

Comparison of liver function after laparoscopically assisted and open distal gastrectomies for patients with liver disease

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Abstract

Background Several studies have suggested that carbon dioxide (CO₂) pneumoperitoneum may have an effect on liver function. This study aimed to compare liver function after laparoscopically assisted distal gastrectomy (LADG) and open distal gastrectomy (ODG) for patients with liver disease.

Methods Between January 2006 and December 2007, the study enrolled 50 patients with EGC and liver disease including 18 liver cirrhosis patients, 3 fatty liver patients ($n = 3$), and 29 healthy hepatitis B or C virus carriers. Albumin, total bilirubin, alkaline phosphatase, aspartate aminotransferase, and alanine aminotransferase levels as well as the volume of drainage in the LADG ($n = 18$) and ODG ($n = 32$) groups were determined to assess liver function.

Results The albumin level on postoperative day 7 was significantly higher in the LADG group (3.5 mg/dl) than in the ODG group (3.1 mg/dl; $p = 0.042$), and the volume of drainage on postoperative day 2 was significantly lower in

the LADG group (154.3 ml) than in the ODG group (403.1 ml; $p = 0.013$). Diuretics were needed by three patients (16.7%) in the LADG group and six patients (18.7%) in the ODG group for control of ascites ($p = 0.587$). For the patients with liver cirrhosis, none of the parameters between the two groups were significantly different.

Conclusion For gastric cancer patients with chronic liver disease, LADG can be considered a safe surgical procedure showing surgical outcomes comparable with those for ODG.

Keywords Gastric cancer · LADG · Liver disease

The proportion of early gastric cancer (EGC) cases has increased recently, and the treatment of EGC has expanded to include laparoscopically assisted distal gastrectomy (LADG). During laparoscopic procedures, a carbon dioxide (CO₂) pneumoperitoneum is established. In cirrhotic rats, CO₂ pneumoperitoneum markedly decreases the total hepatic blood flow by mechanical compression or hypercapnia-induced vasoconstriction [1]. A CO₂ pneumoperitoneum of 4 or 8 mmHg decreases the sinusoidal perfusion rate and increases sinusoidal leukostasis and venular leukocyte adherence in a rat model [2].

It was thought that CO₂ pneumoperitoneum had a deleterious effect on postoperative liver function. Patients with liver disease sometimes experience uncontrolled postoperative ascites. Therefore, many surgeons hesitate to perform a laparoscopic operation using CO₂ pneumoperitoneum, especially for patients with liver cirrhosis.

This study compared liver function after LADG and open distal gastrectomy (ODG) for patients with EGC and liver disease.

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Materials and methods

We retrospectively reviewed 1,604 patients who underwent surgery for EGC between January 2006 and December 2007 at Seoul National University Hospital and Seoul National University Bundang Hospital. The study enrolled 51 patients who had liver disease and underwent distal gastrectomy by LADG or ODG with more than D1 + a lymphadenectomy for EGC.

The diagnoses for the patients were determined by endoscopy, endoscopic ultrasound, and computed tomography (CT). One patient was excluded from the study because he underwent gastrectomy and distal pancreatectomy.

The study included liver cirrhosis patients, fatty liver patients, healthy hepatitis B virus (HBV) carriers, and healthy hepatitis C virus (HCV) carriers. Liver cirrhosis was classified by the Child-Pugh classification. The Child-Pugh scores were calculated according to the degrees of hepatic encephalopathy, ascites, total bilirubin level, serum albumin level, and prothrombin time or international normalized ratio (INR). With the Child-Pugh classification, total scores are classified as 5 to 6 (grade A), 7 to 9 (grade B), and 10 to 15 (grade C). A healthy HBV or HCV carrier was defined as a patient without cirrhosis who had hepatitis B surface antigen (HBsAg) or anti-HCV as diagnosed by a blood sample test. Fatty liver was preoperatively diagnosed by CT.

During laparoscopy, the CO₂ pressure was kept at 12 mmHg. Data were collected from medical charts, operative records, and pathology reports. We measured the volume of drainage and laboratory data including albumin,

aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), and total bilirubin (TB). Blood samples were collected before surgery and on postoperative days 2, 5, and 7.

In the current study, one Jackson-Pratt closed suction drain (200 ml) was placed routinely in the right subhepatic area just before closure, and the volume of drainage through the closed suction drain was checked daily. Removal of the drain was performed when the daily drainage amount was less than 200 ml. We compared the LADG group with the ODG group using the chi-square test and the Mann-Whitney *U* test.

Results

In this study of patients with liver disease, 18 patients underwent LADG and 32 patients underwent ODG. Table 1 shows the patient demographic and clinicopathologic factors in relation to the type of surgery. There were no significant differences between the LADG and ODG groups in terms of age, gender, operative time, or number of resected lymph nodes. There were no perioperative mortalities, and 10 cases of perioperative complications occurred.

In the LADG group, two patients had uncontrolled ascites, and one patient had reoperations because of abdominal bleeding. In the ODG group, four patients had uncontrolled ascites, two patients had paralytic ileus, and one patient had pneumonia.

Table 1 Patient demographic and clinicopathologic factors

	LADG	ODG	<i>p</i> Value
Age (years)	56.7 ± 8.5	57.4 ± 10.7	0.34
Gender (M:F)	13:5	28:4	0.07
Operative time (min)	223.6 ± 54.4	192.5 ± 63.2	0.21
Resected lymph nodes	38.0 ± 22.9	36.1 ± 19.4	0.51
Liver disease			0.59
Liver cirrhosis (child class A or B)	7 (6/1)	11 (10/1)	
HBsAg(+)	8	19	
Anti-HCV(+)	1	1	
Fatty liver	2	1	
LN dissection			0.03
D1	0	0	
D1 + a	3	3	
D1 + b	6	4	
D2	9	25	
Complication			0.57
Abdominal bleeding	1	0	
Uncontrolled ascites	2	4	
Paralytic ileus	0	2	
Pneumonia	0	1	

HBsAg hepatitis B surface antigen, LADG laparoscopically assisted distal gastrectomy, ODG open distal gastrectomy

With respect to liver function parameters, neither the AST, ALT, and TB levels nor the volume of drainage on postoperative days 2, 5, and 7 differed significantly between the two groups (Table 2). The albumin level on postoperative day 7 was significantly higher ($p = 0.042$; Fig. 1) and the volume of drainage on postoperative day 2 significantly lower ($p = 0.013$; Fig. 2) in the LADG group than the ODG group. Three patients (16.7%) in the LADG group and six patients (18.7%) in the ODG group needed diuretics to control the volume of drainage.

Among the patients with liver cirrhosis, the albumin level on postoperative day 7 was lower than in the ODG group ($p = 0.049$; Fig. 3). The other parameters did not differ significantly between the LADG and ODG groups (Table 3).

Table 2 Liver function parameters

	LADG	ODG	<i>p</i> Value
AST (IU/L)			
Preoperative day	33.8 ± 14.4	36.3 ± 18.3	0.754
POD 2	39.7 ± 17.5	50.8 ± 36.7	0.281
POD 5	29.5 ± 9.9	34.7 ± 13.9	0.228
POD 7	33.1 ± 12.6	31.9 ± 14.7	0.531
ALT (IU/L)			
Preoperative day	38.4 ± 21.5	39.1 ± 33.4	0.462
POD 2	39.7 ± 17.6	39.6 ± 29.3	0.364
POD 5	27.9 ± 12.3	32.4 ± 19.2	0.581
POD 7	29.0 ± 16.1	30.3 ± 19.5	0.943
TB (mg/dL)			
Preoperative day	0.91 ± 0.31	0.90 ± 0.30	0.977
POD 2	1.23 ± 0.45	1.31 ± 0.53	0.814
POD 5	1.37 ± 0.68	1.55 ± 1.24	0.821
POD 7	1.31 ± 0.69	1.31 ± 1.03	0.420
Alb (g/dL)			
Preoperative day	4.11 ± 0.57	4.01 ± 0.37	0.283
POD 2	3.39 ± 0.38	3.17 ± 0.28	0.059
POD 5	3.36 ± 0.44	3.32 ± 0.35	0.561
POD 7	3.45 ± 0.31	3.14 ± 0.20	0.042*
ALP (IU/L)			
Preoperative day	72.0 ± 19.19	79.0 ± 23.9	0.521
POD 2	60.4 ± 22.3	53.7 ± 11.6	0.403
POD 5	61.5 ± 23.1	58.1 ± 16.7	0.649
POD 7	68.9 ± 28.3	62.2 ± 19.3	0.761
Volume of drainage (mL)			
POD 2	148.3 ± 143.6	382.6 ± 539.0	0.013*
POD 5	425.3 ± 541.5	601.0 ± 762.5	0.391
POD 7	584.3 ± 482.8	538.4 ± 868.2	0.448

LADG laparoscopically assisted distal gastrectomy, ODG open distal gastrectomy, AST aspartate aminotransferase, POD postoperative day, ALT alanine aminotransferase, TB total bilirubin, Alb albumin, ALP alkaline phosphatase

* $p < 0.05$

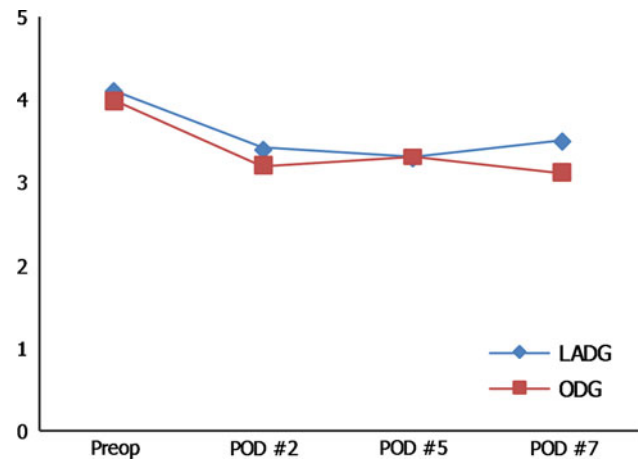


Fig. 1 Albumin is higher in laparoscopically assisted distal gastrectomy (LADG) and especially significant on postoperative day (POD) 7 ($p = 0.042$)

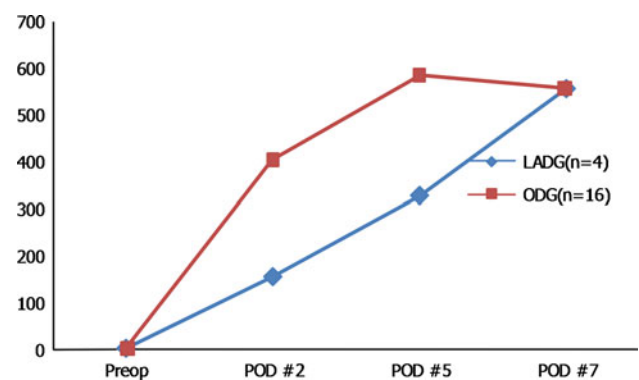


Fig. 2 The volume of drainage is lower in laparoscopically assisted distal gastrectomy (LADG) and especially significant on postoperative day (POD) 2 ($p = 0.013$)

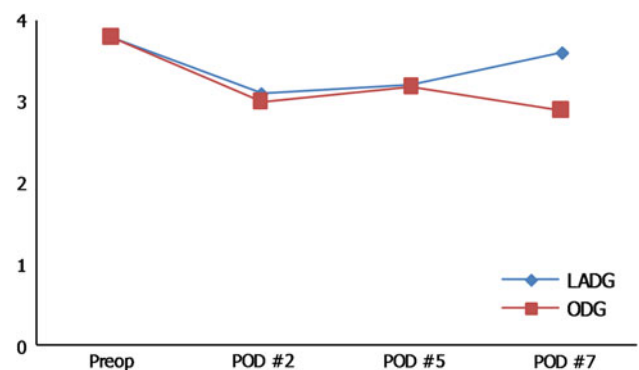


Fig. 3 Albumin is higher in laparoscopically assisted distal gastrectomy (LADG) and especially significant on postoperative day (POD) 7 ($p = 0.049$)

Discussion

This retrospective study compared liver function between LADG and ODG for patients with EGC and liver disease.

Table 3 Liver function parameters in patients with liver cirrhosis

	LADG	ODG	<i>p</i> Value
AST (IU/L)			
Preoperative day	42.0 ± 16.6	46.7 ± 17.7	0.602
POD 2	54.9 ± 17.7	47.7 ± 19.8	0.383
POD 5	37.6 ± 10.3	42.7 ± 19.8	0.785
POD 7	39.4 ± 13.0	40.4 ± 17.3	0.906
ALT (IU/L)			
Preoperative day	48.7 ± 27.1	40.9 ± 28.4	0.292
POD 2	48.0 ± 19.4	32.5 ± 15.2	0.091
POD 5	33.4 ± 15.2	29.5 ± 12.7	0.858
POD 7	35.0 ± 16.6	29.6 ± 14.9	0.513
TB (mg/dL)			
Preoperative day	0.79 ± 0.25	0.97 ± 0.35	0.241
POD 2	1.03 ± 0.40	1.43 ± 0.42	0.088
POD 5	1.27 ± 0.26	2.29 ± 1.73	0.153
POD 7	1.28 ± 0.08	1.91 ± 1.50	>0.999
Alb (g/dL)			
Preoperative day	3.77 ± 0.60	3.81 ± 0.46	0.862
POD 2	3.13 ± 0.21	3.04 ± 0.39	0.661
POD 5	3.17 ± 0.39	3.21 ± 0.37	0.855
POD 7	3.64 ± 0.41	2.86 ± 0.34	0.049*
ALP (IU/L)			
Preoperative day	75.0 ± 16.3	87.1 ± 26.4	0.431
POD 2	67.9 ± 31.5	55.2 ± 11.2	0.434
POD 5	67.6 ± 31.4	58.7 ± 17.7	0.656
POD 7	70.8 ± 29.8	56.3 ± 16.0	0.323
Volume of drainage (mL)			
POD 2	167.9 ± 76.0	627.9 ± 787.4	0.071
POD 5	622.3 ± 601.6	904.3 ± 995.0	0.882
POD 7	715.0 ± 15.0	1184.4 ± 1287.6	>0.999

LADG laparoscopically assisted distal gastrectomy, ODG open distal gastrectomy, AST aspartate aminotransferase, POD postoperative day ALT alanine aminotransferase, TB total bilirubin, Alb albumin, ALP alkaline phosphatase

* $p < 0.05$

Normal portal venous pressure is 7 to 10 mmHg, and about one-half of the hepatic blood flow is derived from the portal venous system. The healthy liver receives about 25% of its blood supply via the hepatic artery and the remainder through the portal vein.

In laparoscopic surgery, a CO₂ pneumoperitoneum (12–14 mmHg) is required for optimal visualization of the operative field. Sala-Blanch et al. [3] showed that hepatic blood flow was significantly lower than at baseline with both helium (He) (63%; $p < 0.001$) and CO₂ (24%; $p < 0.05$) pneumoperitoneum 90 min after insufflation. Etoh et al. [4] reported that decreased portal blood flow under a CO₂ pneumoperitoneum is the most likely reason for transient liver dysfunction after LADG.

Elevated serum transaminase levels within 3 days after surgery and decreased serum albumin levels recovered more rapidly after LADG than after ODG [4]. Guven and Oral. [5] reported that unexplained elevation of ALT was common after laparoscopic cholecystectomy and

pneumoperitoneum and that the consequent intraabdominal hypertension-induced hepatic ischemia appeared to be the cause.

Such disturbances, however, were self-limited and not associated with any morbidity in the setting studied. Bickel et al. [6] showed that for 1,034 patients, induction of a CO₂ pneumoperitoneum did not cause deranged liver function tests after laparoscopic cholecystectomy.

In the current study, all parameters of liver function except AST on day 7 and ALP on day 2 seemed better in the LADG group than in the ODG group, and among these parameters, albumin level on postoperative day 7 ($p = 0.042$; Fig. 1) and volume of drainage on postoperative day 2 ($p = 0.013$; Fig. 2) were significant. All the parameters except volume of drainage in both the LADG and ODG groups were within the normal range.

Concerning the low volume of drainage in the LADG group in the current study, CO₂ pneumoperitoneum perhaps did not complicate the liver function, and LADG may

have been less invasive than ODG from the viewpoint of less handling of tissue and bowel. A high volume of drainage may require diuretics and a salt-restricted diet for control of ascites, and discharge may be delayed.

In liver cirrhosis, because portal venous blood flow is reduced, the maintenance of hepatic arterial blood flow and the preserved hepatic arterial buffer response probably represents a beneficial mechanism for hepatic circulation [2]. Our study showed that in patients with liver cirrhosis, only the ALT level on postoperative day 2 was abnormal and higher in the LADG group, but the difference was not significant, and recovery was rapid. Because the portal vein pressure is 7 to 10 mmHg, a CO₂ pneumoperitoneum mainly influences portal blood flow.

Postoperative ascites occurs more frequently in Child's class B and C patients (63.6%) than in class A patients (13%; $p = 0.001$) [7]. The hepatoduodenal ligament in patients with liver cirrhosis contains more lymphatic vessels than in patients with healthy livers [8].

Compared with ODG, LADG is minimally invasive. Our study showed that the volume of drainage was lower in the LADG group and that no significant difference existed in the number of resected lymph nodes. A CO₂ pneumoperitoneum did not seem to influence the amount of ascites.

In a prospective randomized trial, Hasukic [9] reported significantly decreased postoperative changes in liver function tests after laparoscopic cholecystectomy using low-pressure (7 mmHg) instead of high-pressure (14 mmHg) procedures. We performed LADG under a 12-mmHg pneumoperitoneum. If performed under low pressure, LADG is a reasonable choice for the patient with liver cirrhosis.

Conclusion

For gastric cancer patients with chronic liver disease, LADG can be considered a safe surgical procedure with outcomes comparable with those for ODG.

Disclosures Hong Man Yoon, Han-Kwang Yang, Hyuk-Joon Lee, Do-Joong Park, Hyung-Ho Kim, Kuhn-Uk Lee, Hye Seong Ahn, and Jae-Jin Jo have no conflicts of interest or financial ties to disclose.

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