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Retrospective Study

Modified hepatic left lateral lobe inversion in laparoscopic proximal gastrectomy: An analysis of 13 cases

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Abstract

BACKGROUND

In laparoscopic proximal gastrectomy (LPG), the prolapse of the hepatic left lateral lobe near the lesser curvature and esophageal hiatus can obstruct the field of vision and operation. Therefore, it is necessary to retract or obstruct the hepatic left lateral lobe to ensure a clear field of vision.

AIM

To investigate the safety and clinical efficacy of the modified hepatic left lateral lobe inversion technique for LPG.

METHODS

A retrospective analysis was conducted on the clinical data of 13 consecutive patients with early-stage upper gastric adenocarcinoma or adenocarcinoma of the esophagogastric junction treated with LPG from January to December 2023 at the Department of Gastrointestinal Surgery, Second Affiliated Hospital of Fujian Medical University. The modified hepatic left lateral lobe inversion technique was used to expose the surgical field in all patients, and short-term outcomes were observed.

RESULTS

In all 13 patients, the modified hepatic left lateral lobe inversion technique was successful during surgery without the need for re-retraction or alteration of the liver traction method. There were no instances of esophageal hiatus occlusion, eliminating the need for forceps to assist in exposure. There was no occurrence of intraoperative hepatic hemorrhage, hepatic vein injury, or hepatic congestion. No postoperative digestive complications of Clavien-Dindo grade ≥ II occurred within 30 days after surgery, except for a single case of pulmonary infection. Some

patients experienced increases in alanine aminotransferase and aspartate aminotransferase levels on the first day after surgery, which significantly decreased by the third day and returned to normal by the seventh day after surgery.

CONCLUSION
The modified hepatic left lateral lobe inversion technique has demonstrated satisfactory results, offering advantages in terms of facilitating surgical procedures, reducing surgical trauma, and protecting the liver.

Key Words: Hepatic left lateral lobe; Inversion technique; Laparoscopy; Proximal gastrectomy; Liver injury

Core Tip: This study retrospectively analyzed the clinicopathological data of patients who underwent laparoscopic proximal gastrectomy (LPG) with the modified hepatic left lateral lobe inversion technique. According to our research, the modified hepatic left lateral lobe inversion technique in LPG can facilitate surgical procedures, reduce surgical trauma, and protect the liver.

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INTRODUCTION

In laparoscopic proximal gastrectomy (LPG), prolapse of the hepatic left lateral lobe near the lesser curvature of the stomach and the esophageal hiatus obstruct the field of vision and operation. Except for a few cases in which the hepatic left lateral lobe adheres to the diaphragm, the hepatic left lateral lobe should be retracted or obstructed to obtain a good field of view[1]. This procedure is more critical in surgeries for adenocarcinomas of the esophagogastric junction (AEG). Various methods to reduce liver obstruction have been clinically applied in LPG, including Nathanson liver retractors, suture suspensions, silicone disc retraction and liver adhesion[2-5]. However, these methods have disadvantages, such as increased auxiliary incisions, intraoperative liver damage, poor surgical field exposure and the use of new consumables that increase surgical costs[6]. To overcome these limitations, Nakamura *et al*[7] first reported hepatic left lateral lobe inversion, which completely isolated the hepatic left lateral lobe outside the surgical field and significantly reduced liver damage. Harada *et al*[6] simplified this method, shortening the operative time to approximately 16 minutes. In January 2023, our center pioneered the use of hepatic left lateral lobe inversion in the LPG and subsequently made additional enhancements to the technique. The results are reported below.

MATERIALS AND METHODS

General conditions

The clinical data from 13 consecutive patients with early upper gastric cancer or adenocarcinoma of the AEG who underwent LPG in the Department of Gastrointestinal Surgery at the Second Affiliated Hospital of Fujian Medical University between January and December 2023 were retrospectively analyzed. In all the patients, the modified hepatic left lateral lobe inversion was used to expose the surgical field. Moreover, all patients were diagnosed preoperatively by contrast-enhanced computed tomography, endoscopic ultrasonography and pathological examination[8], including 4 patients with Siewert type II adenocarcinoma of the AEG and 9 patients with upper gastric adenocarcinoma. The clinical data are presented as the M (interval). Among the 13 patients, 12 were male and 1 was female, with an average age of 65 (34-81) years and a body mass index of 21.764 (18.365-30.041) kg/m^2. One patient had hepatitis B and fatty liver, and 5 had liver cysts. Ten patients were in pathological stage I, and 3 were in stage II. All patients had normal preoperative alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels (Table 1). Gastric resection was performed using LPG. Kamikawa anastomosis was conducted in 7 patients, side overlap anastomosis in 2 patients, and dual-channel anastomosis in 4 patients for intraoperative digestive tract reconstruction[9]. This study was approved by the ethics committee of our hospital.

Surgical methods

After routine preoperative preparation and successful anesthesia, the patients were placed in the split-leg supine position. Using the conventional five-hole approach, surgeons stood on the right of the patients, with a main operating hole of 12 mm located superolateral to the right observing hole and the remaining operating holes of 5 mm. D1+ lymph node dis-

Table 1 Clinicopathological characteristics

Number	Sex	Age	BMI (kg/m²)	Tumor location	Pathological stage	Complicating liver disease	Preoperative ALT (U/L)	Preoperative AST (U/L)	Digestive tract reconstruction method
1	Male	79	22.491	Siewert II AEG	II	None	13.1	15.9	Double tract
2	Male	81	22.649	Upper stomach	II	None	10.7	20.4	Double tract
3	Male	79	30.041	Upper stomach	I	Hepatic cyst	13.2	17.9	Kamikawa
4	Male	68	23.473	Siewert II AEG	I	None	11.7	8.0	Double tract
5	Female	56	22.342	Upper stomach	I	None	20.4	19.1	Kamikawa
6	Male	70	20.415	Upper stomach	II	Hepatic cyst	10.6	15.2	Kamikawa
7	Male	60	19.030	Upper stomach	I	None	13.0	15.3	Kamikawa
8	Male	79	21.764	Siewert II AEG	II	Hepatic cyst	10.6	19.6	Double tract
9	Male	63	20.384	Upper stomach	I	Hepatitis B and fatty liver	17.8	19.8	Kamikawa
10	Male	34	20.529	Upper stomach	I	None	41.1	27.8	Kamikawa
11	Male	65	21.139	Upper stomach	I	None	13.8	22.7	Side overlap
12	Male	62	25.952	Upper stomach	I	Hepatic cyst	20.0	17.5	Kamikawa
13	Male	63	18.365	Siewert II AEG	I	Hepatic cyst	38.8	38.0	Side overlap

AEG: Adenocarcinomas of the esophagogastric junction; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; BMI: Body mass index.

section was performed according to the extent of gastric resection and lymph node dissection, as well as the method for digestive tract reconstruction in accordance with the Japanese Gastric Cancer Treatment Guidelines (6th Edition)[10].

The procedures for the modified hepatic left lateral lobe inversion were as follows. First, the hepatogastric ligament was opened (Figure 1A), and the left deltoid ligament was disconnected (Figure 1B). The falciform ligament in the avascular area was subsequently dissected with an ultrasound knife or electric hook on the cephalic round ligament (Figure 1C), and the left coronary ligament was continuously dissected (Figure 1D), avoiding damaging the veins from the diaphragm. After confirming the activity of the hepatic left lateral lobe, it was pushed through the dissected falciform ligament gap to the right superior hepatic space and inverted (Figure 1E). In cases of difficult inversion, the accessory left hepatic artery was clamped and disconnected after opening the hepatogastric ligament at the lower edge of the liver. A 2-0 purse-string suture needle was subsequently inserted into the abdominal cavity from the left side of the falciform ligament, closely adhering to the xiphoid process caudally, followed by further insertion into the abdominal cavity close to the puncture point after perforation of the cavity, passing through the round ligament near the liver inside the cavity and then perforation of the cavity from the right side of the falciform ligament (Figure 1F). The purse-string suture was fixed to the upper edge of the opened hepatogastric ligament *via* an absorbable clip below the liver (Figure 1G), and the inverse hepatic left lateral lobe was fixed to the upper edge of the dissected falciform ligament *via* an absorbable clip (Figure 1H). Afterward, the purse-string suture was tightened outside the body to obstruct the inverse hepatic left lateral lobe between the abdominal wall and the liver (Figure 1I). After surgery, the external purse-string suture was released, the fixed purse-string suture inside the body was cut, the absorbable clips were removed, and the hepatic left lateral lobe was carefully repositioned (Video).

RESULTS

All the patients were treated with modified hepatic left lateral lobe inversion during LPG, with an operative time of 12.1 (11.1-13.7) minutes and an overall surgical duration of 195.0 (172.0-219.0) minutes. The patients did not require liver re-retraction or alteration of the retraction method and had no obstruction of the esophageal hiatus by the liver, and no

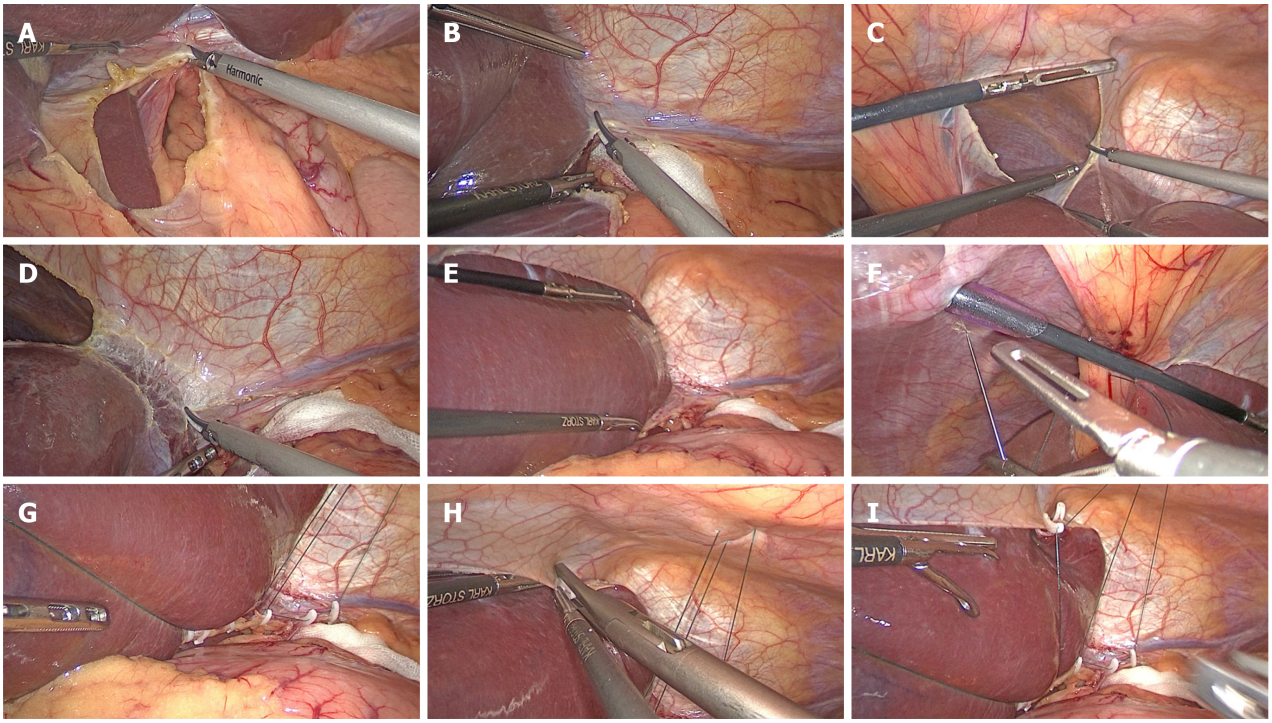

Figure 1 The procedures for the modified hepatic left lateral lobe inversion. A: The hepatogastric ligament was opened; B: The left deltoid ligament was disconnected; C: The falciform ligament in the avascular area was dissected with an ultrasound knife or electric hook on the cephalic round ligament; D: The left coronary ligament was continuously dissected; E: After confirming the activity of the hepatic left lateral lobe, it was pushed through the dissected falciform ligament gap to the right superior hepatic space and inversed over; F: Subsequently, a 2-0 purse-string suture needle was inserted into the abdominal cavity from the left side of the falciform ligament, closely adhering to the xiphoid process caudally, followed by further insertion into the abdominal cavity close to the puncture point after perforation out the cavity, passing through the round ligament near the liver inside the cavity and then perforation out the cavity from the right side of the falciform ligament; G: The purse-string suture was fixed to the upper edge of the opened hepatogastric ligament using an absorbable clip below the liver; H: The inverse hepatic left lateral lobe was continued to be fixed to the upper edge of the dissected falciform ligament using an absorbable clip; I: The purse-string suture was tightened outside the body to obstruct the inverse hepatic left lateral lobe between the abdominal wall and the liver.

pliers to assist in exposure were needed. Three patients underwent accessory left hepatic artery ligation, and no patient experienced hepatic bleeding, vein injury or congestion during LPG. The average postoperative length of hospital stay was 8 (7-12) days. Within 30 days after LPG, no Clavien-Dindo grade ≥ II complications in the digestive system occurred, and only one patient experienced pulmonary infection. On day 1 post-LPG, some patients presented elevated ALT and AST levels. The elevations were more obvious in two patients who underwent accessory left hepatic artery ligation and then decreased significantly on day 3, and both decreased to normal preoperative levels on day 7 (Table 2).

DISCUSSION

In laparoscopic radical gastrectomy for gastric cancer, surgical field exposure affects the surgical difficulty and process, and effective hepatic left lateral lobe obstruction is crucial for exposing the surgical field. Compared with laparoscopic distal gastrectomy (LDG), LPG requires better exposure of the esophageal hiatus, especially in cases where lower mediastinal lymph node dissection and high-level anastomosis within the mediastinum are needed[11]. The most commonly used exposure method in clinical practice involves fixing the purse-string suture to the hepatogastric ligament with a locking clip. Although this method is simple and practical, it is unsuitable for vagus nerve-preserving gastrectomy for early gastric cancer because it is ineffective in exposing the esophageal hiatus and may damage the hepatic branch of the vagus nerve. Similarly, organ hooking is unsuitable. Furthermore, the hypertrophic hepatic left lateral lobe often obstructs surgery. In LDG or laparoscopic pylorus-preserving gastrectomy, adhesion of the liver to the diaphragm with glue can expose the surgical field and protect the hepatic branch of the vagus nerve; however, it is not suitable for surgery that requires exposing the diaphragmatic hiatus[5]. Some scholars have used the Nathanson liver retractor for exposure, which has a reliable effect but requires additional abdominal incisions and leads to hepatic congestion and elevated postoperative hepatic enzymes[12]. According to the literature, the use of the Nathanson retractor primarily results in postoperative elevation of transaminase levels. Using the Clavien-Dindo classification system, 80.1% of patients experienced grade 1 complications, 5.7% experienced grade 2 complications, 9.9% experienced grade 3 complications, and 2.8% experienced grade 4 complications. Moreover, the use of silicone discs has been reported to achieve good tissue protection and exposure but requires additional consumables and has not been widely adopted[4].

Table 2 Intraoperative and postoperative conditions

Number	Overall surgical duration (min)	Hepatic left lateral lobe inversion time (min)	Length of hospital stay (d)	Postoperative complications	ALT on the 1st day after surgery (U/L)	ALT on the 3rd day after surgery (U/L)	ALT on the 7th day after surgery (U/L)	AST on the 1st day after surgery (U/L)	AST on the 3rd day after surgery (U/L)	AST on the 7th day after surgery (U/L)
1	172.0	11.1	9	None	26.3	19.8	10.8	28.7	18.2	15.9
2	175.0	11.2	9	None	23.5	4	14.5	41.3	20.4	4.2
3	185.0	11.4	8	None	22.2	20.8	46.2	21.4	17.2	32.8
4	186.0	11.5	11	None	11.5	4.1	21.8	22.8	12.1	21.8
5	190.0	11.7	7	None	74.6	21.6	36.4	79.6	21.5	34.4
6	193.0	11.9	7	None	28.6	15.7	12.6	22.9	10.7	18.6
7	195.0	12.1	7	None	11.6	25.2	6.3	8.2	30.4	11.6
8	198.0	12.2	8	Pulmonary infection	112.1	47.8	20.3	109.6	40.4	15.6
9	200.0	12.3	7	None	44.7	42.6	19.3	18.2	25.3	23.4
10	204.0	12.5	7	None	50.6	19.3	20.4	62.9	18.9	21.7
11	216.0	12.8	10	None	23.1	9.2	5.5	15.4	8.2	11.5
12	217.0	13.2	12	None	296.3	13.5	16.1	234.1	72.4	43.4
13	219.0	13.7	12	None	27.9	10.8	16	36	14.1	14.8

ALT: Alanine aminotransferase; AST: Aspartate aminotransferase.

The modified hepatic left lateral lobe inversion used in this study involves exposing the diaphragmatic hiatus and dissecting the lower mediastinal lymph nodes during open surgery, completely isolating the hepatic left lateral lobe and providing a broad field of view. In 10 patients, the esophageal hiatus was adequately exposed, without the need for readjustment of hepatic left lateral lobe inversion or additional sutures, suspensions and puncture holes, while not affecting the hepatic branch of the vagus nerve. Therefore, hepatic left lateral lobe inversion is suitable for nerve-preserving surgery in early-onset patients. Additionally, in two cases of LPG requiring anastomosis in the lower mediastinum, the modified hepatic left lateral lobe inversion achieved good surgical field exposure.

In 2020, Nakamura *et al*[7] first proposed hepatic left lateral lobe inversion, which requires dissection of the round, falciform, coronary and left deltoid ligaments and superficial hepatogastric ligament beneath the Arantius duct and physiological adhesion of hepatic segments S3-S4. After it was modified by Harada *et al*[6], it only required the falciform, coronary and left deltoid ligaments to be dissected. In our study, further modifications were made, and the average operative time was 12.1 (11.1-13.7) minutes, without a significant increase. The operative time is expected to be further shortened with the learning curve.

According to the literature, liver dysfunction may occur after laparoscopic radical gastrectomy and fundoplication, which is related to liver compression or large accessory left hepatic artery ligation when the field of view is exposed[13, 14]. Nakamura *et al*[7] revealed that hepatic left lateral lobe inversion resulted in slight abnormalities in liver function indicators and that the postoperative ALT and AST levels were significantly lower than those in patients treated with the Nathanson liver retractor. This study yielded similar results, possibly because the inverse hepatic left lateral lobe is located on the right side of the falciform ligament without external pressure or compression. Although two patients in our study underwent accessory left hepatic artery ligation, their postoperative hepatic enzymes were significantly elevated and decreased to preoperative levels on day 7 postsurgery. The other patient, complicated with hepatitis B and fatty liver, had no significant increase in hepatic enzymes. Therefore, intraoperative hepatic left lateral lobe inversion is relatively safe even for patients who have accessory left hepatic artery ligation or concomitant hepatitis B. In patients with severe cirrhosis and significant hepatic left lateral lobe hypertrophy (rare), if hepatic left lateral lobe inversion is difficult, it should not be forced.

When performing hepatic left lateral lobe inversion, direct or retraction-induced damage to the left inferior phrenic vein should be avoided, and dissection of the coronary ligament should not be too deep to avoid hepatic vein damage. The operation should be gentle, and the liver should be gently pushed when using pliers to avoid direct liver compression. In patients in whom hepatic left lateral lobe inversion is difficult, assistants can assist in pushing the hepatic left lateral lobe to the right side of the falciform ligament by pulling the severed left deltoid ligament from the right side through the dissected falciform ligament. The modification made by our center increased the use of purse strings and absorbable clips, which better fixed the inverse hepatic left lateral lobe, thus preventing the hepatic left lateral lobe from sliding back to the left side of the falciform ligament and maintaining the inverse state of the hepatic left lateral lobe.

We believe that hepatic left lateral lobe inversion is not strongly needed during LDG. The indications for hepatic left lateral lobe inversion are LPG and laparoscopic total gastrectomy, especially for cases requiring long-term maintenance of the field of view near the esophageal hiatus, such as muscle flap reconstruction (single- or double-muscle flaps) and side overlap anastomosis. The necessity and feasibility of hepatic left lateral lobe inversion should be evaluated based on its size and hardness, as well as surgical difficulty.

CONCLUSION

In summary, modified hepatic left lateral lobe inversion during LPG is a safe, effective and low-cost method for exposing the field of view with minimal impact on liver function. However, this method is still in the early stage of exploration, and larger, multicenter studies in the future are needed to further evaluate its safety and advantages.

FOOTNOTES

Author contributions: Lin JA contributed to data curation, original draft preparation, project administration, and funding acquisition; Wu CY contributed to software, writing, review, and editing; Ye K contributed to conceptualization, supervision, and funding acquisition; all authors have read and agreed to the published version of the manuscript. Lin JA and Wu CY contributed equally to this work as co-first authors.

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Institutional review board statement: This study was reviewed and approved by the Ethics Committee of the Second Affiliated Hospital of Fujian Medical University.

Informed consent statement: The requirement for informed consent was waived by the Ethics Committee considering the retrospective design of the study.

Conflict-of-interest statement: All authors report no conflicts of interest.

Data sharing statement: The datasets that were used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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