

CASE REPORT

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Successful modified CLEAN-NET with semicircular seromuscular layer incision for a gastric GIST near the cardia: a case report and video demonstration

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Abstract

Background The combination of laparoscopic and endoscopic approaches to neoplasia with a non-exposure technique (CLEAN-NET) is a laparoscopic and endoscopic cooperative surgery (LECS). It combines laparoscopic gastric resection and endoscopic techniques for local resection of gastric tumors, such as gastrointestinal stromal tumors (GIST), with minimal surgical margins. A conventional CLEAN-NET surgical procedure is complex, requiring careful techniques to preserve the cardia, particularly in case of nearby lesions. We describe the case of a patient who underwent a modified CLEAN-NET approach with a semi-circular seromuscular layer incision surrounding the base of the tumor, different from a circular shape seromuscular layer in the conventional CLEAN-NET: around the tumor to preserve mucosal continuity, which acts as a barrier to avoid intraoperative tumor dissemination.

Case presentation A 43-year-old woman was referred to our hospital because of a gastric submucosal tumor near the cardia, detected on medical examination. The patient was diagnosed with gastric GIST based on the results of endoscopic ultrasound-guided fine-needle aspiration. Modified CLEAN-NET was performed with a semicircular incision of the seromuscular layer on the opposite side of the cardia, making the surgical procedure simple and minimizing partial resection of the gastric wall, including the tumor, while preserving the cardia. The operative time was 147 min, preoperative blood loss volume was 3 mL, and postoperative hospital stay was 9 days. The resected specimen revealed a minimal resection of the gastric wall, including the tumor. The cardia and gastric nerves were preserved, and the postoperative food intake was good.

Conclusions The modified CLEAN-NET with semicircular seromuscular layer dissection is a simple and reliable surgical procedure for GIST near the cardia.

Keywords Stomach, Submucosal tumor, Gastrointestinal stromal tumor (GIST), Laparoscopic and endoscopic cooperative surgery (LECS), Combination of laparoscopic and endoscopic approaches to neoplasia with a non-exposure technique (CLEAN-NET), Case report

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Background

Most gastrointestinal stromal tumors (GIST) developing intraluminally are detected within the stomach and may not be externally visible [1]. Determining the optimal resection lines for gastric intraluminal tumors using conventional laparoscopic wedge resection from outside the stomach wall can be challenging. The excessive resection lines required in conventional laparoscopic wedge resection may alter the stomach and gastric stasis during food uptake [1]. Therefore, determining an accurate cutting line using intraoperative endoscopy is important for minimal and safe local resection of gastric tumors. Cases of gastric GIST near the cardia require cardia preservation during partial gastric resection, including the tumor. However, if cardia preservation proves challenging, proximal gastrectomy may be performed, significantly affecting the patient's postoperative quality of life.

The combination of laparoscopic and endoscopic approaches to neoplasia with a non-exposure technique (CLEAN-NET), developed by Inoue et al. in 2012, is a laparoscopic and endoscopic cooperative surgery (LECS)-related procedure that involves a nonexposed full-thickness resection after seromuscular layer incision around the tumor to preserve the continuity of the mucosa, which functions as a barrier [2, 3]. Conventionally, the seromuscular layer is incised in a circular shape surrounding the base of the tumor in CLEAN-NETs. Conventional CLEAN-NET surgical procedures are complex, requiring careful techniques to preserve the cardia, especially in case of nearby lesions. In this report, we describe the successful surgical treatment of a gastric GIST near the cardia using a simplified and modified CLEAN-NET technique, incorporating a semicircular seromuscular layer incision exclusively on the side opposite the cardia.

Case presentation

Patient information, clinical findings, and diagnostic assessments

An asymptomatic 43-year-old woman was referred to our hospital because of a gastric submucosal tumor discovered during an endoscopy conducted for a routine medical examination 1 month prior. Endoscopic and upper gastrointestinal contrast findings identified that the tumor had developed intraluminally, measured approximately 3 cm in diameter, and was situated in the posterior wall of the upper gastric body, near the cardia. The submucosal tumor was pathologically diagnosed as a GIST based on findings from ultrasound-guided fine-needle aspiration biopsy; spindle tumor cells: immunopathological KIT-positive, CD34-positive, discovered on GIST 1 [DOG1]-positive, alpha-smooth muscle actin (α -SMA)-negative, and S-100-negative. No clinical findings suggesting dissemination and distant metastases

were detected using contrast-enhanced computed tomography and ultrasonography (Fig. 1A–D); hence, surgery was undertaken.

Surgical procedure

The modified CLEAN-NET was performed, including the semicircular incision of the seromuscular layer on the side opposite the cardia to achieve full-thickness minimal resection while preserving the cardia (Fig. 2A–E, Additional File 1: A video illustrating the modified CLEAN-NET).

The patient was positioned in the reverse Trendelenburg position with their upper and lower extremities spread apart. The operator, assistant, and laparoscopist were positioned on the right side, left side, and between the patient's legs, respectively, while the endoscopist was positioned on the left side of the patient's head. LECS requires cooperation between experienced surgeons and endoscopists. The surgeons in our hospital are certified as surgeons and endoscopists. As the CLEAN-NET does not allow the surgeon and endoscopist to perform the procedure simultaneously, the surgeons acted as both surgeons and endoscopists while moving to each location.

After induction of general anesthesia, a camera port with a balloon was inserted through the umbilicus using an open technique, and pneumoperitoneum was established by insufflation of carbon dioxide to 10 mmHg abdominal pressure. Four additional ports (two 5-mm and two 12-mm ones) were inserted in an inverted trapezoid shape, similar to routine gastrectomy. The proximal jejunum near the ligament of Treitz was clamped using detachable forceps to prevent inflation of the distal intestine with air during intraoperative endoscopy. After releasing the omental bursa by incising the omentum, the stomach was cranially turned to confirm its upper posterior wall. Because of the intraluminal developing submucosal tumor, it was difficult to visually identify the location of the tumor in the posterior wall of the stomach with high accuracy. The blood vessels were then prepared around the tumor using a vessel sealer paying attention to preserving the gastric nerves after the operator identified the upper posterior wall of the gastric body using two laparoscopic forceps to confirm the approximate tumor location. After moving to the intraoperative endoscope, 5 mL of indocyanine green (ICG) was injected into the submucosal layer at four points around the base of the tumor using an endoscopic needle. For the laparoscopic surgery, a semicircular seromuscular layer incision near the tumor was performed only on the side opposite the cardia using a laparoscopic electric scalpel based on the ICG injection. After a sufficient seromuscular layer incision was made, the tumor was pushed out of the lumen through the incision site using two laparoscopic

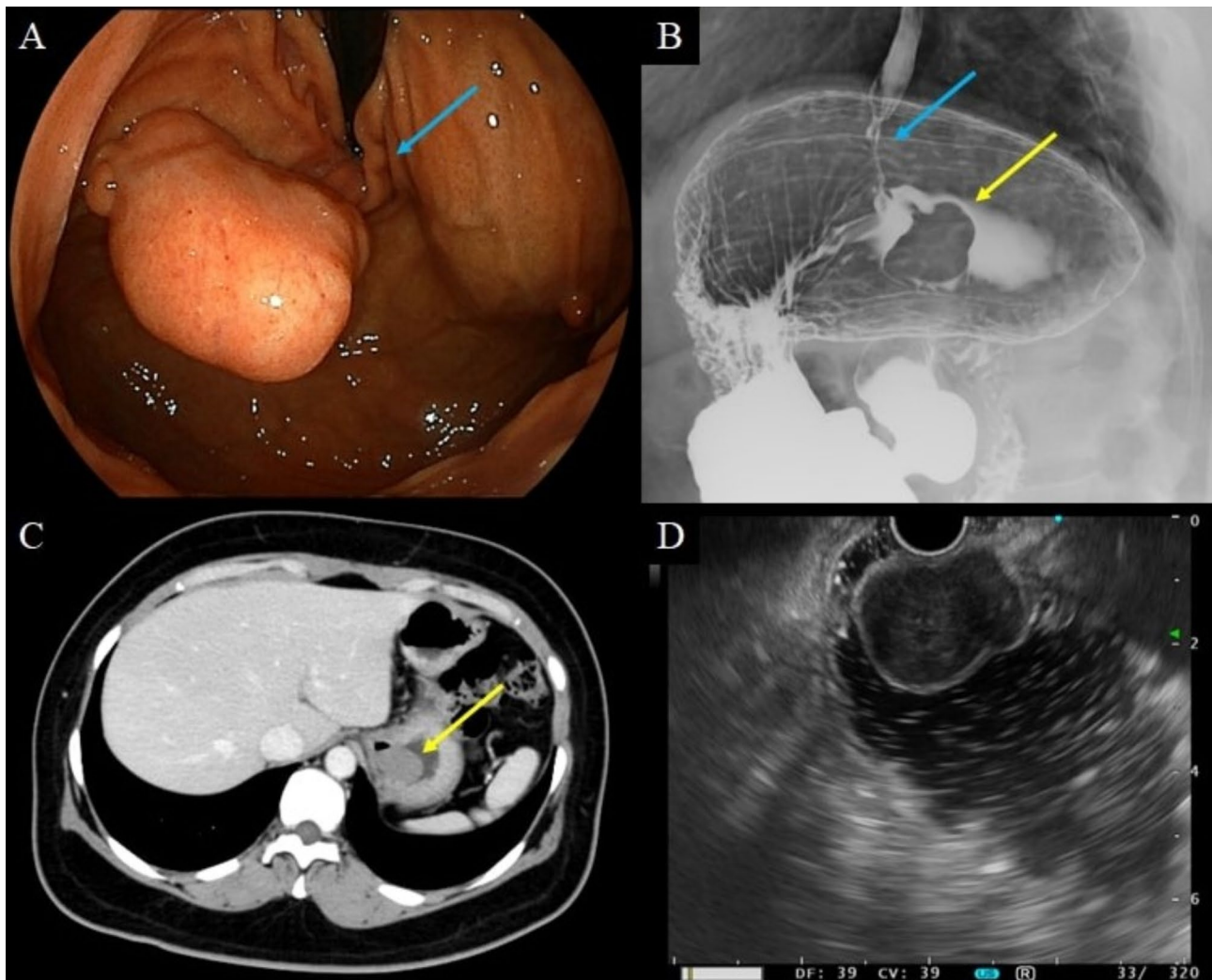


Fig. 1 Preoperative examinations. **A.** Endoscopic findings on medical examination. A gastric submucosal tumor without ulceration, approximately 3 cm in diameter, was observed in the posterior wall of the upper gastric body near the cardia (blue arrow). **B.** Upper gastrointestinal contrast findings indicating a gastric submucosal tumor (yellow arrow) located near the cardia (blue arrow). **C.** Contrast-enhanced computed tomography image showing an intraluminal tumor (3 cm in diameter) in the stomach (yellow arrow). **D.** Endoscopic ultrasonographic findings showing a submucosal tumor originating from the fourth layer

forceps. While pushing the tumor extra-luminally, the stomach wall including the tumor was clamped at full thickness using a laparoscopic linear stapler. During clamping, attention was required to ensure that the gastric wall opposite the cardia was fully clamped. While still clamped with the linear stapler, and after confirming via intraoperative endoscopy that the cardia was preserved and no tumor remained in the lumen, the linear stapler was fired laparoscopically to remove the gastric wall, including the tumor. Only one 60-mm long linear stapler was used to remove the tumor. After resection, the final intraoperative endoscopy showed cardia preservation, no tumor remnants in the gastric lumen, no active bleeding at the staple line, and no pseudodiverticulum with a defect in the seromuscular layer on the staple line during air insufflation to expand the stomach. The staple line

was also confirmed laparoscopically, and full-thickness stapling of the gastric wall without seromuscular layer defects was confirmed. After removing the upper jejunal clamp, the resected tumor was placed in a retrieval bag and extracted through the umbilical port. The operative time was 147 min, with an operative blood loss of 3 mL.

Outcomes

The postoperative hospital stay was 9 days. The resected specimen revealed minimal resection of the gastric wall, including the tumor, and no mucosal injury; thus, nonexposed resection was achieved. The tumor specimen was pathologically diagnosed as a GIST with low risk according to the modified Fletcher classification and showed negative surgical margins and complete resection of the tumor without exposure (Fig. 3A–D). The cardia and

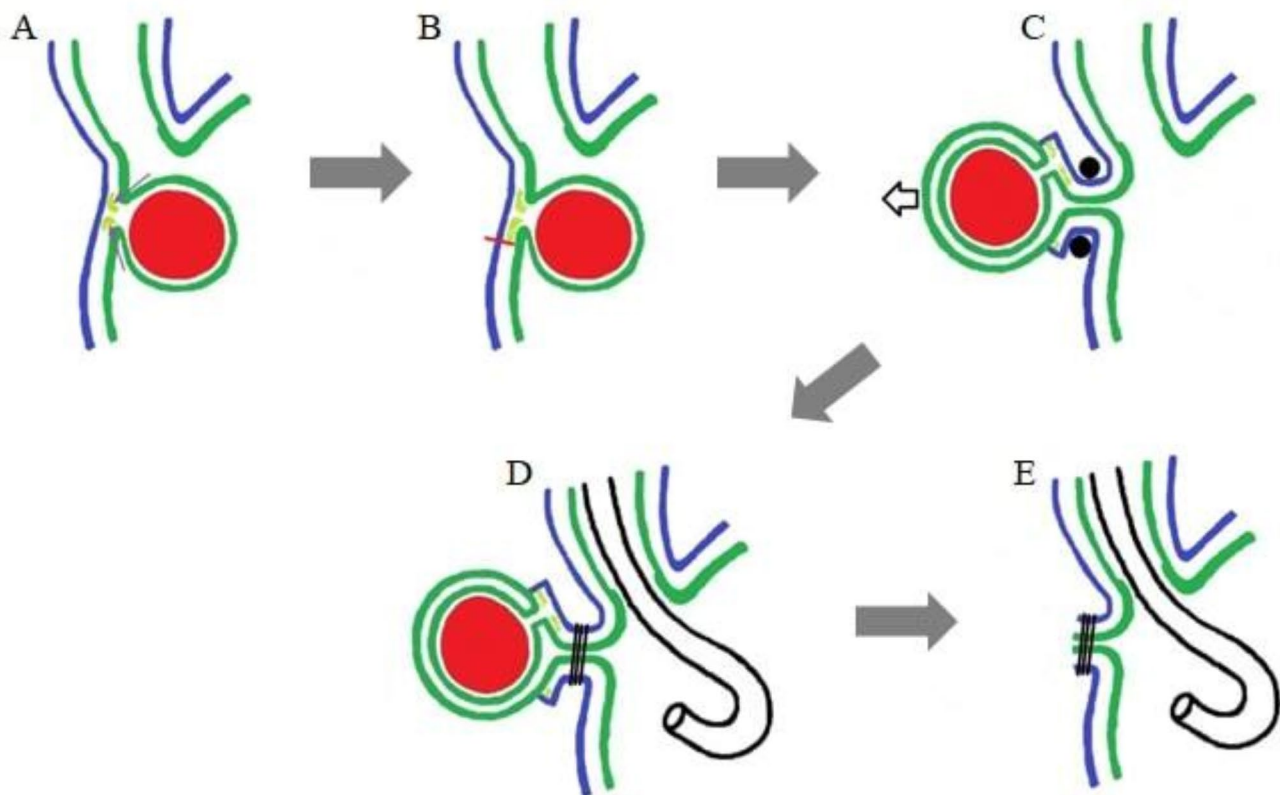


Fig. 2 Modified combination of laparoscopic and endoscopic approaches for neoplasia with non-exposure technique (CLEAN-NET) procedure. **A.** Four points of indocyanine green (ICG) injection into the peri-tumoral submucosal layer using intraoperative endoscopy. **B.** After confirming the tumor location using ICG injection with high accuracy, a semicircular seromuscular layer incision is made only opposite the side of the cardia using a laparoscopic electrocautery scalpel in laparoscopic surgery. **C.** The tumor is pushed out to the extra-luminal side from the seromuscular incision site using two forceps in laparoscopic surgery. **D.** Laparoscopic full-thickness clamp of the gastric wall including the tumor using a liner stapler and confirmation of no remaining tumor and cardia preservation using intraoperative endoscopy. **E.** After tumor resection, intraoperative endoscopy confirms no remaining tumor, definite cardia preservation, no active bleeding on the staple line, and no pseudo-diverticulum on the staple line when expanded with air

gastric nerves were preserved, and the patient showed good postoperative food intake during the hospital stay. Three months after the operation, there were no signs of tumor recurrence and the patient's dietary intake remained good.

Discussion and conclusions

This case report details the successful surgical treatment of a case of gastric GIST near the cardia using a modified CLEAN-NET. Additionally, we present a video demonstration showcasing the technique, which does not employ the circular incision of conventional CLEAN-NET. Instead, it utilizes a semicircular seromuscular layer incision exclusively on the side opposite the cardia, necessitating preservation.

Previous studies have outlined techniques for combined laparoscopic and intraoperative endoscopy surgery. The laparoscopic and endoscopic cooperative surgery (LECS) procedure, developed by Hiki et al. in 2008, integrates endoscopic mucosal dissection and laparoscopic gastric wall resection to delineate the exact cutting line

[3]. The combination of laparoscopic and endoscopic approaches to neoplasia with a non-exposure technique (CLEAN-NET) is an LECS-related procedure developed by Inoue et al. in 2012. Thus, nonexposed, full-thickness resection is performed after a seromuscular incision that preserves the continuity of the mucosa that works as a barrier [2]. The CLEAN-NET is generally indicated for tumors up to 3 cm in diameter and calls for the incision of the seromuscular layer in a circular shape around the base of the tumor [1, 2, 4, 5]. Additionally, intragastric surgery has been reported as a procedure for partial gastrectomy that does not require lymph node dissection [6–8].

The CLEAN-NET surgical procedure is straightforward when the tumor can be extruded from the lumen through the seromuscular layer incision site and full-thickness resection can be entirely performed using a linear stapler [5]. However, if the tumor is close to the cardia, which requires reliable preservation of the cardia, full-thickness resection using a linear stapler is challenging. In such cases, the gastric wall, including the tumor, is removed at

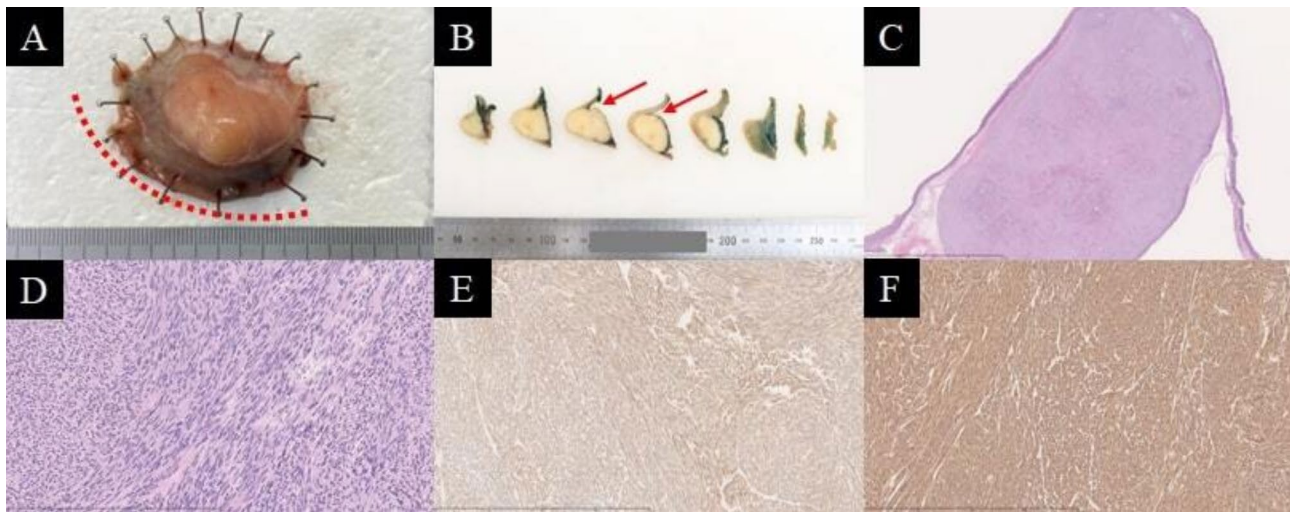


Fig. 3 Resected specimen and pathological findings. **A.** Resected specimen showing minimal resection of the gastric wall including the tumor and no mucosal injury to achieve nonexposed resection. The slightly wider area of the surgical margin, indicated by the dotted line, corresponds to the area of the semicircular seromuscular layer incision. **B.** Section images of formalin-fixed specimens also showing complete tumor resection with minimal gastric wall resection. The arrow indicating the sight of the seromuscular layer incision. **C.** Low magnification image via hematoxylin and eosin staining. **D.** High magnification image via hematoxylin and eosin staining showing spindle tumor cells and histopathology findings consistent with the diagnosis of gastrointestinal stromal tumor. **E.** Immunopathology findings indicating KIT positivity. **F.** Immunopathology findings indicating CD34 positivity

the mucosal level using a linear stapler, and the seromuscular layer defect is manually sewn laparoscopically [9]. This requires a more complicated surgical technique and is more difficult to perform than full-thickness resection using a linear stapler.

The seromuscular layer incision proposed in this case report for the modified CLEAN-NET differs from the circular incision around the base of the tumor, as in conventional CLEAN-NET. Instead, it is a semicircular incision made near the base of the tumor, specifically on the opposite side of the cardia. Using two laparoscopic forceps, the tumor was easily pushed out through the seromuscular layer incision with optimal and minimal length relative to the tumor size. When clamping the gastric wall, including the tumor, full-thickness resection is easily performed with only the linear stapler if attention is paid to full-thickness clamping of the gastric wall on the side opposite to the cardia, because the gastric wall on the side of the cardia is preserved in full-thickness. Because the optimal and minimal seromuscular layer incision suppressed excessive extension of the gastric wall during clamping, tumor resection was easily achieved using a single 60 mm linear stapler. Because the seromuscular layer incision is shorter than that of conventional CLEAN-NET, the likelihood of mucosal damage is reduced; this is expected to improve the feasibility of non-exposed surgery. Intraoperative endoscopy to confirm cardia preservation and residual tumor absence also improved the accuracy of this method. One advantage of LECS is the use of endoscopic air inflation to expand the stomach after tumor resection, confirming

the absence of pseudodiverticula with seromuscular layer defect on the staple line. In cases with lesions close to the cardia, the surgical field opposite to the cardia is suitable for lesions on the anterior wall; even in cases with lesions on the posterior wall, as in the present case, the surgical field of view opposite to the cardia is favorable because the stomach is inverted cranially. Therefore, a semicircular seromuscular layer incision in this surgical procedure can be performed with a good surgical field view for both anterior and posterior wall lesions. To the best of our knowledge, this is the first report of a modified CLEAN-NET with a semicircular incision in the seromuscular layer.

The surgical procedure described in this case report has several limitations. While the application of CLEAN-NET to early gastric cancer surgery has recently been reported [10, 11], only tumors of certain sizes may be extracted out of the lumen through the minimal semicircular seromuscular layer incision. Thus, it is not a suitable surgical procedure for substantial or small GIST or flat tumors, such as early gastric cancer, as pushing the tumor extraluminally is difficult. Although this surgical procedure has some advantages, its indications are limited to submucosal tumors, such as GIST, that are 2–3 cm in size. This limitation is relatively minor as transitioning to conventional CLEAN-NET is straightforward; it involves simply changing the seromuscular layer incision from semicircular to circumferential.

In conclusion, although surgical procedures for treating gastric GIST near the cardia demand meticulous attention to tumor size, which can present challenges, the

modified CLEAN-NET with a semicircular seromuscular layer incision emerges as a potentially valuable option for surgical procedures. It leverages the benefits of conventional CLEAN-NET while streamlining the surgical technique, offering a promising approach for these complex cases.

Abbreviations

GIST	Gastrointestinal stromal tumors
CLEAN	NET-Combination of laparoscopic and endoscopic approaches to neoplasia with non-exposure technique
LECS	Laparoscopic and endoscopic cooperative surgery
ICG	Indocyanine green

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12957-024-03528-w>.

Supplementary Material 1: Additional File 1: File format: .mp4. Title of data: Surgical demonstration of modified CLEAN-NET. Description of data: An intraoperative video demonstrating the surgical procedure for the modified CLEAN-NET.

Acknowledgements

The authors thank Dr. Hiroko Ogata and Dr. Rei Makishima for their supports in the pathological diagnosis and Editage (www.editage.jp) for English language editing.

Author contributions

H.H. wrote the manuscript text of the case report. H.H. and M.I. revised the manuscript. All the authors contributed substantially to the conception and design of this case report. H.H., S.S., and T.K. performed the surgery. H.H., S.S., Y.M., T.K., and R.M. performed the postoperative management. M.T., K.T., T.M., T.A., A.Y., and T.N. performed preoperative examinations. All the authors have read and approved the final version of the manuscript.

Funding

The authors declare no financial or any other type of support.

Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

This case report has been performed in accordance with the tenets of the Declaration of Helsinki. The patient provided informed consent and patient anonymity was preserved.

Consent for publication

The authors obtained written informed consent from this patient for the publication of this report.

Competing interests

The authors declare no competing interests.

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Received: 29 May 2024 / Accepted: 1 September 2024

Published online: 06 September 2024

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