

STUDY PROTOCOL

Open Access



Randomized controlled phase III trial to investigate superiority of robot-assisted gastrectomy over laparoscopic gastrectomy for clinical stage T1-4aN0-3 gastric cancer patients (JCOG1907, MONA LISA study): a study protocol

Rie Makuuchi¹, Masanori Terashima^{2*}, Mitsumi Terada³, Junki Mizusawa⁴, Ryosuke Kita⁴, Masanori Tokunaga⁵, Takeshi Omori⁶, Toshiyasu Ojima⁷, Kazuhisa Ehara⁸, Masaya Watanabe⁹, Yoshitomo Yanagimoto¹⁰, Souya Nunobe¹, Takahiro Kinoshita¹¹, Seiji Ito¹², Yasunori Nishida¹³, Jun Hihara¹⁴, Narikazu Boku¹⁵, Yukinori Kurokawa¹⁶, Takaki Yoshikawa¹⁷ the Stomach Cancer Study Group of Japan Clinical Oncology Group

Abstract

Background Laparoscopic gastrectomy (LG) is considered a standard treatment for clinical stage I gastric cancer. Nevertheless, LG has some drawbacks, such as motion restriction and difficulties in spatial perception. Robot-assisted gastrectomy (RG) overcomes these drawbacks by using articulated forceps, tremor-filtering capability, and high-resolution three-dimensional imaging, and it is expected to enable more precise and safer procedures than LG for gastric cancer. However, robust evidence based on a large-scale randomized study is lacking.

Methods We are performing a randomized controlled phase III study to investigate the superiority of RG over LG for clinical T1-2N0-2 gastric cancer in terms of safety. In total, 1,040 patients are planned to be enrolled from 46 Japanese institutions over 5 years. The primary endpoint is the incidence of postoperative intra-abdominal infectious complications, including anastomotic leakage, pancreatic fistula, and intra-abdominal abscess of Clavien–Dindo (CD) grade \geq II. The secondary endpoints are the incidence of all CD grade \geq II and \geq IIIA postoperative complications, the incidence of CD grade \geq IIIA postoperative intra-abdominal infectious complications, relapse-free survival, overall survival, the proportion of RG completion, the proportion of LG completion, the proportion of conversion to open surgery, the proportion of operation-related death, and short-term surgical outcomes. The Japan Clinical Oncology Group Protocol Review Committee approved this study protocol in January 2020. Approval from the institutional review board was obtained before starting patient enrollment in each institution. Patient enrollment began in March 2020. We revised the protocol to expand the eligibility criteria to T1-4aN0-3 in July 2022 based on the results

*Correspondence:

Masanori Terashima
m.terashima@scchr.jp

Full list of author information is available at the end of the article



© The Author(s) 2023. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

of randomized trials of LG demonstrating non-inferiority of LG to open surgery for survival outcomes in advanced gastric cancer.

Discussion This is the first multicenter randomized controlled trial to confirm the superiority of RG over LG in terms of safety. This study will demonstrate whether RG is superior for gastric cancer.

Trial registration The protocol of JCOG1907 was registered in the UMIN Clinical Trials Registry as UMIN000039825 (<http://www.umin.ac.jp/ctr/index.htm>). Date of Registration: March 16, 2020. Date of First Participant Enrollment: April 1, 2020.

Keywords Stomach neoplasms, Robotic surgery, Minimally invasive surgery, Postoperative complication, Multicenter study, Randomized controlled trial

Background

The Stomach Cancer Study Group (SCSG) of the Japan Clinical Oncology Group (JCOG) previously established evidence of the safety and efficacy of laparoscopic gastrectomy (LG) for clinical stage I (cT1N0/T1N1/T2N0) gastric cancer. JCOG0912, a randomized controlled trial, confirmed the non-inferiority of laparoscopic distal gastrectomy (LDG) to open distal gastrectomy (ODG) in terms of relapse-free survival (RFS) [1]. JCOG1401, a single-arm confirmatory trial, also showed the safety of laparoscopic total gastrectomy (LTG) and proximal gastrectomy (LPG) for patients with clinical stage I gastric cancer [2]. Based on these results, LG is recommended as a standard treatment for clinical stage I gastric cancer in the Japanese Gastric Cancer Treatment Guidelines [3].

To confirm the safety and efficacy of LDG for advanced gastric cancer, randomized controlled trials have been conducted in Japan (JLSSG0901), Korea (KLASS-02), and China (CLASS-01). With respect to short-term outcomes, the incidence of postoperative complications was not different between LDG and ODG in CLASS-01 [4], whereas it was significantly lower in LDG than ODG in KLASS-02 [5]. In terms of survival, only the result of CLASS-01 was available at the time the present study was designed, and it showed the non-inferiority of LDG to ODG regarding 3-year RFS [6].

Because surgical procedures and results such as the operation time and blood loss may differ slightly between Japan and other countries, the efficacy of LG for advanced gastric cancer was debated in Japan until the survival outcomes of Japanese trials were obtained. The SCSG of the JCOG reached a consensus that LG should be a standard treatment for clinical T1-2N0-2 gastric cancer because the target of JCOG0912 and JCOG1401 was clinical T1N0/T1N1/T2N0 in the 13th edition of the Japanese Classification of Gastric Carcinoma, which is not significantly different from surgery for clinical T1-2N0-2 in the 15th edition (current classification).

Although the indications for LG are expanding, LG has some drawbacks that must be overcome, such as motion restriction using straight forceps and difficulties in spatial

perception due to the use of two-dimensional imaging. Real-world data indicate that compared with open gastrectomy, LDG is associated with a higher incidence of pancreatic fistula [7] and that LTG is associated with a higher incidence of anastomotic leakage [8].

Surgical robots are equipped with articulated forceps, tremor-filtering capability, and high-resolution three-dimensional images. Therefore, robot-assisted gastrectomy (RG) is expected to overcome the drawbacks of LG and enable performance of more meticulous surgery. Many retrospective studies have been conducted, and a meta-analysis of these studies revealed that RG was associated with fewer postoperative complications, especially pancreas-related complications; an increased number of harvested lymph nodes; an earlier time to first flatus; and less intraoperative blood loss [9]. Additionally, a multi-institutional prospective study showed the safety of RG for clinical stage I and II gastric cancer [10]. However, that was a single-arm study comparing LG as the historical control. Validation by randomized controlled trials is therefore necessary.

The SCSG of the JCOG designed a multicenter randomized controlled phase III trial to investigate the superiority of RG over LG for clinical T1-2N0-2 gastric cancer (JCOG1907, MONA LISA study). During enrollment of patients in this study, the results of KLASS-02 [11] and JLSSG0901 [12] were published, demonstrating non-inferiority of LDG to ODG with respect to survival outcomes in patients with advanced gastric cancer. Based on these results, we revised the protocol for eligible patients from clinical T1-2N0-2 to T1-4aN0-3 in July 2022.

Methods/design

Aim

This study aims to confirm the superiority of RG over LG in terms of safety for patients with clinical T1-4aN0-3 gastric cancer.

Study setting

This is a multi-institutional, two-arm, open-label, randomized phase III trial.

Endpoints

The primary endpoint is the incidence of postoperative intra-abdominal infectious complications (IAIC), defined as Clavien–Dindo (CD) [13, 14] grade \geq II complications. IAIC includes anastomotic leakage, pancreatic fistula, and intra-abdominal abscess. The secondary endpoints are the incidences of all postoperative complications of CD grade \geq II and \geq IIIA, the incidence of IAIC of CD grade \geq IIIA, RFS, overall survival (OS), the proportion of RG completion, the proportion of LG completion, the proportion of conversion to open surgery, the proportion of operation-related death, and short-term surgical outcomes.

All postoperative complications, including IAIC, are defined as those that develop within 30 days after surgery among all patients undergoing operations. OS is defined as the time from randomization to death of any cause and will be censored on the last day of contact for a surviving patient. RFS is defined as the time from randomization to relapse or death of any cause and will be censored on the last day of contact when the patient is alive with no evidence of relapse. The proportion of RG completion is defined as the proportion of patients for whom RG is completed without conversion to open or laparoscopic surgery among all patients undergoing operations in the RG arm. The proportion of LG completion is defined as the proportion of patients for whom LG is completed without conversion to open surgery among all patients undergoing operations in the LG arm. The proportion of conversion to open surgery is defined as the proportion of patients who undergo open surgery among all patients undergoing operations in each group. The short-term surgical outcomes are (i) the time from the end of surgery to the first episode of flatus and (ii) the proportion of patients requesting an analgesic on postoperative days 5 to 10.

Eligibility criteria

Inclusion criteria

- 1) The cancer is histologically proven adenocarcinoma of the stomach.
- 2) The cancer is clinical T1–T4a and N0–3 according to the Japanese Classification of Gastric Carcinoma (15th edition).
- 3) The cancer has been diagnosed as HOPOM0 with no bulky metastatic lymph nodes.
- 4) In cases of T2 or deeper cancer in the upper third of the stomach, the tumor does not involve the greater curvature.

- 5) There is no indication for endoscopic mucosal resection (EMR) or endoscopic submucosal dissection (ESD).
- 6) For patients who have previously undergone EMR or ESD, all of the following conditions must be fulfilled:
 - (a) Pathological findings indicate the requirement for additional gastrectomy.
 - (b) EMR or ESD was performed \leq 91 days previously.
 - (c) Perforation by EMR or ESD is not considered.
- 7) R0 resection is expected.
- 8) Neither a Borrmann type 4 tumor nor a large (\geq 8-cm) type 3 tumor is present.
- 9) No invasion to the esophagus or duodenum is present.
- 10) The cancer is not remnant gastric cancer.
- 11) The patient is \geq 20 years of age.
- 12) The patient has an Eastern Cooperative Oncology Group performance status of 0 or 1.
- 13) The patient has a body mass index of $<$ 30 kg/m².
- 14) The patient has no history of upper abdominal surgery except for laparoscopic cholecystectomy.
- 15) No prior abdominal radiation therapy was received for any other malignancies. Patients with a history of chemotherapy and/or hormone therapy are eligible.
- 16) Sufficient organ function is confirmed within 28 days of registration:
 - (a) White blood cell count of \geq 3000/mm³.
 - (b) Platelet count of \geq 10×10^4 /mm³.
 - (c) Total bilirubin concentration of \leq 2.0 mg/dL.
 - (d) Aspartate aminotransferase concentration of \leq 100 IU/L.
 - (e) Alanine aminotransferase concentration of \leq 100 IU/L.
 - (f) Creatinine concentration of \leq 1.5 mg/dL.
- 17) Written informed consent is provided.

Exclusion criteria

- 1) Synchronous or metachronous (within 5 years) malignancies except cancer with a 5-year relative survival rate of \geq 95%, such as carcinoma in situ, intramucosal tumor, or early-stage cancers.

- 2) Infectious disease requiring systemic treatment.
- 3) Body temperature of ≥ 38 °C.
- 4) Women who are pregnant, possibly pregnant, within 28 days after delivery, or breastfeeding; men who wish for their partner to become pregnant.
- 5) Severe psychiatric disease.
- 6) Continuous systemic steroids or immunosuppressive drug therapy.
- 7) Unstable angina pectoris (angina developed or attack worsened within the previous 3 weeks) or myocardial infarction within the previous 6 months.
- 8) Poorly controlled valvular heart disease, dilated cardiomyopathy, or hypertrophic cardiomyopathy.
- 9) Positive for HIV antibody.
- 10) Severe interstitial pneumonia, severe lung fibrosis, or severe emphysema.

Randomization

After confirming the eligibility criteria, registration to the JCOG Data Center will be performed using a web-based system. Patients will be randomized to either the LG arm or the RG arm by the minimization method with a random component balancing the arm with the institution, clinical stage (cT1N0/ cT1N1-3 or cT2-4aN0-3), and type of gastrectomy [DG or pylorus-preserving gastrectomy (PPG) / TG or PG].

Treatments

LG or RG will be performed in each respective arm. All procedures will be identical except for the surgical approach. The extent of lymph node dissection will be decided according to the clinical T and N stages based on the 5th version of the Gastric Cancer Treatment Guidelines in Japan. D1+ dissection will be applied for cT1N0 tumors, and D2 dissection will be applied for cT2-4a or cN1-3 tumors. PPG and PG will be allowed only for cT1N0 tumors. Splenectomy or bursectomy will not be allowed. Omentectomy will be required for cT3-T4a tumors. Mini-laparotomy should be limited to one site, and the length of the skin incision should be ≤ 6 cm. When the skin incision requires extension by > 6 cm, conversion to open surgery will be considered. Intraoperative lavage cytology will be required for cT2-4a tumors. If the intraoperative findings reveal a T4b or stage IVB tumor, the protocol treatment will be terminated; subsequent treatment for the patient is not specified.

Surgical robot

The da Vinci Surgical System by Intuitive Surgical (Sunnyvale, CA, USA) will be used for the RG arm because it was the only surgical robot available in Japan at the time of protocol development. However, if other surgical

robots become available for clinical use during the study, their availability will be discussed and reviewed in the SCSG of the JCOG.

Quality control of study

The principal investigator will designate a certified surgeon in charge of the study according to the criteria outlined below. The SCSG chair of the JCOG will designate a study-specific surgical quality assurance (QA) committee.

Certified surgeon for LG

In the LG arm, surgeons must fulfill the following criteria according to the degree of lymphadenectomy or type of gastrectomy: for any type of gastrectomy with D1 + lymphadenectomy, the surgeon must fulfill (1) and (2); for DG with D2 lymphadenectomy, the surgeon must fulfill (1) to (3); and for TG with D2, the surgeon must fulfill (1) to (4).

- (1) Experience in performing ≥ 30 LG procedures.
- (2) Certification in the field of gastric cancer by either a study-specific surgical QA committee or the Japan Society for Endoscopic Surgery (JSES).
- (3) Experience in performing ≥ 20 LG procedures with D2 lymphadenectomy.
- (4) Experience in performing ≥ 15 laparoscopic esophagojejunal anastomoses.

Certified surgeon for RG

In addition to the criteria in the LG arm, all the following criteria must be fulfilled for certified surgeons in the RG arm.

- (1) Experience in performing ≥ 10 RG procedures, at least one of which must be TG or PG.
- (2) Certification as an RG proctor by the JSES or the study-specific surgical QA committee.

A certified surgeon will perform LG and RG as an operator. The certified surgeon can be a teaching assistant for RG with D1 + lymphadenectomy using a dual console or for LG with D1 + lymphadenectomy.

Intraoperative photographs and video recording

The study coordinator will conduct a central peer review of the surgical procedure every 6 months by checking the intraoperative photograph of the surgical field from all registered patients. Intraoperative videos of arbitrary patients will also be shown in a group conference held three times yearly to share the surgical procedure.

Follow-up

After curative resection, adjuvant chemotherapy with S1 for 1 year will be recommended for patients with pathological stage II cancer, and S1 plus docetaxel for 1 year will be recommended for those with pathological stage III cancer. The post-study treatment is not specified for patients with non-curative resection or pathological stage IV cancer.

All randomized patients will be followed up for at least 5 years. Tumor marker measurement, chest X-ray examination, and enhanced computed tomography examination will be performed at least every year, and upper gastrointestinal endoscopy will be performed every 2 years for the duration of follow-up for patients with pathological stage I cancer. For patients with pathological stage II and III cancer, the follow-up schedule is as follows: tumor markers will be evaluated every 3 months for the first 2 years and every 6 months for the next 3 years; enhanced computed tomography will be performed every 6 months for the first 3 years, and for the next 2 years, chest X-ray examination will be performed every year; and upper gastrointestinal endoscopy will be performed every 2 years.

Study design and statistical analysis

This randomized study is designed to demonstrate that RG is superior to LG in terms of safety. RFS and OS are secondary endpoints to confirm that RG is not inferior to LG in terms of long-term survival. When the data demonstrate superiority of the safety of RG over LG, RG will be considered one of the treatment options for gastric cancer. In addition, if RFS is confirmed to be non-inferior in RG versus LG, the SCSG of the JCOG will consider RG the new standard treatment.

In JCOG0912 and JCOG1401, the incidence of IAIC (CD grade \geq II) was 2.6% for LDG/LPPG with D1+, 6.7% for LDG with D2, 7.8% for LTG/LPG with D1+, and 20.0% for LTG with D2. We assume that the distribution of the type of gastrectomy and degree of lymphadenectomy in the present study will be as follows: DG/PPG with D1+: 50%, DG with D2: 17%, TG/PG with D1+: 25%, and TG with D2: 8%. Based on the above, the incidence of IAIC in the LG arm is expected to be approximately 6.0%. We anticipate that the use of the robot will halve the incidence of IAIC to 3% according to the results of previous prospective studies [10].

With a one-sided alpha of 5%, 1,006 patients will be required to preserve the power of 70%. The total sample size is set at 1,040 patients, assuming that a few patients would not undergo gastrectomy. All statistical analyses will be conducted at the JCOG Data Center.

Interim analysis and monitoring

We plan to conduct one interim analysis, considering multiplicity using the Lan–DeMets method with the O’Brien–Fleming type alpha spending function [15]. The Data and Safety Monitoring Committee of the JCOG will independently review the interim analysis reports and recommend early termination of the trial if necessary. In-house monitoring will be performed every 6 months by the JCOG Data Center to evaluate and improve the study progress, data integrity, and patient safety.

Discussion

This study aims to confirm the superiority of RG over LG for gastric cancer. Unless a clear advantage of robot-assisted surgery is demonstrated, it cannot be recommended as standard treatment because the cost of RG is much higher than that of LG [9].

RG is expected to overcome the drawbacks of LG, such as movement restrictions and difficulties in spatial perception, which would trigger IAIC. Thus, we are adopting the incidence of CD grade \geq II IAIC as the primary endpoint. IAIC is a significant burden for the patient because it requires treatment with antimicrobials, drainage, and extended hospitalization. In addition, IAIC can lead to pseudoaneurysm formation, which can cause intra-abdominal bleeding and death. Moreover, recent studies have shown a negative impact of postoperative complications on long-term survival outcomes. We previously reported that CD grade \geq II IAIC adversely affected on OS [16] using data from JCOG1001, which compared bursectomy and non-bursectomy for patients with cT3/4a locally advanced gastric cancer. A meta-analysis showed that IAIC was a poor prognostic factor in gastric and other cancers [17].

If the issues of surgical time and medical costs have been resolved or alleviated at the end of this study, the results will be carefully interpreted and discussed within the SGCS of the JCOG. Ancillary analyses of surgeon fatigue and postoperative patient-reported outcomes, including cost-effectiveness, are also planned.

The real benefit of RG can be evaluated from this study because it is the only multicenter randomized controlled trial to confirm the superiority of RG.

Abbreviations

SCSG	Stomach Cancer Study Group
JCOG	Japan Clinical Oncology Group
LG	laparoscopic gastrectomy
LDG	laparoscopic distal gastrectomy
ODG	open distal gastrectomy
RFS	relapse-free survival
LTG	laparoscopic total gastrectomy
LPG	laparoscopic proximal gastrectomy
RG	robot-assisted gastrectomy

IAIC	intra-abdominal infectious complications
CD	Clavien–Dindo classification
EMR	endoscopic mucosal resection
ESD	endoscopic submucosal dissection
PPG	pylorus-preserving gastrectomy
QA	quality assurance
JSES	Japan Society for Endoscopic Surgery

Acknowledgements

The authors thank all JCOG Data Center/Operation office members and the SCSG of the JCOG. The authors also thank Angela Morben, DVM, ELS, from Edanz (<https://jp.edanz.com/ac>), for editing a draft of this manuscript.

Authors' contributions

RM and M. Terashima wrote the manuscript. RM, M. Terashima, and M. Tokunaga proposed the concept of the JCOG1907 study and drafted the protocol design for the study. M. Terada, JM, and RK contributed to the design and logistics of the protocol, proofread the manuscript, and will undertake the statistical analysis. T. Omori, T. Ojima, KE, and TK contributed to the quality control of the surgery by establishing a study-specific surgical QA committee. All authors contributed to revisions of this manuscript and approved the final manuscript.

Funding

This study is partly supported by the National Cancer Center Research and Development Fund (29-A-3, 2020-J-3, 2023-J-03) and by the Japan Agency for Medical Research and Development (AMED) under grant number JP23ck0106844. This study is also funded by Intuitive Surgical Sàrl, which will not be involved in the research itself (including planning, management, and data analysis).

Availability of data and materials

Data sharing is not applicable to this article because no datasets had been generated or analyzed at the time of submission.

Declarations

Ethics approval and consent to participate

This study is being conducted according to the principles expressed in the Declaration of Helsinki, the Japanese Ethical Guidelines for Medical and Health Research Involving Human Subjects, and the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) guidelines. The JCOG Protocol Review Committee approved this protocol in January 2020. Approval from the institutional review board was obtained before starting patient enrollment in each institution. Written informed consent has been obtained from all enrolled patients. At the time of submission (July 2022), 46 institutions were participating in this study. The participating institutions were as follows: Hakodate Goryoukaku Hospital, Keiyukai Sapporo Hospital, Miyagi Cancer Center, Fukushima Medical University Hospital, Southern Tohoku General Hospital, Saitama Prefectural Cancer Center, National Cancer Center Hospital East, Chiba Cancer Center, National Cancer Center Hospital, Tokyo Metropolitan Cancer and Infectious Diseases Center Komagome Hospital, Tokyo Medical and Dental University Hospital, Cancer Institute Hospital of Japanese Foundation for Cancer Research, Toranomon Hospital, Juntendo University School of Medicine Juntendo Clinic, Kanagawa Cancer Center, Kitasato University School of Medicine, Toyama Prefectural Central Hospital, Ishikawa Prefectural Central Hospital, Yamanashi Prefectural Central Hospital, Gifu University School of Medicine, Shizuoka General Hospital, Shizuoka Cancer Center, Aichi Cancer Center, Nagoya University School of Medicine, National Hospital Organization Kyoto Medical Center, Osaka University Graduate School of Medicine, Osaka Metropolitan University Hospital, Osaka International Cancer Institute, National Hospital Organization Osaka National Hospital, Osaka Medical and Pharmaceutical University, Toyonaka Municipal Hospital, Kobe University Graduate School of Medicine, Kansai Rosai Hospital, Hyogo Cancer Center, Wakayama Medical University School of Medicine, Shimane University Faculty of Medicine, Okayama University Hospital, Hiroshima University Hospital, Hiroshima City Hiroshima Citizens Hospital, Hiroshima City North Medical Center Asa Citizens Hospital, Kagawa Prefectural Central Hospital, National Hospital Organization Shikoku Cancer Center, and Kurume University Graduate School of Medicine.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Department of Gastroenterological Surgery, Cancer Institute Hospital of Japanese Foundation for Cancer Research, 3-8-31, Ariake, Koto-ku, Tokyo 135-8550, Japan. ²Division of Gastric Surgery, Shizuoka Cancer Center, 1007, Shimonagakubo, Nagaizumi-Cho, Sunto-Gun, Shizuoka, Japan. ³Department of International Clinical Development, National Cancer Center Hospital, Tokyo, Japan. ⁴Japan Clinical Oncology Group Data Center/Operations Office, National Cancer Center Hospital, Tokyo, Japan. ⁵Department of Gastrointestinal Surgery, Tokyo Medical and Dental University, Tokyo, Japan. ⁶Department of Gastroenterological Surgery, Osaka International Cancer Institute, Osaka, Japan. ⁷Second Department of Surgery, Wakayama Medical University Scholl of Medicine, Wakayama, Japan. ⁸Department of Gastroenterological Surgery, Saitama Cancer Center, Saitama, Japan. ⁹Department of Gastroenterological Surgery, Shizuoka General Hospital, Shizuoka, Japan. ¹⁰Department of Surgery, Toyonaka Municipal Hospital, Osaka, Japan. ¹¹Department of Gastric Surgery, National Cancer Center Hospital East, Kashiwa, Japan. ¹²Department of Gastroenterological Surgery, Aichi Cancer Center Hospital, Nagoya, Japan. ¹³Department of Surgery, Keiyukai Sapporo Hospital, Hokkaido, Japan. ¹⁴Department of Surgery, Hiroshima City North Medical Center Asa Citizens Hospital, Hiroshima, Japan. ¹⁵Department of Oncology and General Medicine, IMSUT Hospital, The Institute of Medical Science, The University of Tokyo, Tokyo, Japan. ¹⁶Department of Gastroenterological Surgery, Osaka University Graduate School of Medicine, Osaka, Japan. ¹⁷Department of Gastric Surgery, National Cancer Center Hospital, Tokyo, Japan.

Received: 25 August 2023 Accepted: 5 October 2023

Published online: 17 October 2023

References

- Katai H, Mizusawa J, Katayama H, Morita S, Yamada T, Bando E, et al. Survival outcomes after laparoscopy-assisted distal gastrectomy versus open distal gastrectomy with nodal dissection for clinical stage IA or IB gastric cancer (JCOG0912): a multicentre, non-inferiority, phase 3 randomised controlled trial. *Lancet Gastroenterol Hepatol*. 2020;5:142–51.
- Katai H, Mizusawa J, Katayama H, Kunisaki C, Sakuramoto S, Inaki N, et al. Single-arm confirmatory trial of laparoscopy-assisted total or proximal gastrectomy with nodal dissection for clinical stage I gastric cancer: Japan Clinical Oncology Group study JCOG1401. *Gastric Cancer*. 2019;22:999–1008.
- Japanese Gastric Cancer Association. Japanese Gastric Cancer Treatment Guidelines 2021 (6th edition). *Gastric Cancer*. 2023;26:1–25.
- Hu Y, Huang C, Sun Y, Su X, Cao H, Hu J, et al. Morbidity and mortality of laparoscopic Versus Open D2 distal gastrectomy for Advanced Gastric Cancer: a Randomized Controlled Trial. *J Clin Oncol*. 2016;34:1350–7.
- Lee H-J, Hyung WJ, Yang H-K, Han SU, Park Y-K, An JY, et al. Short-term outcomes of a Multicenter Randomized Controlled Trial comparing laparoscopic distal gastrectomy with D2 lymphadenectomy to Open Distal Gastrectomy for locally Advanced Gastric Cancer (KLASS-02-RCT). *Ann Surg*. 2019;270:983–91.
- Yu J, Huang C, Sun Y, Su X, Cao H, Hu J, et al. Effect of laparoscopic vs Open Distal Gastrectomy on 3-Year disease-free survival in patients with locally advanced gastric Cancer: the CLASS-01 Randomized Clinical Trial. *JAMA*. 2019;321:1983–92.
- Hiki N, Honda M, Etoh T, Yoshida K, Koderia Y, Kakeji Y, et al. Higher incidence of pancreatic fistula in laparoscopic gastrectomy. Real-world evidence from a nationwide prospective cohort study. *Gastric Cancer*. 2018;21:162–70.
- Koderia Y, Yoshida K, Kumamaru H, Kakeji Y, Hiki N, Etoh T, et al. Introducing laparoscopic total gastrectomy for gastric cancer in general practice: a retrospective cohort study based on a nationwide registry database in Japan. *Gastric Cancer*. 2019;22:202–13.

9. Jin T, Liu H-D, Yang K, Chen Z-H, Zhang Y-X, Hu J-K. Effectiveness and safety of robotic gastrectomy versus laparoscopic gastrectomy for gastric cancer: a meta-analysis of 12,401 gastric cancer patients. *Updates Surg.* 2022;74:267–81.
10. Uyama I, Suda K, Nakauchi M, Kinoshita T, Noshiro H, Takiguchi S, et al. Clinical advantages of robotic gastrectomy for clinical stage I/II gastric cancer: a multi-institutional prospective single-arm study. *Gastric Cancer.* 2019;22:377–85.
11. Hyung WJ, Yang H-K, Park Y-K, Lee H-J, An JY, Kim W, et al. Long-term outcomes of laparoscopic distal gastrectomy for locally advanced gastric Cancer: the KLASS-02-RCT Randomized Clinical Trial. *J Clin Oncol.* 2020;38:3304–13.
12. Etoh T, Ohyama T, Sakuramoto S, Tsuji T, Lee S-W, Yoshida K, et al. Five-year survival outcomes of Laparoscopy-Assisted vs Open Distal Gastrectomy for Advanced Gastric Cancer: the JLSG0901 Randomized Clinical Trial. *JAMA Surg.* 2023. <https://doi.org/10.1001/jamasurg.2023.0096>.
13. Clavien PA, Barkun J, de Oliveira ML, Vauthey JN, Dindo D, Schulick RD, et al. The Clavien-Dindo classification of surgical complications: five-year experience. *Ann Surg.* 2009;250:187–96.
14. Dindo D, Demartines N, Clavien P-A. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg.* 2004;240:205–13.
15. Gordon Lan KK, Demets DL. Discrete sequential boundaries for clinical trials. *Biometrika.* 1983;70:659–63.
16. Tokunaga M, Kurokawa Y, Machida R, Sato Y, Takiguchi S, Doki Y, et al. Impact of postoperative complications on survival outcomes in patients with gastric cancer: exploratory analysis of a randomized controlled JCOG1001 trial. *Gastric Cancer.* 2021;24:214–23.
17. Shimada H, Fukagawa T, Haga Y, Oba K. Does postoperative morbidity worsen the oncological outcome after radical surgery for gastrointestinal cancers? A systematic review of the literature. *Ann Gastroenterol Surg.* 2017;1:11–23.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Ready to submit your research? Choose BMC and benefit from:

- fast, convenient online submission
- thorough peer review by experienced researchers in your field
- rapid publication on acceptance
- support for research data, including large and complex data types
- gold Open Access which fosters wider collaboration and increased citations
- maximum visibility for your research: over 100M website views per year

At BMC, research is always in progress.

Learn more biomedcentral.com/submissions

