The region ahead of the pancreas is a suitable place for performing endoscopic ultrasound-guided gastroenterostomy: from clinical data to swine trial

Jinlong Hu

Shengjing Hospital of China Medical University

Guoxin Wang

Shengjing Hospital of China Medical University

Haixin Gao

Shengjing Hospital of China Medical University

Shiyun Sheng

Shengjing Hospital of China Medical University

Siyu Sun (✉ sun-siyu@163.com)

Endoscopy Center, Shengjing Hospital of China Medical University <https://orcid.org/0000-0002-7308-0473>

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Abstract

Background and Aims: Endoscopic ultrasound-guided gastroenterostomy (EUS-GE) is a minimally invasive treatment for gastric outlet obstruction that results in a low incidence of recurrence. This is the first study to investigate a suitable position for performing EUS-GE.

Methods: We reviewed the clinical data from 20 upper gastrointestinal examinations and 20 computed tomography scans of the abdomen and hypothesized that the posterior wall of the stomach was a suitable place to perform EUS-GE. We verified this hypothesis by performing an animal study using 5 swine.

Results: All retrievable anchor assisted EUS-GE were successfully performed at the intestinal region that was proximal to the head of the pancreas. The mean procedure time of EUS-GE was 28.4 ± 3.85 minutes (range of 22–32 minutes). There were no adverse events, such as bleeding. Necropsy of the animals showed that all of the stents were in the correct position. The mean distance between the site of gastroenterostomy and pylorus was 34.6 ± 3.58 cm (range of 30–38 cm).

Conclusions: The intestinal region that was proximal to the head of the pancreas was a suitable place for performing endoscopic ultrasound-guided gastroenterostomy. The suitability of this location should be confirmed by further animal and clinical studies.

Background

Gastric outlet obstruction (GOO) caused by benign or malignant disease is a common situation in clinical practice.^{1,2} Surgical gastrojejunostomy and endoscopic stenting are traditional treatment options, but these two treatments have limitations. Recently, endoscopic ultrasound-guided gastroenterostomy (EUS-GE) has emerged as an alternative option for GOO^{3–5} that is minimally invasive and provides an effective outcome. However, EUS-GE is a technically challenging procedure. Several studies have focused on improving the success rate of EUS-GE by developing new procedures, such as retrievable anchor-assisted EUS-GE⁶ and double-balloon enteric tube-assisted EUS-GE.⁷ There are no studies about where to perform EUS-GE in the stomach. In this study, we combined clinical data with a swine model to identify a suitable position in the stomach for performing EUS-GE. We hypothesized that the posterior wall of the stomach was a suitable place to perform EUS-GE.

Methods

Clinical data

We reviewed results of upper gastrointestinal examinations of 20 patients after a barium meal and computed tomography scans of the abdomens of 20 patients to investigate the positional relationship between the stomach and small intestine. These 40 patients had not received surgery of the digestive tract.

Animal model

The experiments were conducted on Bama mini 5 pigs that weighed 22 to 28 kg. The pigs were fed liquids for 3 days and fasted for 8 hours prior to the procedure. Propofol was used for anesthesia. We prepared the pigs by shaving the skin for electrode placement and performed tracheal intubations. This study was approved by the institutional review board of Shengjing Hospital of China Medical University.

Retrievable anchor-assisted EUS-GE

An experienced endoscopist performed the procedure. A gastroscope was advanced into the duodenum and a drainage tube was subsequently inserted. Methylene blue-tinted saline (200 mL) was injected to dilate the small intestine and the drainage tube was connected to a water pump. If the small intestine did not dilate sufficiently, the water pump was used to inject additional water. A longitudinal echoendoscope was advanced and the pancreas was scanned at the posterior wall of the stomach. The echoendoscope was moved towards the head of pancreas and rotated slightly left immediately before the pancreas disappeared from the endoscopic image. An image of the dilated bowel was obtained (Figure 1) and color Doppler was used to avoid the blood vessels. A 19-gauge needle with a stylet was used to puncture the dilated small intestine and the stylet was removed. The aspiration of blue liquid indicated that the needle was in the small intestine and was confirmed by injecting a contrast agent. A retrievable puncture anchor (Jiangsu Vedkang Medical Science and Technology Co., Changzhou, China) was then passed along the shank of the needle and inserted into the bowel. The echoendoscope was withdrawn and the anchor remained. The small intestine was pulled adjacent to the gastric wall. The longitudinal echoendoscope was re-advanced (due to the limitations of the working channel of echoendoscope) and the bowel was punctured by a 19-gauge needle again with the help of the anchor and a guidewire was inserted. A double-flanged, fully covered, self-expandable, metal stent combined with cautery was placed along the guidewire in one step (Figure 2). The anchor was retrieved by grasping the retrieval cord.

Necropsy

All pigs were euthanized by anesthesia and air embolism 7 days after the procedure to evaluate the site of gastroenterostomy and the distance between the pylorus and site of the gastroenterostomy.

Results

The review of upper gastrointestinal examinations after a barium meal and computed tomography scans of the abdomens of a total of 40 patients showed that the proximal portion of the jejunum was closest to the posterior wall of the stomach in all cases. EUS imaging of the dilated small intestine at the region immediately in front of the head of pancreas was 100% successful. The retrievable anchor-assisted EUS-GE procedure was performed successfully in all 5 animals. The mean procedure time for EUS-GE was 28.4 ± 3.85 minutes (range of 22–32 minutes). There were no adverse events, such as bleeding, and the pigs were able to eat normally.

During the necropsy, all of the stents were found in the correct position, making the stomach and jejunum. The mean distance between the site of gastroenterostomy and pylorus was 34.6 ± 3.58 cm (range of 30–38 cm).

Discussion

With the development of endoscopic devices^{8–10}, guided EUS interventions have been widely used in clinical practice.^{11, 12} Due to the limitation of the present treatment for GOO, EUS-GE has been a promising treatment that is micro-invasive and provides a low incidence of GOO recurrence. In recent years, efforts have been made to increase the success rate of this challenging procedure.

There are several key points in performing EUS-GE. First, the position of the small intestine must be determined. Second, a collapsed and free small intestine must be distended and fixed before the procedure. Third, EUS-GE should be performed using simple devices. The double balloon enteric tube can be useful for locating the ideal region of the jejunum to perform EUS-GE. However, this device is not available everywhere and not every endoscopist uses this method. If we performed anastomosis between the stomach and colon or distal part of ileum, it would cause serious complications. In order to maintain a relatively normal physiological anatomy, the ideal position for performing EUS-GE is in the proximal jejunum close to the ligament of Treitz where nutrients are absorbed. Itoi et al. reported that, anatomically, the jejunum beyond the ligament of Treitz is at the closest position to the gastric wall based on upper gastrointestinal radiography (unpublished data). We reviewed both the upper gastrointestinal radiography and computed tomography and found a similar result that the proximal jejunum was at the closest position to the posterior wall of stomach. The stomach is an organ of variable size due to the gas exchange during the endoscopic procedure. The pancreas, which is a fixed retroperitoneal organ, and the proximal jejunum are close to the posterior wall of the stomach. Therefore, the pancreas may be used as a landmark to locate the jejunum. The swine model has been thought of as a realistic model for EUS training.¹³ In our study, we obtained EUS imaging of the distended small intestine at the region ahead of the pancreas in all 5 pigs and the anastomosis was within a certain range. Furthermore, when we scanned the pancreas in patients, we were able to obtain EUS images of the small intestine at the region in front of pancreas (unpublished data), so this may be a suitable location to perform EUS-GE in humans.

Several techniques have been investigated to improve the EUS-GE procedure. For dilating the small intestine, the water-filling, water-inflated balloon, and double-balloon occluded techniques have been used while performing EUS-GE¹⁴, but EUS-GE also appears to be difficult because the small intestine is a free organ. Itoi et al. reported two unsuccessful stent deployments that were due to pushing the jejunum away from the stomach during the guidewire insertion.⁷ When we inserted the guidewire, we chose a long axis section of the small intestine to avoid pushing the small intestine away. In order to make the small intestine fixed, we used the retrievable anchor to pull the small intestine back toward the stomach and bring the two non-adherent organs together. In addition, using a metal stent combined with cautery can

provide a one-step stent placement, thereby reducing the dilation step.¹⁵ This type of stent can reduce the incidence of pushing the small intestine away.

There were limitations in our study design. This was an animal trial and only a small number of pigs were included. The anatomy of the gastrointestinal tract for swine and humans is not identical. In addition, we did not compare it with performing EUS-GE in another position. These results should be confirmed by further clinical studies.

Conclusion

We found that the region proximal to the head of the pancreas is a suitable place for performing EUS-GE.

Abbreviations

EUS-GE

EUS guided gastroenterostomy

GOO

Gastric outlet obstruction

EUS

Endoscopic ultrasound

Declarations

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Authors' Contributions:

JLH: study concept and design; acquisition of data; analysis and interpretation of data; drafting of the manuscript; GXW, SYS and HXG: study concept and design; critical revision of the manuscript for important intellectual content; administrative, technical, or material support; SYS: study concept and design; analysis and interpretation of data; critical revision of the manuscript for important intellectual content administrative, technical, or material support; study supervision. All authors approved the final version of the manuscript.

Ethics approval and consent to participate

This was a animal study. It was approved by our institution's Institutional Review Board.

Consent to publish

Not Applicable

Availability of data and materials

The dataset supporting the conclusions of this article is available from the corresponding author on reasonable request.

Competing interests

Siyu Sun is the consultant of Vedkang Medical Science and Technology company and Microtech Technology company.

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Figures

Figure 1

Immediately before the pancreas disappeared from the endoscopic image, the endoscopic probe was rotated left and advanced or withdrawn to obtain imaging of the dilated bowel.

Figure 2

The metal stent combined with cautery was placed with the help of the anchor.

Supplementary Files

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