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Article type: Technical note

Received: January 30, 2026.

Revision accepted: April 7, 2026.

Published online: May 26, 2026.

Online ISSN: 2299-0054

Wideochir Inne Tech Maloinwazyjne

DOI: 10.20452/wiitm.2026.18029

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TECHNICAL NOTE

Hybrid laparoendoscopic full-thickness gastric resection with lymphatic mapping–guided lymphadenectomy for a gastric neuroendocrine tumor

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Abstract

In this note, we present laparoscopy-assisted endoscopic full-thickness gastric resection with lymphatic mapping–guided regional lymphadenectomy for a G2 gastric neuroendocrine tumor located on the lesser curvature. The procedure achieved complete R0 resection, node-negative status, and uneventful recovery with no recurrence. This experience supports further evaluation of hybrid strategies in selected localized gastric neuroendocrine lesions.

Key words

hybrid surgery, minimally-invasive surgery, neuroendocrine tumor

Introduction Gastric neuroendocrine tumors (GNETs) are rare gastric neoplasms arising from enterochromaffin-like cells of the gastric mucosa, and account for less than 2% of all gastric tumors. Although many GNETs follow an indolent course, their biological behavior ranges from low to high malignant potential [1]. The growing detection rate observed in recent years is likely a result of the increasing use of endoscopic procedures [2]. According to the World Health Organization classification [3], well-differentiated NETs are graded as G1, G2, or G3 based on mitotic rate and / or Ki-67 proliferation index, while the clinical classification identifies 3 types of GNETs based on their pathophysiology and biological behavior.

Management of GNETs is tailored to tumor type (1–3), size, depth of invasion, and metastatic status. Small type 1 lesions confined to the mucosa or superficial submucosa without nodal disease are usually suitable for endoscopic treatment or even surveillance, whereas type 2 tumors, which arise in the setting of primary hypergastrinemia, more often require surgery, with endoscopic resection reserved for very small, localized lesions. Large tumors—most of type 3 GNETs—invading the muscularis propria and any lesions with lymph node involvement are generally managed with partial or total gastrectomy and regional

lymphadenectomy [4]. These conventional surgical approaches provide excellent oncological control but sacrifice a substantial portion of the stomach, with potential impact on function and quality of life. Cooperative laparoscopic and endoscopic techniques have been developed to achieve organ-preserving gastric resections, while maintaining minimal invasiveness [5]. However, their use for full-thickness resection (FTR) combined with regional nodal dissection remains poorly defined. To address this gap, we present this technical note describing hybrid endoscopic full-thickness gastric resection with lymphadenectomy for a localized GNET.

Aim We aimed to present a laparoendoscopic hybrid procedure combining endoscopic full-thickness gastric resection with laparoscopic lymphatic mapping-guided lymphadenectomy as a minimally-invasive, organ-sparing alternative to conventional gastrectomy in selected patients with localized GNETs.

Materials and methods A 37-year-old woman presented to our clinic with persistent epigastric pain and episodic nausea. Upper gastrointestinal endoscopy performed externally identified multiple small gastric lesions consistent with NETs. Three additional small gastric neuroendocrine lesions were removed using band-assisted endoscopic mucosal resection prior to the hybrid procedure. These were not included in the video, as they were not directly related to the presented technique. The remaining small lesions were consistent with hyperplastic (enterochromaffin-like cell-related) polyps and were managed conservatively. One nongranular, laterally spreading lesion measuring 10 mm (laterally spreading tumor, nongranular type; 0-IIb+c according to the Paris classification) was located on the lesser curvature of the gastric body (Figure 1). An attempt at endoscopic removal with a diathermic snare resulted in nonradical mucosectomy, and histopathological examination of the resected tissue and biopsies from the resection base confirmed a G2 GNET with positive margins. Physical examination and routine laboratory test results were unremarkable, and biochemical assessment on the referral showed levels of chromogranin A of 80 ng/ml and gastrin of 63

mg/l . Considering the patient's age, previous incomplete resection, histological grade, and the need for local and nodal assessment, hybrid laparoendoscopic FTR with regional lymphadenectomy was planned.

The procedure was carried out under general anesthesia. Laparoscopic access was obtained with a supraumbilical camera port, 2 5-mm working trocars in the right and left middle abdomen, and an additional 5-mm trocar for liver retraction in a French-style setup. Upper endoscopy was performed with a transparent distal attachment, allowing precise reassessment of the residual lesion and delineation of its margins using narrow-band imaging (i-scan, PENTAX Medical, Tokyo, Japan). The resection line was marked circumferentially with forced coagulation at 40 W and a submucosal injection of 1:1 mixture of indigo carmine, while Gelaspan (B. Braun Melsungen AG, Melsungen, Germany) was administered around and beneath the lesion to achieve mucosal lifting and enable intraoperative visualization of the lymphatic drainage pathways (lymphatic mapping).

Under laparoscopic view, the gastric serosa and perigastric lymphatic basin were assessed. Indigo carmine staining enabled visualization of the lymphatic vessels and nodal stations along the lesser curvature. Based on this mapping, targeted lymphadenectomy was performed, including nodal stations 3, 5, 7, 8, and 9 along the lesser curvature. The resected lymph nodes were submitted for histopathological examination.

After the completion of lymphadenectomy, endoscopic dissection at the marked site was resumed. Using a TT Knife (Olympus Medical Systems Corp., Tokyo, Japan) in Endocut I (effect 2, duration 2, interval 2) and spray coagulation modes (effect 2, 50 W) with carbon dioxide insufflation, a circumferential incision was made outside the marking line and gradually deepened. This was not a classical endoscopic submucosal dissection, but intentionally planned endoscopic FTR (EFTR) performed under combined laparoscopic and endoscopic control. Clip-line traction using a surgical suture was applied to the lesion,

providing stable exposure of the dissection plane. The presence of pneumoperitoneum from laparoscopy facilitated controlled continuation of the procedure after full-thickness penetration. Under combined endoscopic and laparoscopic visual control, the dissection was continued through the entire gastric wall to achieve intentional EFTR. The completed dissection left a full-thickness gastric defect with no visible residual lesion, and the indigo-stained specimen, still attached to the clip line, was removed endoscopically. After the completion of the endoscopic dissection, laparoscopic assistance was used to assess the full-thickness defect, ensure complete resection, and facilitate safe closure of the gastric wall. The gastric defect was inspected laparoscopically and closed with a 2-layer running suture using 3/0 absorbable monofilament (biosyn Arzneimittel GmbH, Fellbach, Germany). The suture line was then checked endoscopically and laparoscopically to confirm satisfactory closure and hemostasis (Figure 2). The procedure is presented in *Video 1*.

Results Histopathological examination of the resected gastric specimen confirmed a well-differentiated G2 NET corresponding to the previously identified 10-mm lesion on the lesser curvature (Figure 3). The lesion was completely excised, with tumor-free resection margins. The lymph nodes obtained from stations 3, 5, 7, 8, and 9 showed no evidence of metastatic involvement on histopathological examination. Total operative time was 85 minutes, with no clinically significant loss of blood.

The postoperative course was uneventful, without documented surgical or medical complications. Follow-up upper gastrointestinal endoscopy performed 3 months after the procedure demonstrated a well-healed scar, with no macroscopic evidence of local recurrence (Figure 4).

Discussion Several published case reports have shown that hybrid laparoscopic-endoscopic procedures can be effectively utilized in managing NETs of the upper gastrointestinal tract. For instance, Igarashi et al [6] reported a case of a small GNET arising

from the deep submucosal layer, which was successfully removed via laparoscopic and endoscopic cooperative surgery, along with regional lymph node dissection. The authors concluded that this combined approach represented a safe and practical treatment option for carefully selected GNETs that extended into the muscularis propria. Kriger et al [7] described 2 GNET cases managed with combined laparoscopy and gastroscopy, where intraluminal gastric resection was performed in 1 patient and laparoscopic gastric resection with endoscopic assistance in the other, according to tumor location. Broader experience in other gastric tumors further supports this concept. In a series on gastric stromal tumors, hybrid EFTR was established as a feasible and safe technique [8]. Taken together, these reports and the present case suggest that small, well-localized NETs of the upper gastrointestinal tract can be effectively managed with minimally-invasive procedures instead of routine open or segmental resections.

Hybrid techniques offer several specific advantages. They allow for precise local FTR with excellent visualization from the mucosal side and direct laparoscopic assessment of the serosal defect. Moreover, by limiting the extent of gastric wall resection and closing the defect in a controlled manner, they are designed to preserve gastric anatomy and function. Additionally, they enable regional lymphadenectomy and pathological nodal staging in the same session, which endoscopic therapy alone cannot provide. From a technical perspective, the combination of EFTR with laparoscopic support allows for controlled transmural dissection without loss of exposure. The use of traction techniques and pneumoperitoneum enables safe continuation of the dissection, even after entry into the peritoneal cavity. Recent studies have further highlighted the role of hybrid laparoendoscopic approaches in gastrointestinal surgery, emphasizing their potential in organ-preserving treatment strategies [9].

At the same time, this approach has clear limitations. Hybrid surgeries are technically demanding, requiring advanced therapeutic endoscopy, advanced laparoscopy, and close coordination between teams, which limits its availability to specialized centers. Resection is deliberately limited, so accurate staging and careful selection are essential, as inappropriately liberal use of hybrid procedures in higher-risk tumors could lead to undertreatment, as compared with standard gastrectomy. In addition, there are no established guidelines, which makes case selection, standardization of the technique, and training more difficult.

The concept of sentinel lymph node biopsy in gastric tumors remains controversial due to the complexity of gastric lymphatic drainage. In the present case, indigo carmine was used primarily for lymphatic mapping to visualize drainage pathways and guide targeted lymphadenectomy, rather than identifying a true sentinel node in the classical oncological sense.

Conclusions Hybrid endoscopic full-thickness gastric resection combined with lymphatic mapping-guided lymphadenectomy represents a technically feasible and organ-sparing approach for selected patients with localized GNETs. This strategy enables precise resection with simultaneous nodal assessment while preserving gastric function. Further studies are required to confirm its oncological safety.

Article information

Video The video file is available online at <https://dx.doi.org/10.20452/wiitm.2026.18029>.

Acknowledgments None.

Funding None.

Contribution statement TJK: conceptualization, methodology, investigation, formal analysis, review, and editing. JS: investigation, review, and editing. ARW: investigation and

writing of the original draft. WC: conceptualization, supervision, formal analysis, review, and editing. All authors reviewed and approved the final version of the manuscript.

Conflict of interest None declared.

AI statement In the preparation of this manuscript, ChatGPT-5 by OpenAI was used to enhance the grammar, style, and clarity of the text. The authors have reviewed and edited the output and take full responsibility for the content of this publication.

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How to cite Klimczak TJ, Śmigielski J, Wojtczak AR, Ciesielski W. Hybrid laparoendoscopic full-thickness gastric resection with lymphatic mapping-guided lymphadenectomy for a gastric neuroendocrine tumor: a technical note. *Wideochir Inne Tech Maloinwazyjne*. 2026; Epub ahead of print. doi:10.20452/wiitm.2026.18029

Journal information

Videosurgery and Other Miniinvasive Techniques is an official journal of the Videosurgery Foundation.

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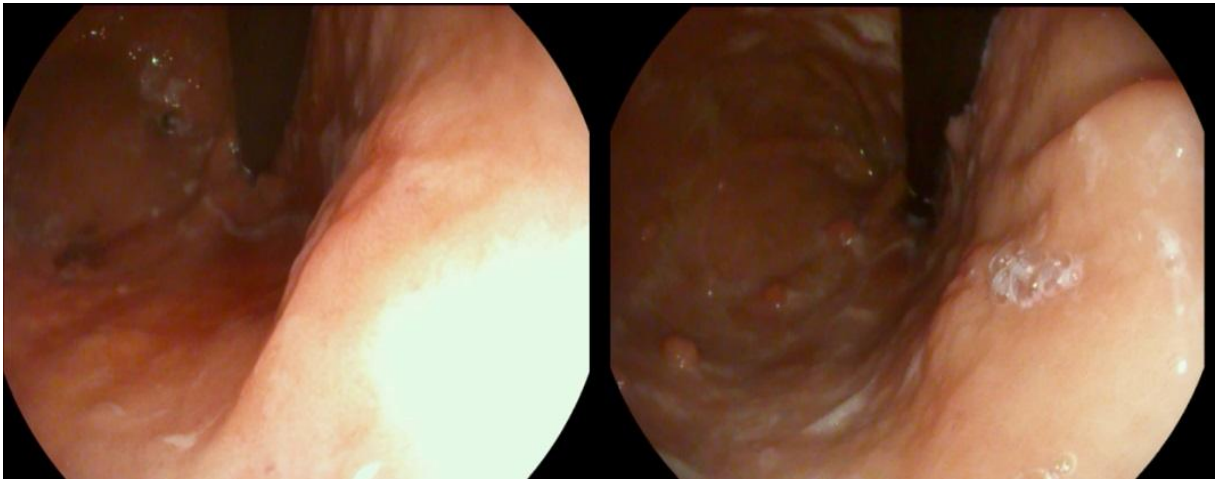


Figure 1 Endoscopic view of the lesion

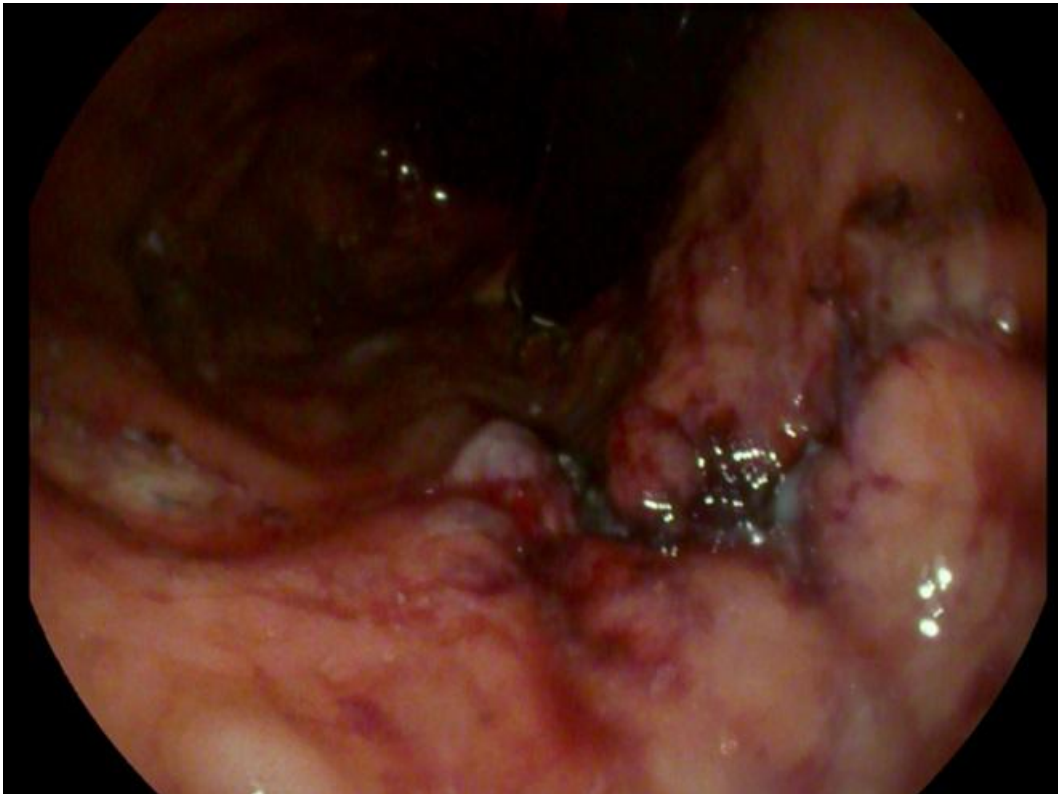


Figure 2 Endoscopic view of the gastric wall defect after laparoscopic suturing

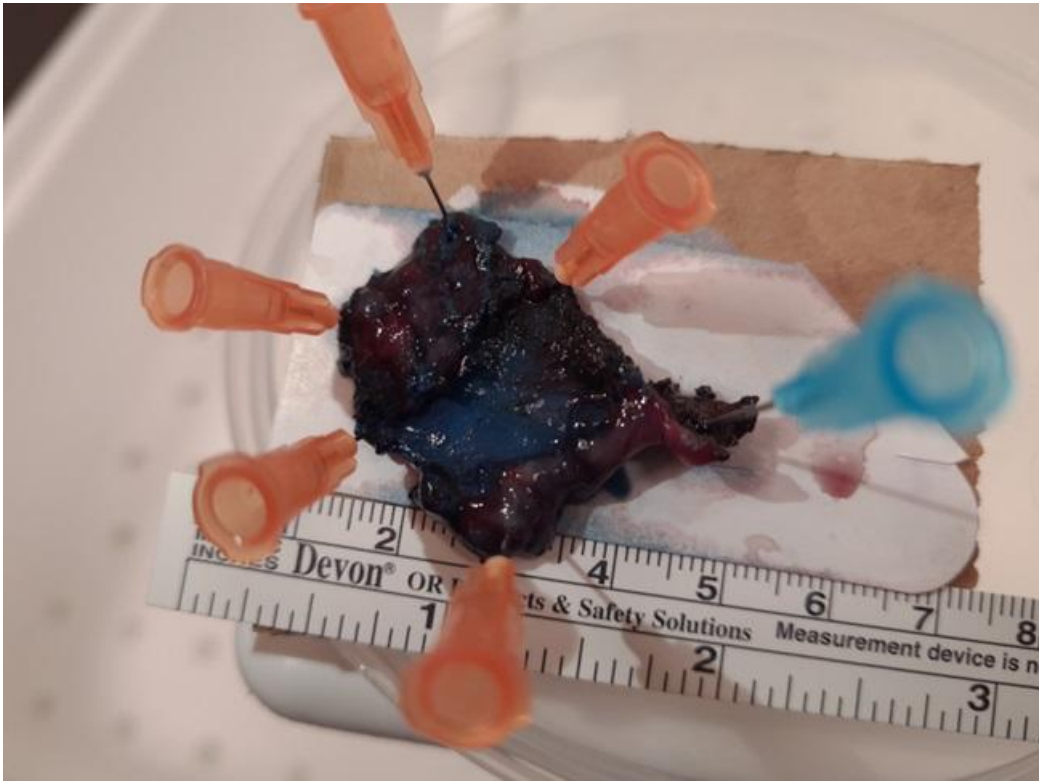


Figure 3 Excised tumor with visible staining



Figure 4 Healed sutured wall defect 90 days postoperatively

Short title: Laparoscopic full-thickness gastric resection with lymphadenectomy for a G-NET