RESEARCH ARTICLE

Short-term Outcome of Laparoscopic vs Open Gastrectomy for Gastric Cancer: A Randomized Controlled Trial

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Abstract

Background: Gastric cancer (GC) is a crucial cause of morbidity and mortality worldwide. In Egypt, GC ranked as the 12th most common cancer. During the last two decades, laparoscopic gastrectomy (LG) has proved to be popular and effective. This study aims to compare the short-term outcomes of LG vs open gastrectomy (OG) in resectable GC patients.

Patients and methods: This is a randomized controlled trial, where patients presented to Assiut university hospital with resectable GC, in the period from January 2017 to December 2019, were randomly allocated to OG (group A) or LG (group B).

Results: During the study period, 46 patients were randomized: 23 patients for OG and 23 for LG. Advanced cases after exploration were excluded from both the groups ended up with a total of 36 patients (20 for OG and 16 for LG). The mean follow-up time was 5 months ranging from 40 days to 10 months. There were no statistically significant differences between the two groups in the baseline clinicopathological data. The mean operative time was longer in LG (260.6 ± 46.7 vs 191.0 ± 24.7 minutes in OG) with a *p*-value <0.001. The postoperative hospital stay was more in OG compared to LG (8.0 ± 4.1 vs 6.9 ± 2.6 days, *p*-value = 0.361). Postoperative complications were more among OG (4/20) compared to (2/16) in LG (*p*-value = 0.549). Just one mortality was reported in the OG.

Conclusion: For GC cases, LG shows comparable outcomes to OG in short-term results, and it is a promising minimally invasive surgery in such cases.

Keywords: Gastrectomy, Gastric cancer, Laparoscopic surgery.

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Introduction

Gastric cancer (GC) is one of the crucial causes of cancer morbidity and mortality worldwide. Globally, East Asia (Korea, Mongolia, Japan, and China) represents the highest percentage of cases and deaths from GC.[1]

In Egypt according to the national population-based cancer registry program, GC ranked as the 12th most common cancer representing 1.6% of the total cancers and 2.2% of the total cancer deaths. The incidence varies among the different regions of Egypt (higher in Upper Egypt 2.48% compared to Lower Egypt 0.98%).[2]

Surgery is the only cure for GC. According to the resection extent, gastrectomy is classified into distal gastrectomy, total gastrectomy, and proximal gastrectomy. Also, the extent of lymph node (LN) dissection is very important. In general, most studies report D1 (dissection of the perigastric LNs) or D2 (dissection of the LNs around the big gastric vessels), which means that at least a D1 LN dissection should be done. However, as mentioned in the 4th Japanese Gastric Cancer Treatment Guidelines for resectable GC, D2 LN dissection is strongly recommended and considered as the standard of care for GC patients.[3]

Laparoscopic gastrectomy (LG) for GC, initially introduced by Kitano et al. in 1993, has been studied in many countries, and nowadays, it became one of the important procedures for the treatment of early GC. Additionally, it has shown comparable short- and long-term outcomes as open gastrectomy (OG), mainly in Far East countries as Korea and Japan.[4,5] Furthermore, as surgical experiences increased and with development of instruments, some experts have extended their use of LG from early GC (EGC) to advanced GC (AGC).[4,6] However, the implementation of LG in our region is challenging because of the low number of cases and high cost of the equipment.

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This study aims to compare the short-term outcomes of LG vs OG in resectable GC patients at our center in Upper Egypt (Assiut University Hospital, Egypt).

Patients and Methods

This randomized controlled trial conducted at the Department of General Surgery in the Assiut University Hospital (one of the largest tertiary centers in Egypt that serves most of Upper Egypt patients) in the period from January 2017 to December 2019, including all GC patients admitted to Assiut university hospital during this period.

The research protocol was approved via the Ethical Review Committee of Assiut Faculty of Medicine before starting the study. Written informed consent was obtained from recruited patients, and this trial was registered in clinicaltrial.gov (NCT02789826). Any adult patient with primary and resectable gastric carcinoma was eligible for the study. All GC patients have been diagnosed by

upper endoscopy and biopsy. Surgical resectability was assessed by multislice computed tomography abdomen (with IV and oral contrast), where resectable tumors, according to TNM classification, had to be T1-3, N0-1, and M0. All patients with infiltrating or metastatic cancer, peritoneal deposits, surgically unfit patient, or pregnant women were excluded from the study. After the diagnosis and assessment of eligibility, patients were randomized into two groups: group A had OG and group B had LG. Random assignment was done by the sealed envelope technique.

All patients had signed an informed consent after a complete explanation of the risks and advantages of the surgery being planned for them.

Baseline clinicopathological data were collected as age, sex, and tumor site.

Surgical Techniques

Laparoscopic Gastrectomy

The patient was placed in supine position for the induction of general anesthesia with cuffed endotracheal tube and then placed in French position. The operator stands between the legs of the patient. The cameraman stood on the patient's right side, while the first assistant stood on the patient's left side and the tower is placed near the patient's head.

A 10-mm camera port was created superior or inferior to the umbilicus by open method, and pneumoperitoneum with carbon dioxide was induced to a pressure of up to 15 mm Hg.

The peritoneal cavity was carefully checked for any secondaries. The table was turned into the steep reverse-Trendelenburg position, and four other trocars (one 12-mm and three 5-mm trocars) were placed carefully using laparoscopic vision. Thereafter, laparoscopic D2 gastrectomy was performed as follows.

We start by dividing the gastrocolic ligament along its transverse colon attachment using ultrasonic shears (Harmonic Scalpel TM; Ethicon Endo-Surgery Inc., Cincinnati, Ohio, United States). We started at the avascular plane to the left of the midline and dissected toward the spleen till it reaches the left gastroepiploic vessels that were divided. Division of the greater omentum was continued in the direction of the first part of the duodenum, and the roots of the right gastroepiploic vessels were divided. The soft tissues attached to the duodenum were dissected.

All LNs around the gastroepiploic vessels (stations 4d and 4sb) were dissected followed by the infra-pyloric LNs (station 6), which were dissected from the pylorus. At this stage, careful dissection was usually done to avoid injury of gastrocolic trunk of Helen, which, if happened, will result in unnecessary bleeding. The lesser omentum was then entered at the pars flaccida, and the origin of the right gastric artery was divided.

In the case of distally located tumors, the distal resection margin was the duodenum 1 to 2 cm distal to the pylorus using a COVIDIEN Endo GIA Ultra Universal Stapler, 12 mm.

The left gastric vein and artery were exposed by raising the stomach upward and to the right, completing dissection till the origin of the left gastric artery from the celiac trunks, where the artery was divided at its origin (station 7) using both clips and the ultrasonic shears. At this point, the LNs around the common hepatic artery were exposed and dissected. The perigastric LNs were dissected along the lesser curvature reaching the esophagogastric junction. At least a proximal 5-cm resection margin starts from the grossly malignant margin is done using COVIDIEN Endo GIA Ultra Universal Stapler, 12 mm (according to gastric wall thickness). Afterward, we dissected the adipose tissue over the anterosuperior border of the pancreas and LNs along the splenic vessels (station 11).

In locating proximal tumors, the proximal resection margin involved the whole proximal gastric segment with 2 to 3 cm esophageal safety margin using linear endo GIA stapler, 45 mm, blue cartilage and a distal resection line of 5 cm safety margin.

In tumors occupying a large area of the stomach, total gastrectomy was done with the duodenum transected 1 to 2 cm distal to the pylorus and the esophagus transected 2 to 3 cm proximal to the stomach.

Reconstruction was done by Roux-en-Y jejunal anastomosis for total and distal resection and esophagogastric anastomosis in upper radical resection.

A nasogastric tube inserted at the start of the operation was then advanced to cross the anastomosis, just beforehand sewing the opening left after the side-to-side stapling. Finally, the resected specimens after putting in a retrieval bag were taken out through a 6-cm vertical supraumbilical incision that starts at the umbilicus. The specimen was then checked for safety margins. A subphrenic tubal drain was then inserted and left until the patient starts semisolid meals without evidence of anastomotic leaks or bleeding, usually for 3 to 5 days.

Open Gastrectomy

A 10–15-cm incision length from the xiphisternum till below the umbilicus was used. Abdominal exploration was routinely done to assess the tumor and exclude metastasis before proceeding to the radical gastric resection. In general, we used the same steps as in the laparoscopic resection.

Pre- and Postoperative Management

Pre- and postoperative management was the same for the two groups. All patients received broad-spectrum antibiotics for 48 hours during their postoperative hospitalization. Feeding was started after passage of flatus. When the patients have adequate pain control, tolerance of oral intake, ability to mobilize and self-care, and no abnormal physical signs or laboratory test they were discharged.

Perioperative data such as operative time, estimated intraoperative blood loss, intraoperative organ injury, postoperative complications, histopathology of the tumor, and clinicopathological TNM stage (according to the International Union Against Cancer staging 10) were recorded. Postoperatively, 30-day follow-up data were collected to assess any complications, hospital stay duration, and need for ICU admission.

Data Management

Data management including data entry and statistical analysis were done by using IBM SPSS software, version 20. Quantitative variables were presented in terms of mean ± SD, and qualitative variables were expressed as frequency and percentage. Student's *t*-test and Chi-square test were used to compare the outcomes of two groups. The level of significance *p*-value was evaluated, where *p*-value <0.05 was considered statistically significant.

Results

During the study period, 73 patients were admitted to the department of general surgery at Assiut university hospital having GC and assessed for eligibility for possibility of curative resection. Twenty-seven patients were excluded as they were not meeting

the eligibility criteria or refusing to be recruited in the study. The remaining 46 patients were randomized: 23 patients for OG (group A) and 23 for LG (group B). After assignment, four patients had been refused to complete the study (early withdrawal): one from OG group and three from LG group. Locally advanced cases received palliative resection and were excluded from both the groups. The study ended up with a total of 36 patients (20 for OG and 16 for LG) (Fig. 1). The mean time of follow-up was 5 months ranging from 40 days to 10 months.

Although there was no statistical difference between the two groups in the clinicopathological data, we noticed the following. The mean age of recruited patients was 52.5 ± 11.4 years old ranging from 33 to 78 years old. There were 24 males and 12 females. As regards tumors, they were more distally located (69.4%), all were adenocarcinoma with 86.1% differentiated, and 55.6% had TNM stage II. (Table 1)

The mean operative time was 260.6 ± 46.7 minutes in LG vs 191.0 ± 24.7 minutes in OG group (p-value <0.001) (Fig. 2). Blood loss was more in OG 372.5 ± 125.1 mL compared to 296.6 ± 124.2 mL in LG with a nonsignificant p-value = 0.077. The number of harvested LNs was nonsignificantly higher in OG 21.0 ± 6.5 compared to LG 16.8 ± 6.5 (p-value = 0.064). Intraoperative injury occurred in one case of open group (5%), where the middle colic artery was injured leading to colonic ischemia that required resection with primary anastomosis. In another case in LG group (6.25%), pleural injury that was dealt with by simple airtight repair was reported with no need for intercostal tube insertion (Table 2).

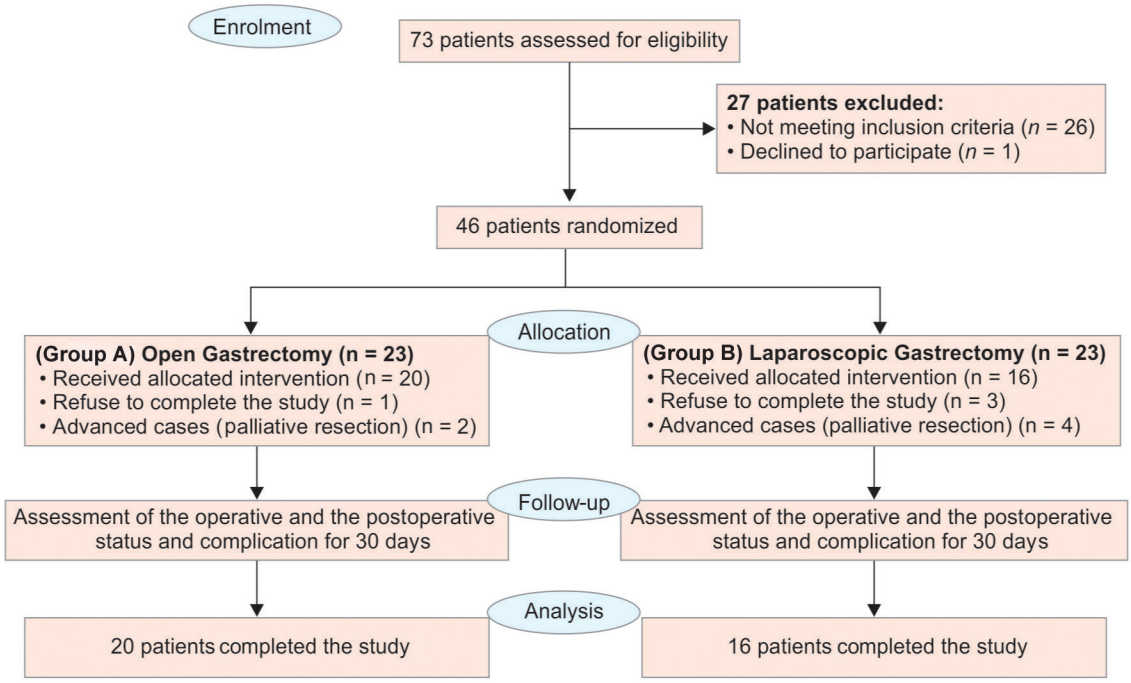

Fig. 1: CONSORT flow diagram of the study

Table 1: Clinicopathological characteristics of studied groups

		Total (N = 36)	*OG (N = 20)*	*LG (N = 16)*	*p value*[†]
	Age	52.5 ± 11.4	54.7 ± 13.7	49.7 ± 7.0	0.192
Sex	Male	24 (66.7%)	13 (65.0%)	11 (68.8%)	0.813
	Female	12 (33.3%)	7 (35.0%)	5 (31.2%)	
Site of tumor	Upper	10 (27.8%)	6 (30%)	4 (25.0%)	0.514
	Middle	1 (2.8%)	0	1 (6.2%)	
	Distal	25 (69.4%)	14 (70%)	11 (68.8%)	
Histopathology	Differentiated	31 (86.1%)	18 (90.0%)	13 (81.2%)	0.451
	Not differentiated	5 (13.9%)	2 (1.0%)	3 (18.8%)	
Resection type	Distal	24 (66.7%)	13 (65.0%)	11 (68.8%)	0.940
	Proximal	10 (27.8%)	6 (30.0%)	4 (25.0%)	
	Total	2 (5.6%)	1 (5.0%)	1 (6.2%)	
TNM stage	II	20 (55.6%)	10 (50%)	10 (62.5%)	0.453
	III	16 (44.4%)	10 (50%)	6 (37.5%)	

Data presented as mean ± SD or number and percentage *n* (%);
[†]Student's *t*-test and Chi-square test were used

The patients were followed up for 30 days. Hospital stay was increased nonsignificantly among OG group 8.0 ± 4.1 days compared to LG group 6.9 ± 2.6 days (p-value = 0.361). Time to first flatus was nonsignificantly longer in OG group (2.4 ± 0.51 days) compared to LG group (2.5 ± 0.52 days) with p value = 0.773 (Table 3). As regard postoperative complications, four complications were recorded in the OG group (20%) including one anastomotic leak in total gastrectomy, two luminal bleedings, and one chest infections. On the contrary, only two complications were recorded in LG group (12.5%), which were two anastomotic leaks (one total and one distal gastrectomy) (Fig. 3). All anastomotic leakages were low output and managed successfully by conservation in both groups. In the OG group, cases which developed luminal bleeding (bleeding less than 100 mL/hour) did not require any emergency procedure. There was no mortality in LG group compared to one patient of OG group (due to massive pulmonary embolism).

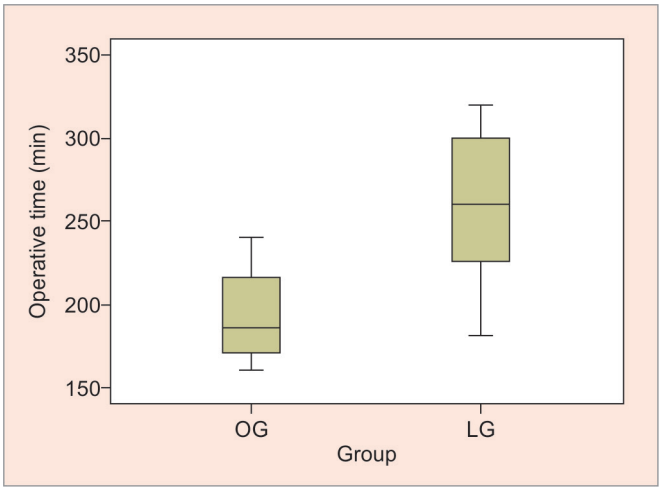

Fig. 2: Boxplot of operative time of studied groups

Table 2: Operative outcomes of studied groups

	OG (N = 20)	*LG (N = 16)*	*p value*†
Operative time (minutes)	191.0 ± 24.7	260.6 ± 46.7	<0.001*
Estimated blood loss (mL)	372.5 ± 125.1	296.6 ± 124.2	0.077
Number of harvested LN	21.0 ± 6.5	16.8 ± 6.5	0.064
Intraoperative organ injury	1 (5.0%)	1 (6.2%)	0.871

Data presented as mean ± SD or number and percentage *n* (%);
†Student's *t*-test and Chi-square test were used;
*Significant *p*-value

Table 3: Postoperative outcomes of studied groups

	OG (N = 20)	*LG (N = 16)*	*p value*†
Length of hospital stay (days)	8.0 ± 4.1	6.9 ± 2.6	0.361
Time to first flatus (days)	2.4 ± 0.51	2.5 ± 0.52	0.773
Diet start time (days)	2.5 ± 0.51	2.3 ± 0.48	0.415
ICU admission	5 (25.0%)	1 (6.2%)	0.134
Postoperative fever	3 (15.0%)	3 (18.8%)	0.764
Blood transfusion	3 (15.0%)	2 (12.5%)	0.829
Complications	4 (20.0%)	2 (12.5%)	0.549
Mortality	1 (5.0%)	0	0.364

Data presented as mean ± SD or number and percentage *n* (%);
†Student's *t*-test and Chi-square test were used

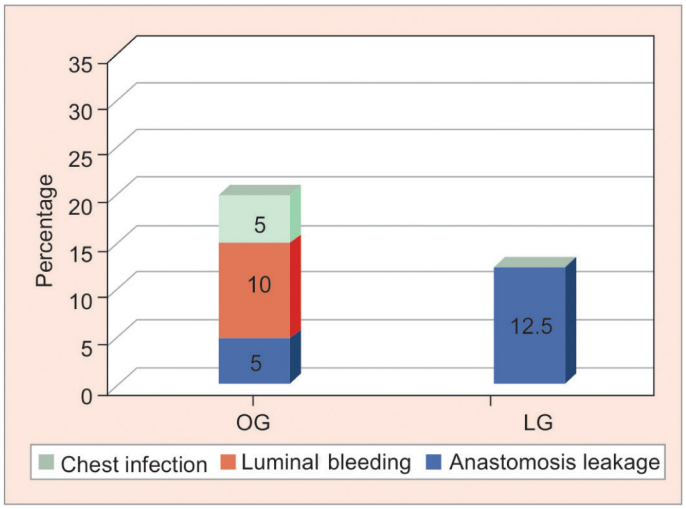

Fig. 3: Postoperative complications of studied groups

Discussion

During the last two decades, minimally invasive surgery has been implemented in gastrointestinal cancer therapy to reduce operative morbidity and enhance recovery, without affecting the oncological outcome.[7] Nowadays, LG is considered to be a promising technique that minimize patient suffering and ensure comparable or, sometimes, improved surgical outcomes.

In our trial, the operative time was significantly longer in LG compared to OG. Other studies reported that LG takes longer time than OG and the time usually depends on the surgeon's experience. As mentioned by Kim et al., the learning curve for LG especially distal gastrectomy has two plateaus: first plateau after the first 10 cases when the operative time reached (230–240 minutes/operation) and then reached a second plateau (<200 minute/operation) for the next 30 cases.[8,9] The same also concluded by Marchesi et al. that at the beginning of the learning curve, the time element was significantly higher in LG patients (301.5 vs 232 minutes, $p = 0.023$), with an evident learning curve effect.[10] In Egypt, we have a lower incidence of GC than in Far East countries, and our study included 16 LGs. This may explain the longer operative time in this study compared to studies conducted in Far East countries as Japan and China where GC is prevalent.

Regarding the pathologic data as number of excised LNs and surgical margins, there was no statistically significant difference between the two groups. The same was reported in the study done by Gong et al.[11] Moreover, a systematic review and meta-analysis done by Beyer et al. showed that laparoscopic approach does not impair D2 lymphadenectomy, indicating oncological equivalence to the open approach.[12]

Furthermore, we noticed more blood loss among the OG group although not statistically significant (p-value = 0.077). This is supported by other studies and generally considered as one of the advantages of laparoscopic surgery.[4,11,13,14]

The present study showed that the postoperative short-term surgical outcomes of LG are comparable to those of the open surgery. We reported less hospital stay among the LG group

that was not statistically significant , which was supported by other authors.[6,15] The postoperative overall complication rate was 20.0% in OG vs 12.5% in LG, a difference that was not statistically significant. Anastomosis leakage was reported more in LG and more at total gastrectomy patients. This was supported by other studies which reported that anastomosis leakage occurred in 0 to 17% of total gastrectomy patients, in 1.1 to 2.7% of distal gastrectomy patients, and more liability of fistula in LG patients.[14,16,17]

Luminal bleeding is a serious complication that can lead to severe morbidity and even mortality if not treated properly. Other authors reported rates of anastomotic hemorrhage ranged from 0 to 2.0%.[18] but it is lethal if not treated immediately. Methods: Of 1400 patients with gastric cancer who underwent gastrectomy between September 2002 and December 2007, postoperative anastomotic hemorrhage was observed in 6 patients. The surgical procedures, bleeding sites, methods of hemostasis, and clinical courses of these 6 patients were analyzed. Results: Of the 1400 patients, 878, 72, and 450 underwent distal, proximal, and total gastrectomy, respectively. The bleeding sites were as follows: transection line of the stomach using a linear stapler ($n = 1$ In our study, we reported two cases of luminal bleeding who were treated successfully by conservative management. Although only one mortality was reported only in OG group, the difference was not statistically significant. This agrees with the results of the Korean multicenter trial named KLASS (Korean Laparoendoscopic Gastrointestinal Surgery Study; NCT00452751), which concluded that there was no significant difference in the morbidity and mortality between the OG and LG groups of GC resection.[19]

The current study has some limitations as the small number of patients and being a single-center study. Further clinical trials on larger number of patients and involving multiple centers are still needed.

In conclusion, for resectable GC cases, early results showed that laparoscopic D2 gastrectomy has comparable outcomes to OG regarding intraoperative blood loss, number of harvested LN, operative organ injury, length of hospital stay, time to first flatus, postoperative morbidity, and mortality. However, the laparoscopic approach was longer than the open one for the early surgeon's experience. Larger trials are needed for further evaluation of the early and late outcomes.

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References

1. Bray F, Ferlay J, Soerjomataram I, et al. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018;68(6):394–424. DOI: 10.3322/caac.21492.
2. Ibrahim AS, Khaled HM, Mikhail NN, et al. Cancer incidence in Egypt: results of the national population-based cancer registry program. J Cancer Epidemiol 2014;2014(January):1–18. DOI: 10.1155/2014/437971.
3. Kodera Y, Sano T. Japanese gastric cancer treatment guidelines 2014 (ver. 4). Gastric Cancer 2017;20(1):1–19. DOI: 10.1007/s10120-016-0622-4.
4. Lee HJ, Yang HK. Laparoscopic gastrectomy for gastric cancer. Dig Surg 2013;30(2):132–141. DOI: 10.1159/000350884.
5. Son T, Hyung WJ. Laparoscopic gastric cancer surgery: current evidence and future perspectives. World J Gastroenterol 2016;22(2):727. DOI: 10.3748/wjg.v22.i2.727.
6. Gurusamy KS. Laparoscopic versus open gastrectomy for gastric cancer. In: Gurusamy KS, editor. Cochrane Database Syst Rev 2014;2014(11). DOI: 10.1002/14651858.CD011389.
7. Orditura M, Galizia G, Sforza V, et al. Treatment of gastric cancer. World J Gastroenterol 2014;20(7):1635–1649. DOI: 10.3748/wjg.v20.i7.1635.
8. Kim MC, Jung GJ, Kim HH. Learning curve of laparoscopy-assisted distal gastrectomy with systemic lymphadenectomy for early gastric cancer. World J Gastroenterol 2005;11(47):7508–7511. DOI: 10.3748/wjg.v11.i47.7508.
9. Kim HG, Park JH, Jeong SH, et al. Totally laparoscopic distal gastrectomy after learning curve completion: comparison with laparoscopy-assisted distal gastrectomy. J Gastric Cancer 2013;13(1):26–33. DOI: 10.5230/jgc.2013.13.1.26.
10. Marchesi F, De Sario G, Cecchini S, et al. Laparoscopic subtotal gastrectomy for the treatment of advanced gastric cancer: a comparison with open procedure at the beginning of the learning curve. Acta Biomed 2017;88(3):302–309. DOI: 10.23750/ABM.V88I3.6541.
11. Gong Y, Wang B, Wang H. A propensity score-matching analysis comparing the oncological outcomes of laparoscopic and open gastrectomy in patients with gastric carcinoma. J BUON 2017;22(1):134–140. PMID: 28365946
12. Beyer K, Baukloh AK, Kamphues C, et al. Laparoscopic versus open gastrectomy for locally advanced gastric cancer: a systematic review and meta-analysis of randomized controlled studies. World J Surg Oncol 2019;17(1):68. DOI: 10.1186/s12957-019-1600-1.
13. Kim HH, Han SU, Kim MC, et al. Long-term results of laparoscopic gastrectomy for gastric cancer: a large-scale case-control and case-matched Korean multicenter study. J Clin Oncol 2014;32(7):627–633. DOI: 10.1200/JCO.2013.48.8551.
14. Hu Y, Huang C, Sun Y, et al. Morbidity and mortality of laparoscopic versus open D2 distal gastrectomy for advanced gastric cancer: a randomized controlled trial. J Clin Oncol 2016;34(12):1350–1357. DOI: 10.1200/JCO.2015.63.7215.
15. Mitrousias AS, Makris MC, Zani Z, et al. Laparoscopic versus open gastrectomy with D2 lymph node dissection for advanced gastric cancer: a systematic review. J BUON 2019;24(3):872–882. PMID: 31424636
16. Lan X, Xi H, Zhang K, et al. Comparison of complications following open, laparoscopic and robotic gastrectomy. Zhonghua Wei Chang Wai Ke Za Zhi 2017;20(2):184–189. DOI: 10.3760/CMA.J.ISSN.1671-0274.2017.02.014
17. Hummel R, Bausch D. Anastomotic leakage after upper gastrointestinal surgery: surgical treatment. Visc Med 2017;33(3):207–211. DOI: 10.1159/000470884.
18. Tanizawa Y, Bando E, Kawamura T, et al. Early postoperative anastomotic hemorrhage after gastrectomy for gastric cancer. Gastric Cancer 2010;13(1):50–57. DOI: 10.1007/s10120-009-0535-6.
19. Lee CM, Park JH, Choi CI, et al. A multi-center prospective randomized controlled trial (phase III) comparing the quality of life between laparoscopy-assisted distal gastrectomy and totally laparoscopic distal gastrectomy for gastric Cancer (study protocol). BMC Cancer 2019;19(1):206. DOI: 10.1186/s12885-019-5396-8.