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ORIGINAL ARTICLE

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Duodenogastric reflux following biliary reconstruction after excision of choledochal cyst

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Abstract Duodenogastric reflux (DGR) was assessed in patients surgically treated for choledochal cyst, with emphasis on two different biliary reconstruction methods: Roux-en-Y hepaticojejunostomy (HJ) and hepaticoduodenostomy (HD). Gastric bile monitoring with the Bilitec device revealed excessive DGR in patients in the HD group. Endoscopic findings demonstrated mild to moderate gastric mucosal erosion in patients after HD. In contrast, neither DGR nor gastritis was found in patients after HJ. This preliminary study suggests that HJ, rather than HD, should be recommended as a method of biliary reconstruction for pediatric patients with choledochal cyst. Careful observation of DGR should be continued in patients who have undergone HD.

Keywords Choledochal cyst · Duodenogastric reflux

Introduction

Total resection of the extrahepatic bile duct is the accepted management of choledochal cyst [1]. Biliary reconstruction may be performed by one of several techniques, however, including Roux-en-Y hepaticojejunostomy (HJ), hepaticoduodenostomy (HD), and jejunal interposition hepaticoduodenostomy. Debate continues regarding the optimal method of biliary reconstruction in order to avoid early or late postoperative complications such as ileus, cholangitis, or development of malignancy [2, 3].

Excessive duodenogastric reflux (DGR) is very common in adults after gastric surgery, pyloroplasty, and cholecystectomy [4, 5]. Biliary reconstruction after excision of choledochal cyst may also be expected to induce DGR. In this study we examined DGR by measuring intragastric bile reflux in patients following biliary reconstruction after removal of choledochal cyst. We compared DGR between patients after HJ and HD, and discuss below the implications for ideal biliary reconstruction.

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Materials and methods

Patients

A total of eight patients diagnosed as having a choledochal cyst were studied. The patients were divided into two groups according to the type of biliary reconstruction. As shown in Table 1, three patients underwent hepaticoduodenostomy after resection of the extrahepatic bile duct (HD group), and the other five patients were reconstructed by using Roux-en-Y hepaticojejunostomy (HJ group). Mean ages at definitive surgery and intraluminal bile monitoring were 8.7 years and 12.6 years, respectively, in the HD group, and 4.8 years and 13.8 years, respectively, in the HJ group. The postoperative periods ranged from 3 to 5 (mean 4.0) years in the HD group and from 1 to 19 (mean 8.2) years in the HJ group. After definitive surgery, no patients in either group complained of cholangitis or gastrointestinal symptoms such as epigastrial pain, nausea, or heartburn.

Intraluminal bile monitoring

The Bilitec device (Medtronic, Denmark) consists of a fiberoptic probe and a portable optoelectronic unit

capable of monitoring the presence of biliary pigments in the foregut lumen over a 24-h period. This system is based on the light absorption characteristics of bilirubin. Absorbance values range from 0 (plain water) to 1.0 (total screen), but the working range of this system has been shown to extend only from 0.14 to 0.80 [6]. Gastric exposure to bile was evaluated as the percentage of total recording time during which absorbance exceeded the threshold of 0.25 [7].

The probe was calibrated in water, passed transnasally and positioned in the gastric body under fluoroscopy. All patients were given three standardized meals, which were composed of nutrients that could not significantly interfere with bile measurements for the duration of the examination. They were also instructed to abstain from coffee, tea, juice, and soups, and were permitted to drink only water [8].

Endoscopic examination

All patients underwent endoscopic examination with gastric mucosal biopsy under general anesthesia at the time of the probe placement. Biopsied specimens were further examined for pathologic findings.

Statistics

Fraction time (%) was evaluated by Welch's *t*-test, and a value of $p < 0.05$ was regarded as significant.

Results

Patient profiles and findings of intragastric bile monitoring and endoscopy are shown in Table 1.

Intraluminal bile monitoring

Mean values of fraction time above 0.14 absorbance were $93.3 \pm 3.96\%$ and $22.5 \pm 21.9\%$ in the HD and HJ groups, respectively. Significantly higher values were found in each fraction time in the HD group compared with those of the HJ group (Fig. 1a, b).

Endoscopic examination

In the HD group, all patients showed mild to moderate gastric mucosal erosion and reflux of bile through the pyloric ring. Gastric erosion was mainly found in the antrum. Esophagitis was also present in one of the three patients in the HD group (Fig. 2a, b). In contrast, no patients in the HJ group showed gastric mucosal erosion or bile reflux.

The histology of the gastric mucosa showed superficial gastritis in both groups.

Discussion

The accepted surgical treatment for choledochal cyst is complete excision of the extrahepatic bile duct and enteric drainage through an intestinal conduit. HJ is currently the most popular method, and HD has not gained wide acceptance, as described by Alonso-Lej et al. [9]. This is likely due to technical considerations as well as concern over reflux of duodenal contents into the bile tree. However, delivering bile into the duodenum, rather than into a Roux limb of the jejunum, is physiologically appealing. Many innovative techniques for biliary reconstruction, such as jejunal interposition and jejunal valves, have been used to prevent cholangitis, enteric reflux, and peptic ulcers. However, Okada and col-

Table 1 Gastric bile exposure in patients operated for choledochal cyst (*HD* hepaticoduodenostomy, *HJ* hepaticojejunostomy)

Patient	Age at operation (years)	Age at examination (years)	Gender	Reconstruction	Bile monitoring fraction time (%)			Endoscopy		
								Erosion		Bile reflux
					> 0.14	> 0.20	> 0.30	Stomach	Esophagus	
1	1	6	F	HD	89.2	77.8	58.8	Mild	+	+
2	16	20	M	HD	97.1	94.5	76.2	Moderate	-	+
3	9	12	F	HD	93.7	88.8	76.2	Mild	-	+
Mean ± SD					93.3 ± 3.96	87.0 ± 8.49	70.4 ± 10.0			
4	6	12	F	HJ	4.8	1.5	0	-	-	-
5	1	9	F	HJ	57.0	31.1	5.8	-	-	-
6	6	16	F	HJ	4.1	0.1	0	-	-	-
7	10	11	F	HJ	29.2	24.8	13.7	-	-	-
8	1	20	F	HJ	17.4	14.1	6.7	-	-	-
Mean ± SD					22.5 ± 21.9[a]	14.3 ± 13.8[b]	5.24 ± 5.68[c]			

Welch's *t*-test for correlation between HD and HJ for fraction time above 0.14, 0.20, and 0.30

[a] $p < 0.005$

[b] $p < 0.001$

[c] $p < 0.002$

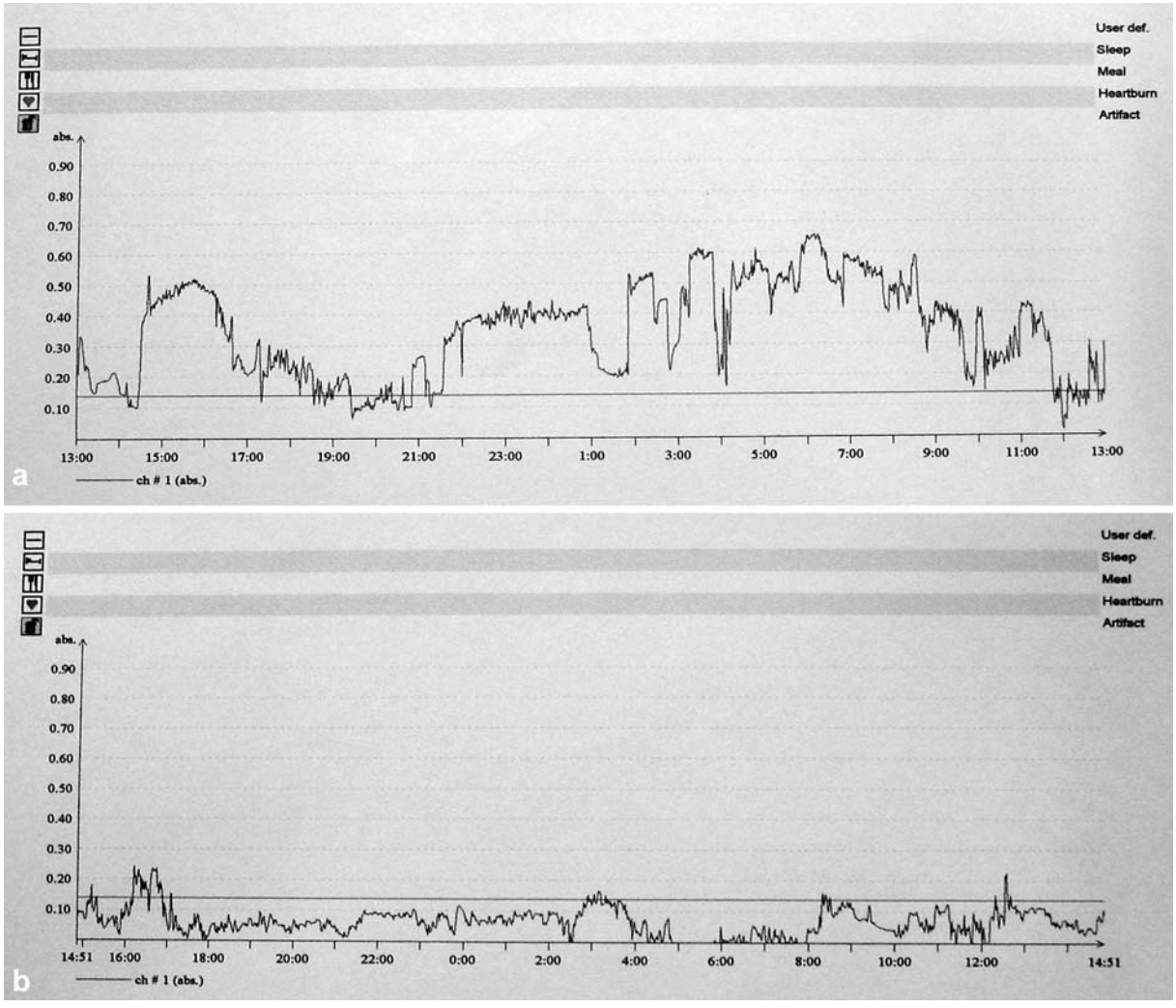

Fig. 1 Characteristic intragastric bile reflux curves. **a** Patient 1 in the HD group. **b** Patient 4 in the HJ group

leagues [10] have reported that jejunal interposition hepaticoduodenostomy often leads to bile reflux into the stomach, as revealed by ^{99m}Tc scintigraphy and gastroscopy.

Objective assessment of DGR with classic diagnostic methods such as chemical analysis of gastric contents, scintigraphic scanning, or 24-h continuous pH monitoring is entirely satisfactory. These methods are either short-term tests or indirect measurements of DGR components in gastric juice [11]. Recently, the intro-

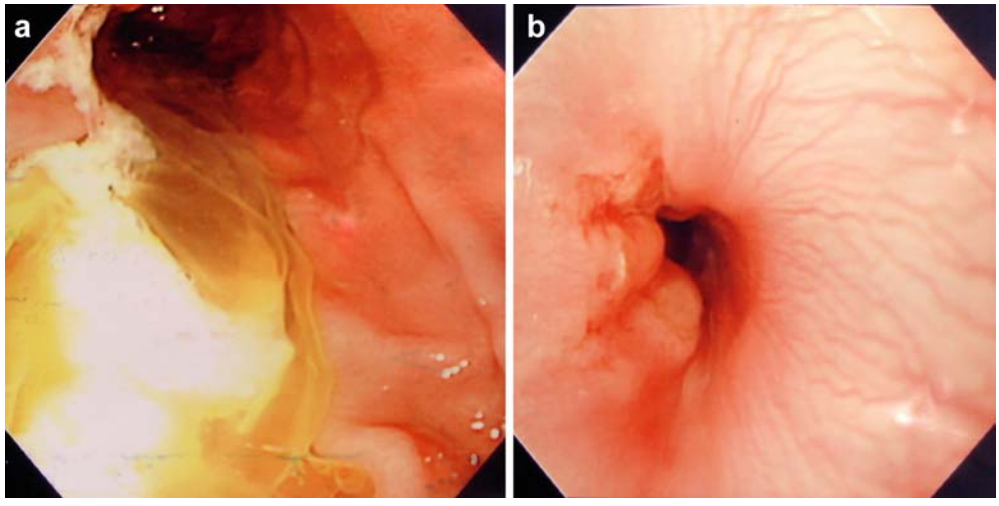

Fig. 2 Endoscopic findings of Patient 1 in the HD group. **a** The mucosal surface of the gastric antrum shows edema and redness associated with bile reflux through the pyloric ring. **b** Erosion is observed in the lower esophagus

duction of the Bilitec device has provided clinicians with a promising method to objectively assess DGR. In the current preliminary study, the patients in the HD group showed excessive DGR compared with the HJ group. This may be explained by the fact that the bile exit was reconstructed near the pyloric ring, so that bile is excreted continuously into the duodenum with no sphincter mechanism.

DGR has been implicated in the pathogenesis of several foregut diseases including chemical gastritis and non-ulcer dyspepsia. Moreover, the presence of bile and/or pancreatic juice in gastroesophageal reflux seems to enhance its harmful effect on esophageal mucosa, and a link between DGR and foregut carcinogenesis has been suggested [12]. *Helicobactor pylori* also induces DGR and gastric cancer [13]. In our study no significant difference was found in the histology of the gastric mucosa between the HD and HJ groups. This may be partly explained, however, by the shortness of the postoperative period. Should a child who had undergone HD only 5 years previously already be suffering from both gastritis and esophagitis, this would be a serious clinical situation.

From the perspective of DGR, HJ, not HD, is to be recommended for biliary reconstruction following excision of choledochal cyst. Further careful observation should be continued in follow-up studies of pediatric patients with HD reconstruction.

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