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Short-term Outcomes in D2 Dissection in Laparoscopic versus Open Gastrectomy for Gastric Cancer

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ABSTRACT

Background: Surgical resection with en-bloc lymphadenectomy is the hallmark of curative therapy for gastric cancer patients. The favoured surgical technique worldwide has been open gastrectomy for a long time. This procedure however, is connected to significant morbidity. Compared to open procedures, multiple meta-analyses have demonstrated a benefit in the short-term results of laparoscopic gastrectomy.
Objective: Comparison of the short-term advantages of radical gastrectomy with dissection D2 (laparoscopic and open in gastric cancer patients).
Methods: This study was a retrospective analysis of 42 patients who underwent either open radical gastrectomy (ORG) (24 patients) or laparoscopic radical gastrectomy (LRG) (18 patients) with D2 lymphadenectomy. The interventions took place at the South Egypt Cancer Institute, Assuit University, Department of Surgical Oncology between September 2017 and September 2020. Through a statistically generated selection of all gastrectomies conducted over the same duration, controls were matched for stage, age and gender, comparison patient demographics, stage of tumor-node-metastasis (TNM), histologic characteristics, tumor position, retrieval of lymph nodes, margins, and intraoperative factors, postoperative morbidity and mortality.
Results: Less intraoperative blood loss (625.94±166.60 mL vs 1096.38±326.76 mL, P<0.0001), the median laparoscopic approach operating time was 307 minutes (range 230-363 minutes) compared to the median 265 minutes (range 219-310 minutes) in the open group (p\0.01). Radical resection types [total radical gastrectomy, radical proximal gastrectomy, radical distal gastrectomy] (P=0.590). The degree of dissection of the lymph node and the number of lymph nodes retrieved did not vary among the two groups [32.06±8.612 vs 30.29±7), (P=0.451)]. After laparoscopic gastrectomy, the hospital stay duration was nine days (range 7-13 days) compared to 12 days (range 9-17 days) in the open group (p = 0.01). Tumor free margins were obtained in all cases. Postoperative recovery shows that postoperative pain was significantly lower in laparoscopic patients with a median period of 3 days (range 2-5 days) compared to 5 days (range 2-8 days) in the open group, as calculated by the number of days of IV narcotics use (p\0.01). Shorter time to mobilization [2(1-3) vs 3 (1-4) d, P <<0.001], intestinal opening time [3(2-4) d vs 4(3-6) d, P < 0.001)] and normal diet time are shorter [3(2-4) d vs 4(3-5)d, P < 0.001)]. No substantial variations were observed among the two groups in overall morbidity (29.1% in LAG vs 27.7% in OG, P = 0.480). For each group, mortality and readmission rates were similar among the two groups, one case p= 1.0.

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Conclusion: Compared with the ORG procedure, LARG provided patients with many improved short-term advantages, such as less intraoperative blood loss, shorter hospitalization period, shorter mobilization time, and shorter intestinal opening time. Additionally, shorter time to resume oral intake, and decreased narcotics. LARG is safer, more efficient and less invasive in treating gastric cancer, with better short-term effectiveness relative to ORG, with equivalent margin status and adequate lymph node retrieval.
Key words: gastric cancer, laparoscopy, gastrectomy D2 dissection, lymph node

INTRODUCTION

Gastric cancer is one of the most common causes of cancer-related death in the world (1). The first laparoscopic wedge resection (LWR) for early gastric cancer treatment (EGC) was reported by Ohgami in 1992, followed shortly thereafter by the first laparoscopic-assisted distal gastrectomy for adenocarcinoma in 1994 and the first laparoscopic-assisted complete gastrectomy with D2 lymphadenectomy for gastric adenocarcinoma in 1999 (2). Over the last two decades, laparoscopic gastrectomy has provided a great deal of clinical evidence, mainly from Korea and Japan. Today, owing to cumulative surgical experience and instrumental developments, some experts have lengthened their use of EGC laparoscopic gastrectomy to advanced gastric cancer (AGC) (3). Open gastrectomy is the favoured surgical approach worldwide. However, this procedure is correlated with substantial morbidity (4). Due to its reduced invasiveness and its ability to effectively treat patients with lymph node metastasis, laparoscopic radical gastrectomy (LARG) has been increasingly used as a successful approach to the treatment of gastric cancer. However, LARG is technically demanding and needs a long learning curve (5) and even then, several studies have recorded advantages of the procedure such as decreased blood loss, reduced pain, early recovery of bowel movements, and short hospital stay (6). Quicker return to normal bowel function with an earlier restart of oral intake, earlier hospital discharge, and lower financial expenses (7). Some studies have recently assessed the result of D2 lymph node dissection in LAG and open gastric cancer surgery. Because of the tumor position, the range of lymph node involvement varies, thus making the appropriate extent of D2 dissection differ (8). There is also controversy related to lymph node dissection. Japanese researchers propose an extended dissection with the regular participation of lymph nodes D1 and D2 (7). However, in the treatment of advanced gastric cancer (AGC), LAG remains controversial, mainly because of the lack of convincing evidence that laparoscopic D2 dissection is equivalent to open surgery. Some research has shown that laparoscopic D2 dissection is realistic, safe and capable of meeting oncological requirements, including our retrospective study including 209 patients with gastric cancer who experienced laparoscopic or open surgery (9).

In the present research, the short-term results for patients with gastric cancer in our department were contrasted among LARG and open radical gastrectomy (ORG).

PATIENTS AND METHODS

This study was a retrospective analysis of 42 patients who underwent either open radical gastrectomy (ORG) or laparoscopy radical gastrectomy (LRG) with D2 lymphadenectomy. The interventions took place in the Department of Surgical Oncology, South Egypt Cancer Institute, Assuit University, between September 2017 and September 2020. The research was accepted by the Institutional Review Board, and written informed consent was obtained from all patients. In all cases, preoperative work-up involved biopsy endoscopy, abdominal ultrasound, and abdomenand pelvic computed tomography scans.

Results of interest

Perioperative results and post-surgery complications have been assessed. The major perioperative results to be evaluated were surgery time, intraoperative blood loss and hospital stays. Anastomotic leakage and stricture, reflux esophagitis, bile reflux, remnant gastritis, dumping symptoms, and delayed gastric emptying were post-operative complications. We excluded instances with surgical results of invasion of adjacent structures, positive wash cytology, distant metastases, or peritonitis carcinomatosa, as well as other organ resections except for the gallbladder or spleen, cardiovascular risk, severe liver disease (Child B or C) and kidney failure, and no approval to take part in the research.

We chose open vs laparoscopic surgery following the criteria:

- experience and preference of surgeons (not all surgeon have laparoscopic expertise);

- the patient had previous surgery mostly open surgeries (only one patient with previous laparoscopic surgery);
- some patients refused laparoscopic surgery;
- most of the laparoscopic surgery supplies were not available (ligasure, stapler).

SURGICAL TECHNIQUES

For both groups, the pre-medication and anesthetic approaches were identical. General epidural analgesia injection was administered in all patients.

The skin incision for mini-laparotomywas an upper abdominal incision (5 cm) made below the xiphoid process. In comparison, the skin incision for ODG was performed from the sub-xiphoid process to the sub-navel area and was around 20 cm long (*fig. 1a*). In short, the surgical procedure composed of the introduction of a peri-umbilical port laparoscope and the use of four trocars (10 mm each). Laparoscopic D2 gastrectomy, using a five-port technique, (*fig. 1b*). Hemostasis and dissection were accomplished by Ligasure and surgical clips. The initial port positioning was carried out using the open technique in the supraumbilical region, and carbon dioxide pneumoperitoneum was used.

Eso-jejunal anastomosis was performed through the extracorporeal small midline incision (laparoscopic as suited, not totally laparoscopic). The hand-sewn anastomosis is performed when the stapler is not available or when the patient insurance does not cover the cost.

Three additional ports were inserted under laparoscopic guidance in the upper abdomen: one in the middle of the epigastrium, 2 cm caudal to the xiphoid process primarily to compress the lateral portion of the liver, and the other two 10 cm away, on both sides of the initial port. An avascular region of the gastrocolic ligament was split proximally toward the spleen's lower pole using ultrasonic shears. Lymph node dissection was conducted laparoscopically. If resection was

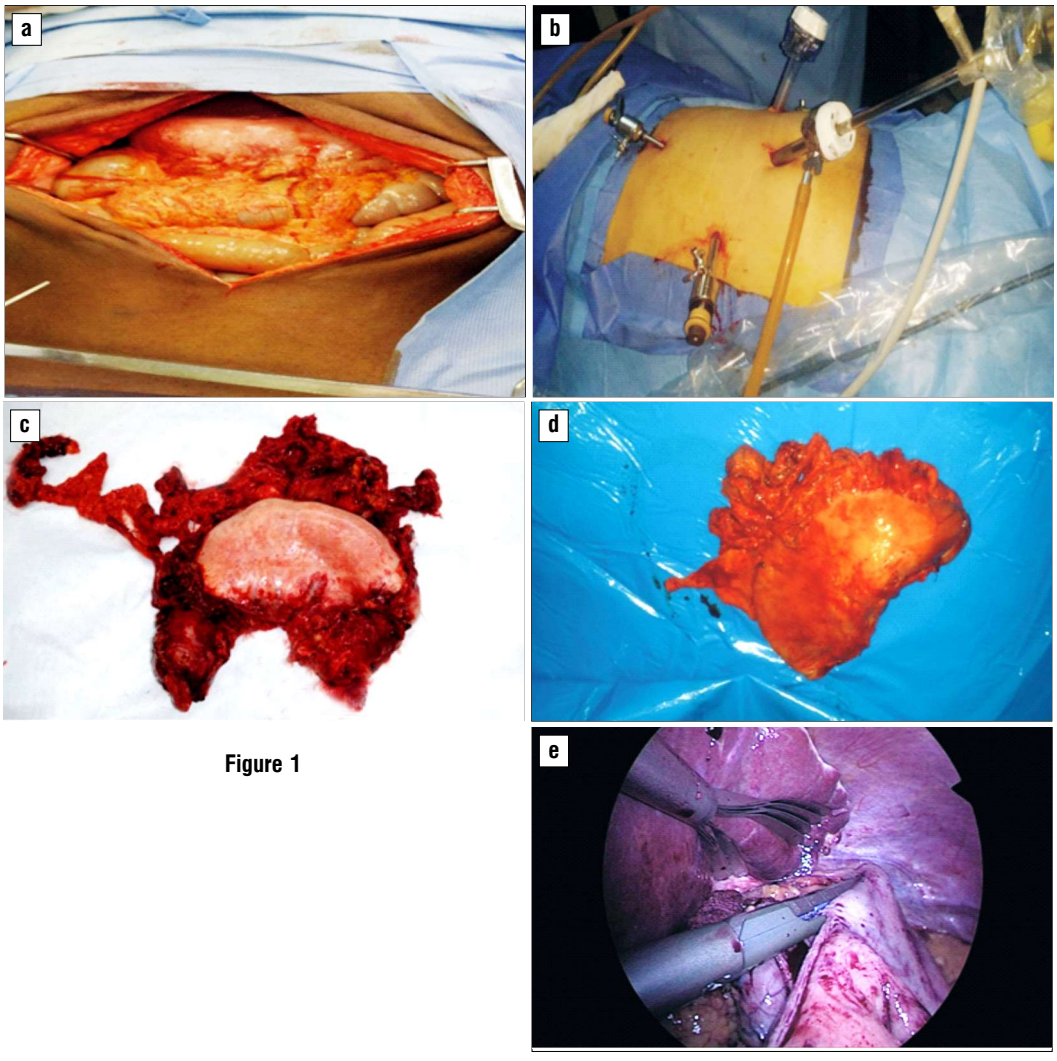

Figure 1

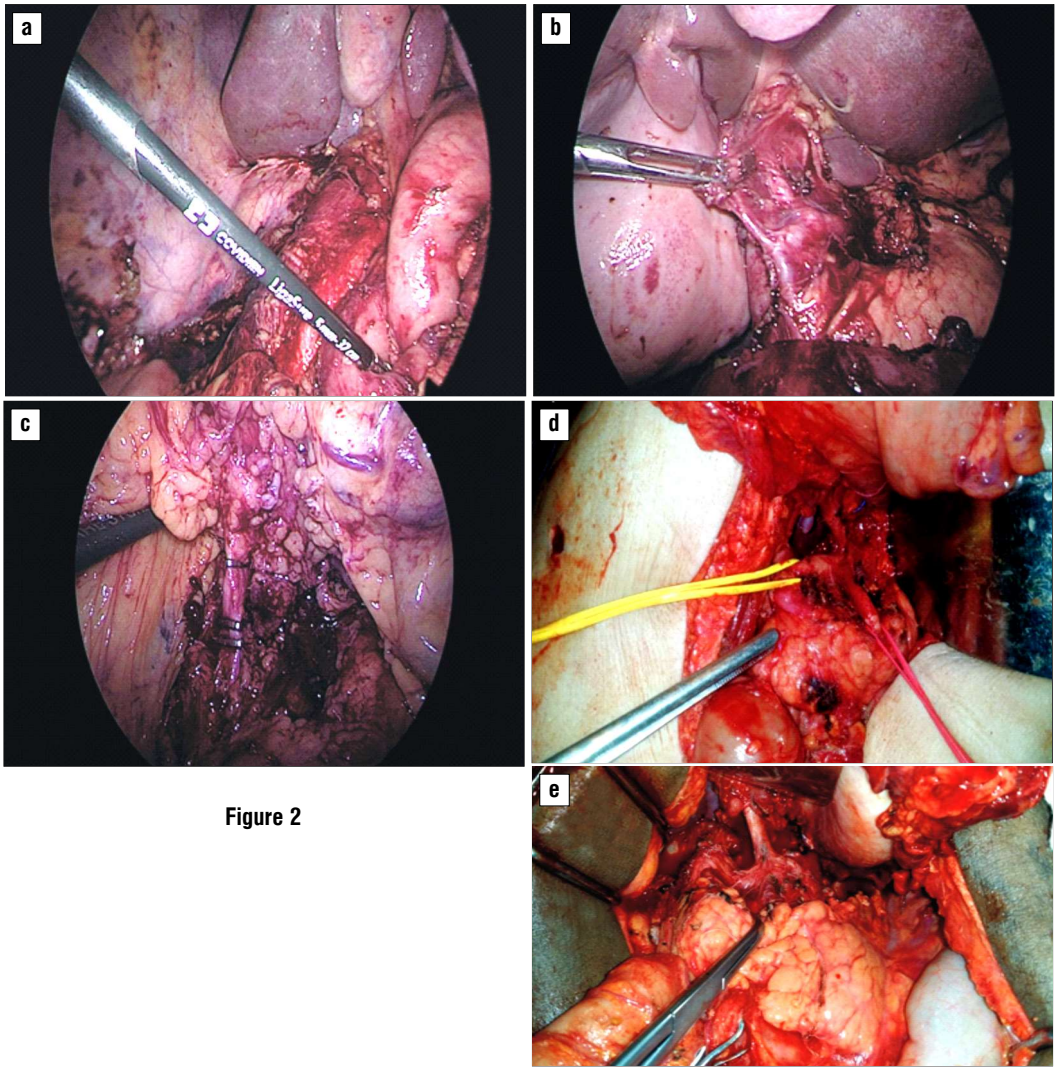

Figure 2

required for lymph node dissection along the right gastroepiploic artery, the omentum was retained.

Depending on the position and macroscopic type of the tumor, all patients were treated with radical gastrectomy and D2 lymph node dissection; total (*fig. 1c)*, or proximal (*fig. 1d*), distal (*fig. 1e*), radical gastrectomy was conducted by the surgeon. The left gastroepiploic vessels' roots were exposed and split with double clips. The split was then guided far to the pylorus, and at their origins, the right gastroepiploic vessels were split by double clips. The duodenal bulb was mobilized, (*fig. 2a*), and the right gastric artery at its origin was split with double clips from the hepatic artery. The right gastric vessels were split, and the hepatoduodenal ligament was dissected en bloc just anterior to the portal vein by the lymph nodes along the common hepatic and proper hepatic arteries (*fig. 2b*). Before the dissection of the lymph nodes along the celiac artery and the left gastric artery, the root of the left gastric artery was double clipped and divided (*fig. 2c*). Lymph nodes were dissected along the lower curvature of the stomach in the basin of the left gastric artery. Lymph nodes in open group Median 32.5 (17-44) in laparoscopic Group Median 33.5 (19-44). The number of invaded nodes in open group Median 3 (0-14) in the laparoscopic group Median 2 (0-16). Lymph Node Ratio in Open Group 9.2% in laparoscopic Group 5.97%

The fatty connective tissue around the splenic artery was completely removed, including the lymph nodes (f*ig. 4a*). At their roots, the right gastroepiploic vein and artery were split separately.

Opening of the lesser omentum; dissection of the lymph nodes around the celiac axis (*fig. 2 d, e*). During total or proximal gastrectomy for proximal tumors, the lower esophagus became adequately mobilized (*fig. 3a*). Roux-en-Y construct (*fig. 3b*), was completed by conducting jejunojejunal anastomosis (*fig. 3c*). After midline mini-laparotomy in the upper abdomen, Billroth-II (*fig. 3d*), reconstruction was performed using the hand-sewn technique esophagojejunostomy. All

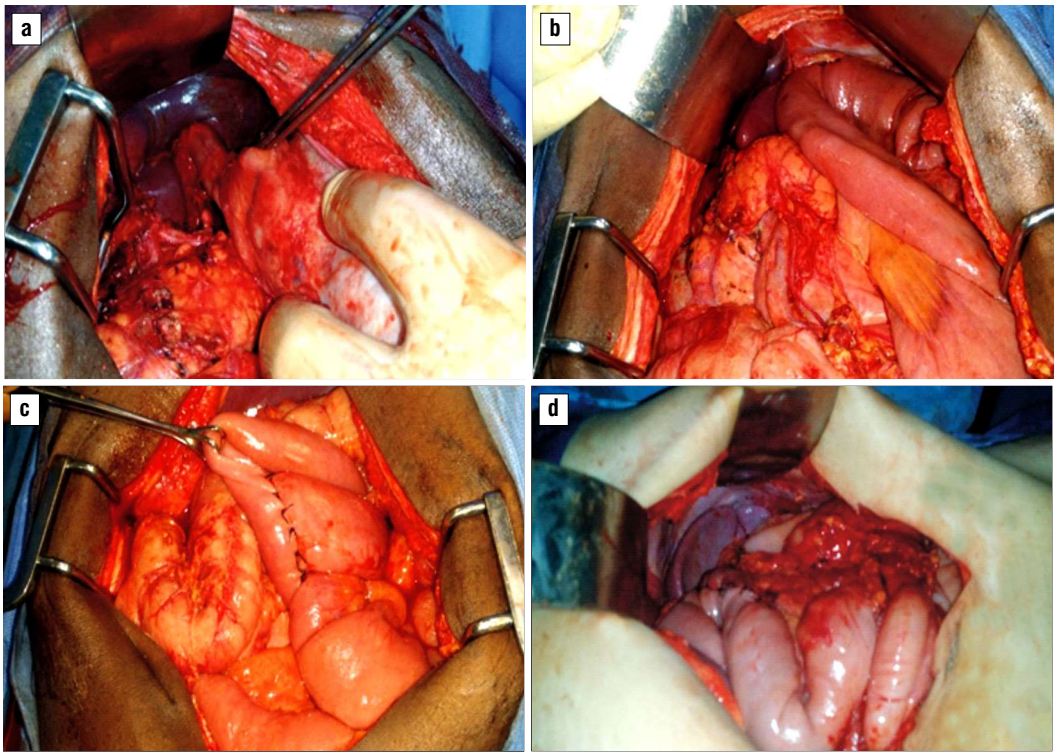

Figure 3

reconstruction procedures were performed extra-corporeally throught small midline incision (*fig. 4b*).

The follow-up took place at 3-month intervals, by the surgical team for the first two years following surgery and every six months afterwards. For the duration of follow-up, tumor markers, chest X-rays, upper gastro-intestinal endoscopy, and improved abdominal computed tomography have been assessed at least annually.

Statistical methods

In Data Management, SPSS version 25.0 was used. For numerical data description, mean and standard deviation or median and range were used. For testing proportion independence, Chi-square tests and Fisher exact tests were used. The non-parametric Mann Whitney test was used to compare means for two independent groups. At 0.05 level, P-value was always two-tailed and substantial.

RESULTS

Demographic details of the two groups. There were no substantial variations among the two groups in sex and age (P = 0.211 and 0.674, respectively). The LG group consisted of ten men and eight women, with a

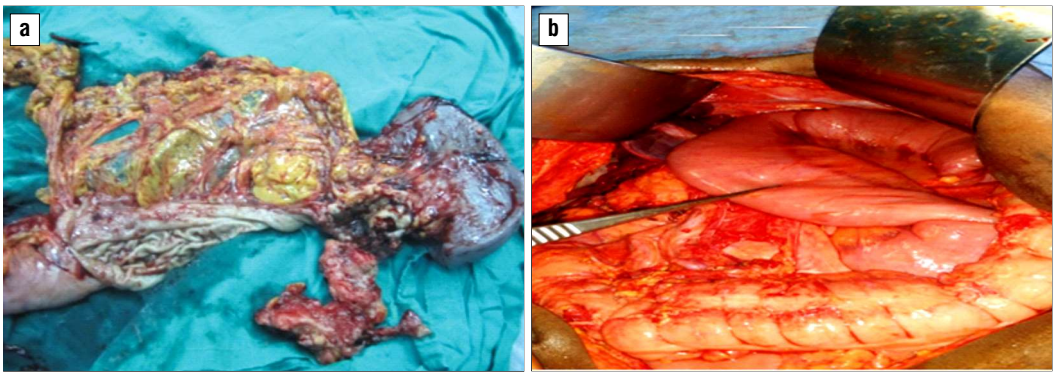

Figure 4

mean age of 58 years (range, 39–74 years). There were 8 men and 16 women in the OG group, with a mean age of 57 years (range, 37–77 years).

Intraoperative characteristics

There were substantial variations among the two groups in blood loss volume and operation time. However, the LG group had a significantly less blood loss (625.94±166.604 ml versus 1096.38±326.768 ml; P<0.001) compared with the OG group in the open group, blood transfusions were more frequently needed than in the laparoscopic group and operation time significantly longer (307.11±39.37 min versus 261.58± 27.19 min; P<0.001) than in the OG group (*table 1*).

Operative characteristics

No substantial variations among the LG and OG groups were observed in the type of radical resection (P = 0.590). Radical Subtotal gastrectomy with D2 dissection was conducted only in one case in the OG group). There were 16 cases of radical proximal gastrectomy with D2 dissection (6 in LG and 10 in OG) and 13 cases of radical distal gastrectomy with D2 dissection (5 in LG and 8 in OG). Radical total gastrectomy with D2 dissection was performed in 12 cases (7 in LG and 5 in OG). Roux-en-Y reconstruction was performed more frequently compared to Billroth I and Billroth II reconstruction. Still, there were no substantial variations in the type of radical resection among the two groups (P = 1.0). In the OG group, the average tumor diameter was substantially greater than in the LAG group (P = 0.0185). Gastrectomy with combined cholecystectomy was performed in one case in the LAG group. The occurrence of gastrectomy with combined splenectomy, tail of pancreases, andcholecystectomy (each in one case) was in the OG group. No significant difference could be seen (P = 0.905) (*table 2*).

Table 1 - Intraoperative characteristics

		Study group		
		Open surgery	**Laparoscopic surgery**	**P value**
Operation time (minutes)	N	24	18	<0.001
	Mean	261.58	307.11	
	Std. Deviation	27.190	39.376	
	Median	265.50	307.00	
	Minimum	219	230	
	Maximum	310	363	
Blood loss (ml)	N	24	18	<0.001
	Mean	1096.38	625.94	
	Std. Deviation	326.768	166.604	
	Median	997.50	622.00	
	Minimum	678	389	
	Maximum	1750	923	

Table 2 - Operative characteristics

		Study group				
		Open surgery		**Laparoscopic surgery**		**P value**
		Count	**%**	**Count**	**%**	
Operative procedure	Radical Subtotal gastrectomy	1	4.2	0	0.0	0.590
	Radical distal gastrectomy	8	33.3	5	27.8	
	Radical proximal gastrectomy	10	41.7	6	33.3	
	Radical total gastrectomy	5	20.8	7	38.9	
	Total	24	100.0	18	100.0	
Combined resection of other organs, n (%)	tail of pancreas	1	4.2	0	0.0	0.905
	Colon	1	4.2	0	0.0	
	Combined cholecystectomy	0	0.0	1	5.6	
	Combined splenectomy	1	4.2	0	0.0	
	No	21	87.5	17	94.4	
	Total	24	100.0	18	100.0	
Reconstruction type	Billroth I	2	8.3	1	5.6	1.0
	Billroth II	6	25.0	5	27.8	
	Roux-en-Y	16	66.7	12	66.7	
	Total	24	100.0	18	100.0	

Pathological findings

There were no significant differences in LG vs OG concerning the location of the tumor (whole/lower /middle/upper stomach, 1/10/3/4 vs. 2/11/5/6, (P=0.963), or histological type (moderately differentiated/mucinous /papillary/poorly differentiated/signet ring cell/tubular adenocarcinoma, well-differentiated (1/2/1/4/7/2/1 in the LG group vs 2/6/3/6/4/1/2, in the OG group (P=0.674), depth of invasion (T2) the muscularis propria (T2a), the subserosa (T2b) /T3 the serosa, 4/14 vs 6/18, P=1.0). Tumor free margins were obtained in all the patients. Furthermore, no substantial variations were noticed among the two groups in the pathological stages (P=0.553). In the LG group, there were six Stage I cases, four Stage II cases and eight Stage III cases, while in the OG group, there were eight Stage I cases, ten Stage II cases and six Stage III cases.

Comorbidities

No significant differences in LG vs OG (P=0.968), prior abdominal surgery - no significant differences one case in LG vs two cases OG (P=1.0). Gross type - no significant differences 14 cases depressed, 4 cases elevated in LAG vs 18 cases depressed, 6 cases elevated OG (P=1.0). The median LG tumor size was 3.6 cm lower than that of the OG group (range, 2.7–4.4) vs 3.8 cm (range, 2.4–5.2); P=0.207), (*table 3*).

The total number of harvested lymph nodes was

Table 3 - Pathological findings

		Study group				
		Open surgery		Laparoscopic surgery		P value
		Count	%	Count	%	
Prior abdominal surgery	No	22	91.7	17	94.4	1.0
	Yes	2	8.3	1	5.6	
	Total	24	100.0	18	100.0	
Gross type	Depressed	18	75.0	14	77.8	1.0
	Elevated	6	25.0	4	22.2	
	Total	24	100.0	18	100.0	
Histologic type	Moderately differentiated	2	8.3	1	5.6	0.674
	Mucinous	6	25.0	2	11.1	
	Papillary	3	12.5	1	5.6	
	Poorly differentiated	6	25.0	4	22.2	
	Signet ring cell	4	16.7	7	38.9	
	Tubular adenocarcinoma	1	4.2	2	11.1	
	Well-differentiated	2	8.3	1	5.6	
	Total	24	100.0	18	100.0	
Comorbidities	Cardiovascular	2	8.3	2	11.1	0.968
	COPD	3	12.5	1	5.6	
	Diabetes mellitus	4	16.7	2	11.1	
	Hypertension	4	16.7	3	16.7	
	Liver	2	8.3	1	5.6	
	No	9	37.5	9	50.0	
	Total	24	100.0	18	100.0	
Pathological T stage	T2	6	25.0	4	22.2	1.0
	T3	18	75.0	14	77.8	
	Total	24	100.0	18	100.0	
Pathological M stage	M0	23	95.8	17	94.4	1.0
	M1	1	4.2	1	5.6	
	Total	24	100.0	18	100.0	
Pathological N stage	N0	2	8.3	3	16.7	0.716
	N1	8	33.3	4	22.2	
	N2	7	29.2	7	38.9	
	N3	7	29.2	4	22.2	
	Total	24	100.0	18	100.0	
Pathological TNM stage	I	8	33.3	6	33.3	0.553
	II	10	41.7	4	22.2	
	III	6	20.8	8	38.9	
	Total	24	100.0	18	100.0	
Tumor location	Whole	2	8.3	1	5.6	0.963
	Lower	11	45.8	10	55.6	
	Middle	5	20.8	3	16.7	
	Upper	6	25.0	4	22.2	
	Total	24	100.0	18	100.0	

32.06±8.612 in the LG group, and 30.29±7in the OG group (P=0.451). There was no substantial variation in the mean distance of the proximal resection margin from the tumor (5.1±1.1 cm in the OG group vs 4.6± 0.9 cm in the LG group; p = 0.153). There was no substantial variation in the mean distance of the proximal resection margin from the tumor (4.9± 1.2 cm OG group vs 4.9± 1.1 cm LG group; p = 0.980) (*table 4*).

Postoperative recovery

The rehabilitation of the patients with laparoscopic surgery was significantly faster than open surgery. The time to ground activities (days) was significantly shorter 3(2-4) days in the LG group compared to 5(3-7) days in the OG group; (p<0.001). The time to the first ambulation was substantially shorter 2 (1-3) days in the LG group compared to 3 (1-4) days in the OG group. For both groups, the average number of days until the first flatus and the day patients began oral intake varied substantially. The time to first flatus was significantly shorter 2 (1-3) days in the LG group compared to 4 (3-6) days in the OG group; (p <0.001). Oral intake was resumed significantly earlier - 5 (3-6) days in the LG group compared to 5.5 (3-7) days in the OG group. The laparoscopic group resumed bowel function earlier 3 (2-4) days versus 4 (3-6) days in the open group (p = 0.001). First stool (days) earlier 5 (3-8) days in the LG group versus 8.5 (4-11) days in the OG (p = 0.001). Time to liquid diet (days) was resumed significantly earlier in the LG group 4 (3-5) days versus 5 (4-7) days; (p 0.002). In the LG group, the soft diet was resumed substantially earlier 6 (5-8) days vs 8.5 (7-10) days; (p <0.001). Time to first oral intake (day) was resumed significantly earlier in the LG group 4.5(3-6) days versus 5.5 (3-7) days in the OG group; p 0.047). Time to normal diet (days) was resumed significantly earlier in the LG group 4.5(3-6) days versus 5.5 (3-7) days; p <0.001). The length of postoperative hospitalization was 9.5 (7-13) days in the LG group, significantly shorter than 12 (9-17) days in the OG group (p < 0.01). A significantly lower frequency of analgesic administration Median 3 (2-5) in the LGD2 group than Median 5 (2-8) in the OG group (p<0.001) (*table 5*).

Morbidity and mortality

The overall occurrence of surgical and medical complications of all grades did not vary substantially among the groups of LG and OG. There were no substantial variations among the two groups in overall morbidity (29.1% in LAG vs. 27.7% in OG, p = 0.480). One patient in the OG group showing duodenal stump leakage, (zero v one), (p=1.0). Anastomotic leakage only occurred in one case in the LG group (one v zero), (p = 0.429). Concerning the occurrence of pancreatic fistula in the LAG group, there were no substantial variations among the two groups (one v zero), (p=1.0), This patient was treated conservatively. Lymphatic fistula only occurred in one case in the OG group (zero v one), (p=1.0). One patient with postoperative bleeding in the LG group (one v zero) (p = 1.0). Abdominal abscess only occurred in one case in the LG group (one v zero), (p = 1.0). Required computed

Table 4 - Harvested lymph nodes

		Study group		
		Open surgery	**Laparoscopic surgery**	**P value**
Number of retrieved lymph nodes	N	24	18	0.451
	Mean	30.29	32.06	
	Std. Deviation	7.451	8.612	
	Median	32.50	33.50	
	Minimum	17	19	
	Maximum	44	44	
Proximal resection margin (cm)	N	24	18	0.153
	Mean	5.025	4.550	
	Std. Deviation	1.1299	.8645	
	Median	4.850	4.300	
	Minimum	3.3	3.3	
	Maximum	7.3	6.9	
Distal resection margin (cm)	N	24	18	0.980
	Mean	4.971	4.917	
	Std. Deviation	1.2146	1.0176	
	Median	4.900	4.850	
	Minimum	3.1	3.1	
	Maximum	7.5	6.6	

Table 5 - Post-operative rehabilitation of patients

		Study group		
		Open surgery	Laparoscopic surgery	P value
Time to ground activities (days)	Median	5.00	3.00	<0.001
	Minimum	3	2	
	Maximum	7	4	
Time to first ambulation (days)	Median	3.00	2.00	<0.001
	Minimum	1	1	
	Maximum	4	3	
Time to first flatus (days)	Median	4.00	2.00	<0.001
	Minimum	3	1	
	Maximum	6	3	
Time to bowel opening (days)	Median	4.00	3.00	0.001
	Minimum	3	2	
	Maximum	6	4	
First stool (days)	Median	8.50	5.00	<0.001
	Minimum	4	3	
	Maximum	11	8	
Time to fluid diet (days)	Median	5.00	4.00	0.002
	Minimum	4	3	
	Maximum	7	5	
Time to soft diet (days)	Median	8.50	6.00	<0.001
	Minimum	7	5	
	Maximum	10	8	
Time to first oral intake (day)	Median	5.50	4.50	0.047
	Minimum	3	3	
	Maximum	7	6	
Time to normal diet (days)	Median	4.00	3.00	<0.001
	Minimum	3	2	
	Maximum	5	4	
Hospital stay (days)	Median	12.00	9.50	<0.001
	Minimum	9	7	
	Maximum	17	13	
Need for IV analgesics (day)	Median	5.00	3.00	<0.001
	Minimum	2	2	
	Maximum	8	5	

tomography - guided drainage, venous thromboembolism only occurred in one case in the OG group (zero v one), (p=1.0). Anastomotic bleeding needed transfusion (n=1 in LG vs n = 1 in OG), (p = 1.0), whereas the complications for the OG patients included post-operative ileus (n=3 vs 1), (p = 0.623). Another patient in the OD group showed anastomotic stenosis (zero v one), (p = 1.0), an endoscopic balloon dilatation has been performed effectively for the anastomosis site stricture. Delayed gastric emptying (n=1 in LG vs. n=3 in OG), (p = 0.623). Small-bowel obstruction due to adhesion. Adhesiolysis for intestinal obstruction was conducted on the 10th postoperative day, (zero v one), (p = 1.0), reoperation one patient in either group, as a result of anastomotic leakages in LG group, Acheilia's in OG (one v one), (p = 1.0). Lung complication and pneumonia, acute liver/kidney failure (n=1 in LG vs. n=2 in OG), (p=1.0). Acute pancreatitis in the LG group (one v zero). (P=0.429). Incisional hernia in two patients in the open group (zero vs two), (p = 0.498), acute myocardial infarction (n = 1) happened in the LAG group (one vs zero) (p = 0.429). Wound problems (incisional hernia only in two cases and poor incision healing only in one case) in the OG group. Open conversion was performed only in one case, the reasons for converting to open surgery was the inability to visualize the operative field left common bile duct injury. Left bile duct intraoperative leakage in one patient with early dumping syndrome (n = 1), occurred in the OG group (zero v one), (p = 1.0), mortality and readmission rates were similar among the two groups one case for each group (p = 1.0). Two patients died in the hospital, one patient of the LG group died of myocardial infarction, and the other one died of thromboembolic and pulmonary Embolism in the open group (*table 6*).

DISCUSSION

Western and Asian researches indicate improved

Table 6 - Morbidity and mortality

		Study group				
		Open surgery		Laparoscopic surgery		P value
		Count	%	Count	%	
Duodenal stump leakage	Yes	1	4.2	0	0	1.00
Anastomotic leakage	Yes	0	0	1	5.6	0.429
Pancreatic fistula	Yes	0	0	1	5.6	1.00
Lymphatic fistula	Yes	1	4.2	0	0	1.00
Postoperative bleeding	Yes	0	0	1	5.6	1.00
Abdominal abscess	Yes	0	0	1	5.6	1.00
Venous thromboembolism	Yes	1	4.2	0	0	1.00
Anastomotic bleeding	Yes	1	4.2	1	5.6	1.00
Ileus	Yes	3	12.5	1	5.6	0.623
Anastomotic stenosis	Yes	1	4.2	0	0	1.00
Delayed gastric emptying	Yes	3	12.5	1	5.6	0.623
Adhesive bowel obstructions	Yes	1	4.2	0	0	1.00
Reoperation	Yes	1	4.2	1	5.6	1.00
Lung complication	Yes	2	8.3	1	5.6	1.00
Acute liver/kidney failure	Yes	2	8.3	1	5.6	1.00
Mortality	Yes	1	4.2	1	5.6	1.00
Acute pancreatitis	Yes	0	0	1	5.6	0.429
Incisional hernia	Yes	2	8.3	0	0	0.498
Poor incision healing	Yes	1	5.6	0	0	0.429
Acute myocardial infarction	Yes	0	0	1	5.6	0.429
Open conversion	Yes	0	0	1	5.6	0.429
Bile duct injury	Yes	0	0	1	5.6	0.429
Readmissions	Yes	1	4.2	1	5.6	1.00
Dumping syndrome	Yes	1	4.2	0	0	1.00

short-term outcomes, with faster postoperative recovery with a significantly shorter hospital stay, shorter time to first flatus, and shorter time to first diet, of supporting of minimally invasive surgical techniques. In the minimally invasive group, perioperative findings suggest significantly less blood loss; however the length of surgery was longer. Additionally, less postoperative complications and no mortality variations have been identified. The less-invasive nature of the minimally invasive method could be due to all these short-term benefits. These findings are consistent with other meta-analyses that compare open gastrectomy with minimally invasive (10). Hayashi et al. demonstrated that surgical stress was significantly higher in ODG than in LADG (11) intraoperative blood loss (range, 96.5–333.3 ml with LAG versus 215–440.6 ml with OG) and operative time (range, 252–282.84 min with LAG vs 180–267.8 min with OG) (12) (192.3 ± 20.9 min vs 180.0 ± 26.9 min, respectively, p<0.0001). 5 (103.1±19.5 mL vs 163.0± 32.9 mL, p <0.0001) 5 in our study. There were substantial variations among the two groups in blood loss volume and operation time. However, the LG group had a significantly less blood loss (625.94±166.604 ml versus 1096.38±326.768 ml; p<0.001) compared with the OG group and operation time significantly longer (307.11±39.37 min vs 261.58±27.19 min; p<0.001) than in the OG group.

In all patients with gastric cancer, standard dissection of D2 is routinely performed (2). Despite the higher postoperative morbidity and mortality, D2 lympha-denectomy enhanced long-term survival (7). D2 lympha-denectomy a surrogate marker, namely of survival (13). In LTG than in OTG, fewer lymph nodes were dissected, although the difference was not significant, Nevertheless a recent case-control study found no significant difference in lymph node dissection (14). The 2014 National Comprehensive Cancer Network (NCCN) guideline recommended that D2 lymph nodes be removed by gastric cancer surgery to examine fifteen or more lymph nodes (9). Both methods removed a similar number of lymph nodes (p = 0.62) (5). Du et al assessed 82 AGC patients undergoing laparoscopy-assisted complete D2 dissection gastrectomy compared to 94 patients undergoing open surgery; comparable

numbers of HLNs were acquired in both groups (34.2 ± 13.5 vs 36.4 ±19.1, p =0.331) (8). Moreover, the mean retrieved lymph nodes were comparable (LADG vs. ODG: 29.5 ± 10.4 vs. 31.4 ± 12.3, p = 0.083) (15). We compared this number among the ODG and LADG groups in our research and observed that the average number was 30.6 and 32.3, respectively, without any substantial difference (p = 0.451).

For both men and women, gastric cancer remains among the top 10 triggers of cancer-related mortality. In these patients, radical surgical tumor resection is the only hope for a recovery. For proximal and middle stomach cancer, complete gastrectomy has been advocated (7). TG, on the other hand, is a technically demanding and time-consuming procedure, needing a very skilled and experienced surgeon. Only 36 (6.5 %) TGs were reported in the literature between 1999 and 2003, most of them laparoscopic-assisted (16). Our study included 12 cases, total radical gastrectomy with D2 dissection (7 in LG and 5 in OG). No substantial variations among the LG and OG groups were observed in the type of radical resection (p = 0.590).

Using a circular stapler, a Billroth I gastrojejunostomy with intraabdominal anastomosis may be conducted, but a Billroth II gastrojejunostomy with linear staplers is mostly favored in a fully laparoscopic approach. For both reconstructions, however the extra-abdominal approach with a small incision is very diffuse. Roux-en-Y reconstructions were performed more frequently compared to Billroth I and Billroth II reconstructions, and no significant differences (p = 1.0).

Invasion to stage T2 or beyond the stomach wall was present in 62.8% of the final pathological results (17). The depth of invasion in our study [T2 the muscularis propria (T2a), the subserosa (T2b)/T3 the serosa, 4/14 vs 6/18, p =1.0)].

The size of the resection margin can affect the tumor-free margin rate. Therefore for oncological safety, LTG should resect the same size of the resection margin as OTG. Proximal stomach resection is more difficult than the duodenal stomach resection. No statistical differences, indicating a similar proximal resection capacity among LTG and OTG, were found in this subject (18). No substantial variation among the two groups was seen in the proximal tumor resection margin (6.3 cm versus 6.5 cm) (1). Tumor-free margins were obtained in all the patients included in the study; the proximal resection margin showed no significant difference (5.1± 1.1 cm OG group vs 4.6±0.9 cm; LG group p = 0.153).

There was no difference among laparoscopic and open D2 gastrectomy in the hospital mortality rate and the total morbidity rate (1.1 % vs 0, and 24.2 % vs 28.5 %, respectively). Our findings are equivalent to the 0.8-3.1 % mortality rate and the 20.1-33.5 % morbidity rate (19). The postoperative mortality rates were reported in 13 studies, with no substantial variation in the rate among the groups of LGD2 and OGD2 (OR =0.69)(20). The mortality and morbidity rates were 0% and 14.8%, respectively (21). It was acceptable for surgical morbidity and mortality (3.1%, 0%, respectively) (8), and for surgical morbidity and mortality (3.1%, 0%, respectively) (8). In JCOG0912, the proportion of postoperative complications in the LADG and ODG arms was similarly low (22). No significant differences in overall morbidity among the two groups were found in our study (29.1% in LAG vs 27.7% in OG, p = 0.480). Mortality was similar between the two groups, one case for each group (p = 1.0).

Gastroparesis was also another major reason for postoperative adverse events, different from CLASS-01. In this trial, the prevalence of gastroparesis was comparable to 0.4-7% in prior reports (15). In our study delayed gastric emptying (n = 1 in LG vs. n =3 in OG), (p = 0.623).

The proportion present in this study was comparable to that recorded in CLASS-01 (6.4 %) for the conversion rate from LADG to ODG, but was higher than the one shown in KLASS-01 (3.2%), JCOG0912 (3.5%), and JCOG0703 (2.9%) (15), (2.2–6.3 %) (17), (1.1%) (21). Kim et al. (0.2 %), Lee (1.7 %) , and Kim (0.9 %) (22) left bile-duct injury was related to D2 lymphadenectomy (23). Conversion to open surgery for only one patient was needed in the current study (0.429%); the reason for converting to open procedures was the inability to visualize the operative field and left common bile duct injury.

The occurrence rates of wound problems (wound infection and dehiscence) and pneumonia in the LGD2 group are considerably lower. No variation was found among the two groups in the occurrence rate of major complications at the surgical site, like anastomotic leakage, anastomotic stenosis, duodenal stump leakage, pancreatitis or pancreatic fistula and intra-abdominal bleeding (20). We found that postoperative complications, including anastomotic leakage and pancreatic fistula, were comparable among LAG and OG (12). There was a percent of 5.3 and 2.3 % for anastomotic leakage and pancreatic fistula (17).

With respect to the occurrence of pancreatic fistula (p = 0.985), abdominal abscess (p = 0.238), anastomotic leakage (p = 0.503), anastomotic stenosis (p = 0.491), or nonsurgical complications (p = 0.283), no

substantial variations were identified among the two groups (19). There were no substantial variations among the two groups in terms of the frequency of duodenal stump leakage, (p = 1.0), anastomotic leakage (p = 0.429), pancreatic fistula (p = 1.0), abdominal abscess (p = 1.0), anastomotic stenosis (p = 1.0), lung complication and pneumonia, acute liver/kidney failure (p = 1.0), acute pancreatitis (P = 0.429), incisional hernia (p =0.498).

The reoperation

No significant difference was found between the LGD2 and OGD2 groups (OR = 1.58, 95%CI: 0.58-4.31) in our study (20). One patient was reoperation in each group, as a result of anastomotic leakages in LG group, and adhesiolysis in OG. (1 vs 1), (p = 1.0).

Due to minimal LTG invasiveness, less pain during recovery is most likely 18 In the LGD2 group, the meta-analysis showed a significantly lower frequency of analgesic administration than in the OGD2 group (WMD = -1.94, 95%CI: -2.50--1.38; p < 0.01) (20). A significantly lower frequency of analgesic administration was noted in the study: Median 3 (2-5) in the LGD2 group compared to Median 5 (2-8) in the OG group p < 0.001.

The average stay in hospital was significantly shorter after laparoscopic gastrectomy D2 than after open gastrectomy D219, 24 shorter stay in the hospital (6.8 ± 1.2 d vs 9.5 ± 1.6 d, p < 0.0001). 2 (16.7 ± 5.6 days with LADG versus 21 ± 11.4 days with ODG) 12 In this study the length of postoperative hospitalization was 9.5 (7-13) days; The LG group had significantly shorter postoperative hospitalization than 12 (9-17) days; the OG group p < 0.01).

The time to the first ambulation in the LGD2 group was substantially shorter than in the OGD2 group (WMD = -1.03 d, 95%CI: -1.90--0.16; P < 0.05) (20) in this study. The time to first ambulation was significantly shorter [2 (1-3) days in the LG group compared to 3 (1-4) days; in the OG].

The time to first flatus in the LGD2 group was substantially shorter than in the OGD2 group (WMD = -0.98 d, 95%CI: -1.30--0.66; p < 0.01) (20) in this study. The time to first flatus was significantly shorter [2 (1-3) days in the LG group than 4 (3-6) days in OG group; p <0.001].

The time to first oral intake in the LGD2 group was substantially shorter than in the OGD2 group (WMD = -0.85 d, 95%CI: -1.67--0.03; p < 0.05) (20). Time to first oral intake (day) was resumed significantly earlier in the LG group 4.5(3-6) days vs 5.5 (3-7) days; p 0.047).

For LTG patients, functional recovery was quicker than for patients with OTG. Most possibly, this stems from less surgical trauma and consequently decreased inflammation (14), less time to normal diet (3.0 ± 0.4 d vs 3.8 ± 0.5 d, p < 0.0001); (5) less time to bowel opening (3.3 ± 0.7 d vs 4.5 ± 0.7 d, p < 0.0001); (5) less bedbound time (1.0 ± 0.3 d vs 3.3 ± 0.4 d, p < 0.0001) (5). In this study the laparoscopic group resumed bowel function earlier 3 (2-4) days vs 4 (3-6) days in the open group, p = 0.001). First stool (days) earlier 5 (3-8) days in the LG group vs 8.5 (4-11) days in the OG group (p = 0.001). Time to liquid diet (days) was resumed significantly earlier in the LG group 4 (3-5) days versus 5 (4-7) days; (p = 0.002). In the LG group, the soft diet was taken up significantly earlier 6 (5-8) days versus 8.5 (7-10) days (p < 0.001). The time for normal diet (days) was resumed substantially earlier in the LG group 4.5 (3-6) days versus 5.5 (3-7) days (p < 0.001).

CONCLUSION

LAG with D2 dissection is a safe, effective, feasible and minimally invasive approach to treating gastric cancer. LARG will provide better short-term advantages than ORG. Decreased length of hospital stay, decreased narcotic use, can achieve the same radicalness as an open surgery equivalent in terms of margin status and sufficient retrieval of lymph nodes, improved post-operative life quality, with similar morbidity, mortality relative to open gastrectomy.

Conflict of interest

All author declare that they have no conflict of interest.

Ethical approval

No institutional ethical approval is required to perform descriptive retrospective studies.

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