.2	+	10 h/AP, vomiting	+	PUD, HP (+)
9	M/3.6	−	4 days/hyperpyrexia, wheal, AP, AD, vomiting	+	Acute urticaria, dexamethasone
10	M/13.3	+	5 h/AP (lower right abdomen)	+	PUD, HP (+)
11	M/8.3	−	4 days/massive hematochezia (tarry stools)	−	Sever pneumonia, pleural effusion, Methylprednisolone
GP					
1	M/7.8	−	3 days/AP, AD, vomiting	−	Bochdalek's hernia
2	M/2.3	−	2 d/AD, vomiting	+	–
3	M/11.9	+	1.5 days/AP, vomiting	+	HP (+)
4	F/12.6	−	5 days/hyperpyrexia, wheal, AP, AD, vomiting	+	Acute urticaria, dexamethasone
5	M/11.2	+	3 days/AP, vomiting	+	HP (+)
6	F/9	+	1 d/AP, vomiting	+	HP (+)
7	F/3.5	−	3 days/hyperpyrexia, AD, vomiting	+	Acute urticaria, dexamethasone
8	M/1	−	3 d/diarrhea, vomiting ,AD, shock	+	Rotavirus gastroenteritis
9	M/12.5	+	7 h/AP (lower right abdomen)	+	HP (+)

PUD peptic ulcer disease, *HP H. pylori*, *AP* abdominal pain, *AD* abdominal distention

The surgical features are shown in Table 2. The most common site of perforation in DP group was duodenal bulb (90.9%), and in GP group was pylorus area (55.6%). The average size of perforation between two groups had no difference ($P > 0.05$). In DP group, two patients had severe perforations with the diameter larger than 2 cm and excessive bleeding near the perforation site. Distal gastrectomy combined with gastrojejunal Roux-en-Y anastomosis was performed. For other nine patients with small perforation diameter varying from 0.3 to 0.8 cm, three patients received simple suture, two patients received simple suture combined with omentum patch, four patients received laparoscopic-assisted simple suture. In GP group, one patient had severe perforation with the size larger than 2 cm in the body of stomach and received distal gastrectomy combined with gastrojejunal Roux-en-Y anastomosis. For other eight patients with the small perforation length varying from 0.5 to 1.0 cm, four patients received simple suture, one patient received simple suture combined with omentum patch, three patients received laparoscopic-assisted simple suture. The length of hospital days in GP group (8.5 ± 2.2 days) was significantly shorter than DP group (12.5 ± 4.0 days), ($P < 0.05$). One patient had serious complication in DP group with gastroduodenal artery aneurysm rupture and upper GI hemorrhage. Two patients had complications in GP group including one patient with wound infection and another with adhesive ileus.

For a mean of 18.5-month follow-up, no patients had digestive symptoms, also no ulcer or perforation recurrence was noted.

Discussion

GDP is a rare entity in the pediatric patients. In this study, we discuss that the most common risk factor for DP is the use of dexamethasone, and for GP is the *HP* infection. The duodenal bulb is the most common perforation site in DP, and in GP it is pylorus area. Simple suture closure is an adequate treatment for perforation but gastrectomy combined with gastrojejunal Roux-en-Y anastomosis may be an alternative procedure for severe perforation with the diameter larger than 2 cm in both DP and GP.

Previous study found that the mean age of pediatric perforated peptic ulcer was 14.2 years, with 90% being adolescents [1]. In this study, we found that the average age in DP was 5.49 ± 1.62 years, in GP was 7.97 ± 1.53 years, which was less than that of earlier report, the differences in age

Table 2 Intraoperative and postoperative outcomes

Cases	Location	Diameter (cm)	Surgical procedure	Complication	Hospital day
DP					
1	Ascending portion	0.5	Simple suture	No	8
2	Bulb, anterior wall	0.5	Simple suture	No	14
3	Bulb, posterior wall	2.0	Distal gastrectomy, gastrojejunal Roux-en-Y anastomosis	No	8
4	Bulb, anterior wall	0.5	Simple suture	No	8
5	Posterior wall	0.6	Simple suture, omentum patch	No	7
6	Bulb, anterolateral wall	0.8	Simple suture, omentum patch; RMDE	No	8
7	Bulb, posterior wall	0.4	Laparoscopic-assisted simple suture	No	7
8	Bulb, anterior wall	0.3	Laparoscopic-assisted simple suture	No	9
9	Bulb, anterior wall	0.5	Laparoscopic-assisted simple suture	No	7
10	Bulb, anterolateral wall	0.4	Laparoscopic-assisted simple suture	No	7
11	Bulb, posterior wall	2.5	Distal gastrectomy, gastrojejunal Roux-en-Y anastomosis	GAAR; UGIB	16
GP					
1	Fundus	1.0	Simple suture, RPPHH, PD, CTD	No	14
2	Fundus	3.0	Distal gastrectomy, gastrojejunal Roux-en-Y anastomosis	Wound infection	12
3	Pylorus area	0.6	Laparoscopic-assisted simple suture	No	8
4	Pylorus area	1.8	Simple suture combined with omentum patch	No	7
5	Lesser curvature	1.0	Simple suture	No	7
6	Pylorus area	0.5	Laparoscopic-assisted simple suture	No	8
7	Pylorus area	0.8	Simple suture	Adhesive ileus	8
8	Body	1.0	Simple suture	No	10
9	Pylorus area	0.6	Laparoscopic-assisted simple suture	No	8

OT operation time, *UGIB* upper gastrointestinal hemorrhage, *GAAR* gastroduodenal artery aneurysm rupture, *RMDE* resection of the Meckel diverticulum with enteroanastomosis, *CTD* closed thoracic drainage, *RPPHH* repair of pleura–peritoneal hiatus hernia, *PD* pleural decortication

maybe a consequence of the differences in pathogenesis or etiology, such as the dietary habit. With respect to sex ratio, we found that 85% of patients were male in GP group and 100% were male in the DP group, which was consistent with previous reports [1, 4, 5].

HP infection accounted for 30% of all patients, all of them over the age of 9 years and had a positive family history of peptic ulcer disease, two of them had a history of duodenal ulcer and defaulted triple therapy who later presented with a bleeding ulcer. Other articles also report that the rate of *HP* infection varied from 15.4 to 91.4% [2, 4, 6, 7]; hence, standard cure for *HP* is necessary for those patients who had a family history of PUD and *HP* infection. Dexamethasone usage is another common risk factor in pediatrics which is used for curing allergic or inflammatory disease. Its indications should be tightly controlled to avoid these side effects in children. Other risk factors or comorbidities including blunt trauma, Bochdalek hernia, heterotopic pancreas, Meckel's diverticulm and rotavirus gastroenteritis also occurred in pediatric patients. We should remember these associations when we see pediatric patients with GI symptoms and order necessary imaging to identify this possibility.

Since the symptoms of pediatric GDP are non-specific, the radiological examination is the preferred method for diagnosis. In this study, sub-diaphragmatic free air detected by X-ray was observed in 71.4% of DP patients and in 85.7% of GP patients, which was consistent with other reports [4, 8, 9]. CT scan can observe the accurate position of perforation with precision up to 91% [10].

Delayed diagnosis and management of perforation is a serious event that may lead to terrible outcomes [10]. In out cases, three patients were diagnosed with sepsis and acute urticaria incipiently because of their typical erythra and hyperpyrexia. They were hospitalized for several days while symptoms of peritonitis were missed. It was recognized when patients had distention and shock when imaging was performed. High suspicion is the key to timely diagnosis to identify this complication.

The surgical approach for GDP depends mainly on the patients' physical condition and complexity of the perforation. Although laparoscopic repair has recently been reported as an effective and reliable alternative treatment for pediatric GDP [2], it seemed to be associated with a smaller size of perforation. Simple suture seems to be an effective and safe procedure for pediatric GDP. Laparoscopic-assisted simple suture with or without an omental patch is appropriate for patients in stable condition with small simple perforations, if patient has severe abdominal distention or the need for acid reduction procedure, omental patch closure may not be the best choice [4, 11, 12]. If the patient presents with uncontrollable bleeding, or presents as serious erosion and inflammation at the periphery of perforation, distal gastrectomy combined with gastrojejunal Roux-en-Y anastomosis is an alternative procedure. During the operation, close attention should be paid to make sure that active bleeding is definitively controlled and there is no injury to the surrounding tissues. All patients in this study received operation successfully.

For postoperative complication, one patient had gastroduodenal artery aneurysm rupture, it is a rare and life-threatening condition, and represents about 1.5% of all visceral artery aneurysms [13]. Surgical trauma, inflammation, duodenal remnant leakage and digestive leakage are the most common risk factors that cause destruction of vascular wall and lead to pseudoaneurysm formation. These complications can be controlled with improved surgical skills. Acid suppression medication and complete eradication of the *HP* after the operation are necessary to reduce the occurrence of perforation [14, 15].

Like their adult counterparts, the main symptoms of GDP in pediatric patients are abdominal pain, distention and vomiting. Potential signs such as typical erythra and hyperpyrexia should alert the clinician of GDP to avoid delays in management. Risk factors including *HP* infection should be cured to reduced secondary damage. Surgical repair including the simple suture or combined with gastrojejunal Roux-en-Y anastomosis is the main procedure for GDP which depends on the severity of the perforation and patients' general condition.

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Compliance with ethical standards

Conflict of interest Xueqiang Yan has received research grants from Health and Family Planning Commission of Wuhan. All authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the Wuhan Children's Hospital and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Written informed consent was obtained from all patients or guardians enrolled in this study.

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