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Original research

Feasibility of laparoscopy-assisted gastrectomy for patients with poor physical status: A propensity-score matching study

Mikito Inokuchi [a, *], Sho Otsuki [a], Hideaki Murase [a], Tatsuyuki Kawano [a], Kazuyuki Kojima [b]

[a] Department of Gastrointestinal Surgery, Tokyo Medical and Dental University, 1-5-45, Yushima, Bunkyo, Tokyo 113-8519, Japan
[b] Department of Minimally Invasive Surgery, Tokyo Medical and Dental University, 1-5-45, Yushima, Bunkyo, Tokyo 113-8519, Japan

HIGHLIGHTS

- This retrospective study using propensity-score-matching focused on risky patients who underwent gastrectomy.
- Patients with American Society of Anesthesiologists physical status (ASA-PS) class 3 and 4 were enrolled.
- Postoperative complications did not differ between LAG and OG.

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ABSTRACT

Background: Laparoscopically-assisted gastrectomy (LAG) has been established to be a minimally invasive treatment for early gastric cancer. However, few studies have shown the feasibility of LAG in patients with risky comorbidities according to the American Society of Anesthesiologists physical status (ASA-PS) classification. We performed this retrospective cohort study to assess the feasibility of LG in patients with an ASA-PS class of 3 or higher.
Methods: We retrospectively identified 214 patients with an ASA-PS class of 3 or 4 among 1192 patients who underwent radical gastrectomy with lymph-node dissection between 1999 and 2014 in our hospital. Finally, 106 patients were generated by propensity-score matching between LAG and open gastrectomy (OG). Postoperative complications were compared between LAG and OG.
Result: The overall incidence of complications was the same in LAG (30%) and OG (30%). Surgical complications were similar in LAG and OG (19% and 17%, $p = 0.80$). Medical complications also did not differ significantly between LAG and OG (21% and 15%, $p = 0.45$).
Conclusion: LAG was a feasible procedure for patients with gastric cancer who had an ASA-PS class of 3 or 4 and could undergo general anesthesia. LAG can become an optional treatment for such risky patients.

1. Introduction

Laparoscopically-assisted gastrectomy (LAG) with lymph-node dissection has been established as a minimally invasive procedure for early gastric cancer [1,2]. Several meta-analyses of randomized trials comparing LAG with open gastrectomy (OG) showed some short-term advantages of LAG, such as less pain and operative bleeding and a shorter hospital stay [3–7]. In addition, the overall incidences of postoperative complications were significantly lower in LAG than in open distal gastrectomy in those meta-analyses. On the other hand, a large randomized trial found no difference in morbidity or mortality between LAG and OG [8].

In general, laparoscopic surgery is considered contraindicated in most patients with risky comorbidities, and such patients were excluded from many prospective studies. During laparoscopic surgery, the use of carbon dioxide induces several hemodynamic changes and adversely affects respiratory function by causing hypercarbia and increasing abdominal pressure. However, we have conducted LAG with lymphadenectomy in patients with heart or pulmonary disease who could receive prolonged general

* Corresponding author. Department of Gastric Surgery, Tokyo Medical and Dental University, 1-5-45, Yushima, Bunkyo-ku, Tokyo 113-8519, Japan.
E-mail address: m-inokuchi.srg2@tmd.ac.jp (M. Inokuchi).

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anesthesia, thereby taking advantage of the minimal invasiveness of laparoscopic surgery. Several studies have reported that LAG is well tolerated in patients with COPD or heart disease, similar to OG [9–11]. However, few studies have demonstrated the feasibility of LAG in patients with various risky comorbidities. The American Society of Anesthesiologists physical status (ASA-PS) classification system has generally been used to assess the severity of patients' comorbidities [12]. Many studies comparing LAG with OG have included less than 10% of patients with an ASA-PS of 3 or 4 [13–27], although at least half of the studies did not report the overall distribution of ASA-PS. On the other hand, some studies have included 12%–28% of patients with an ASA-PS of 3 or 4 [28–34]. We performed this retrospective cohort study to assess the feasibility of LAG in patients with an ASA-PS of 3 or higher, indicating poor physical status.

2. Patients and methods

We initially identified 1192 patients with gastric adenocarcinoma who underwent gastrectomy with lymphadenectomy between 1999 and 2014 in our institution from our prospective database of patients with gastric cancer by July 31, 2015. We excluded patients who had stage IV disease or had any other advanced malignancy, as well as those who underwent emergency operation, R2 resection with macroscopic residual tumor, concurrent resection of the pancreas or colon, or who had received neoadjuvant chemotherapy. Patients with uncontrolled severe comorbidities (*e.g.*, massive pleural effusion or ascites) were excluded because they underwent palliative gastrectomy without lymphadenectomy. First, all patients were preoperatively classified according to the ASA-PS by anesthesiologists. Next, a total of 214 patients (18.0%) with an ASA-PS class of 3 or higher were identified (LAG in 106 and OG in 108). The ASA-PS class was 3 in 201 patients and 4 in 13 patients. No patient had an ASA-PS class of 5 or 6. Class 5 denotes a moribund patient not expected to survive without surgery, and class 6 designates a patient declared brain dead whose organs are being procured for donor purposes. Whether to perform LAG or OG was based on the tumor stage in principle; thus no patient was assigned to LAG or OG on the basis of ASA-PS.

All patients preoperatively underwent chest radiography, venous blood analysis, and pulmonary function testing. The following variables were obtained from our prospective gastric cancer database: patient age and gender; comorbidities; medicine taken constantly; tumor characteristics; type of gastrectomy; extent of lymph-node dissection; operation time; estimated blood loss; and postoperative complications. Chronic obstructive pulmonary disease (COPD) and chronic kidney disease (CKD) were staged according to the global strategy for COPD and the Japanese clinical practice guidebook for the diagnosis and treatment of CKD, respectively [35,36]. Postoperative complications (PCs) were defined as grade 2 or higher events according to the Clavien-Dindo classification that occurred within 30 days after gastrectomy [37]. PCs were classified into either surgical (abdominal) or medical (non-abdominal) complications. Tumors were classified pathologically based on TMN classification, version 7.

LAG was performed as follows. Five or six trocars were used to perform the laparoscopic procedure, and pneumoperitoneum was maintained at an insufflation pressure of 10 mm Hg. After laparoscopic lymph-node dissection, a small incision (4–5 cm) was made in the upper or middle abdomen during the reconstruction phase. The specimen was removed through the incision, and reconstruction was performed mainly extracorporeally and partly intracorporeally. The extent of lymph-node dissection was classified as D1, D1+, or D2 in accordance with the treatment guidelines of the Japanese Gastric Cancer Association [38]. OG was performed in the same manner as LAG through an upper midline or a subcostal incision. For all risky patients with ASA-PS 3 or 4, both LAG and OG were conducted by five board-certified surgeons.

In principle, LAG was used to treat early-stage gastric cancer, while OG was mainly done in patients with advanced disease. Therefore, we matched the 2 groups of patients by propensity scoring. Propensity scores were calculated using a binary logistic regression model and the following variables: sex, age (younger than 80 years or not), body-mass index (BMI, less than 30 or not), ASA-PS class, type of gastrectomy (distal, proximal, total gastrectomy, or total gastrectomy with splenectomy), and pathological tumor stage. The goodness-of-fit of this logistic regression model was acceptable on the Hosmer-Lemeshow test ($p = 0.92$). Patients who underwent LAG were individually matched to patients who underwent OG by the nearest neighbor matching method. Matching was performed by randomly ordering case and control subjects, selecting a case subject, and finding a control subject with the closest propensity score [17]. We used the 5 → 2 digit matching method, in which matches were attempted from five decimal places of the score to two decimal places, until an appropriate matched sample was found. If a case subject could not be matched to any control subject on the basis of two decimal places of the propensity score, the case subject was discarded. After propensity-score matching, 53 patients in the LAG group and 53 patients in the OG group were matched. Thus, 106 patients were selected from a total of 214 patients with ASA-PS 3 or 4.

We retrospectively estimated the surgical risk on the basis of the Portsmouth Physiological and Operative Severity Score for the enUmeration of Mortality and morbidity (P-POSSUM) [39] and compared surgical outcomes and postoperative complications between the LAG group and OG group.

3. Statistical analysis

Categorical data were compared with the use of the chi-square test or Fisher's exact test, as appropriate. The Mann-Whitney test was used to compare continuous variables. To estimate propensity score, binary logistic regression analysis using dummy variables was performed. Values of $p < 0.05$ were considered to indicate statistical significance. All analyses and propensity-score matching were performed with the statistical software package SPSS 21 (SPSS Japan Inc., Tokyo, Japan).

4. Results

The clinical characteristics of the patients are summarized in Table 1. No statistically significant differences were found between the LAG group and OG group in any background characteristics, including age, sex, BMI, comorbidity, and ASA-PS class.

Surgical outcomes are shown in Table 2. Operating time was significantly longer in the LAG group than that in the OG group (median time: 311 vs. 242 min, $p < 0.01$), whereas estimated blood loss was significantly lower in the LAG group than in the OG group (median bleeding volume: 97 vs. 376 ml, $p < 0.01$). The type of gastrectomy, extent of lymphadenectomy, and pathological tumor stage did not differ between the two groups. The distribution of patients did not differ significantly between the LAG group and OG group during the former or latter periods of this study.

The results of P-POSSUM scoring are shown in Table 3. The scores for physiology and operative severity did not differ significantly between the LAG group and OG group ($p = 0.86$, $p = 0.10$, respectively). The predicted morbidity and mortality rates also did not differ significantly between the two groups ($p = 0.20$, $p = 0.27$, respectively).

Postoperative complications were divided into surgical