UDC 616.348-006.6-073.7-089
DOI http://doi.org/10.30978/GS-2025-3-43

ISSN 2786-5584 print
ISSN 2786-5592 online

The role of minimally invasive diagnostic techniques in optimizing treatment strategies in patients with colorectal cancer

O. A. Danylenko, O. O. Piskorskyi

Bogomolets National Medical University, Kyiv

✉ Oleksandr Danylenko: danylenko619@gmail.com

O. A. Danylenko, https://orcid.org/0009-0007-7518-9986
O. O. Piskorskyi, https://orcid.org/0000-0002-2202-4201

Objective – to improve staging accuracy and optimize therapeutic strategies in patients with colorectal cancer by performing minimally invasive diagnostic procedures, specifically diagnostic laparoscopy with peritoneal lavage and cytological examination, and mediastinoscopy with targeted lymph node biopsy, in cases where conventional imaging methods (computed tomography [CT], magnetic resonance imaging [MRI], positron emission tomography combined with computed tomography [PET-CT]) yield equivocal or inconclusive results.

Materials and methods. This ambispective (retrospective–prospective) study was conducted from 2023 to 2025 and included 37 patients with colorectal cancer who had inconclusive standard imaging results regarding distant metastases or peritoneal carcinomatosis. Patients were allocated into two groups: 22 patients with suspected peritoneal carcinomatosis underwent diagnostic laparoscopy with peritoneal lavage, peritoneal biopsy, and cytological analysis, while 15 patients with suspected mediastinal lymph node involvement underwent cervical mediastinoscopy with targeted lymph node biopsy. Diagnostic accuracy, the impact of findings on subsequent therapeutic management, and procedural safety were evaluated.

Results. Peritoneal carcinomatosis was morphologically confirmed in 19 of 22 patients (86.4 %), and metastatic involvement of mediastinal lymph nodes was confirmed in 11 of 15 patients (73.3 %). Verification of the pathological process resulted in a change in therapeutic strategy for 29 of 37 patients (78.4 %). Specifically, 27 patients (73.0 %) received systemic chemotherapy, 7 patients (18.9 %) underwent radical surgical procedures, 2 patients (5.4 %) underwent palliative resection, and 1 patient (2.7 %) declined further treatment. No serious intraoperative complications were observed. Minor postoperative events, including pain at the puncture site, subcutaneous emphysema, and transient fever, occurred in 8 patients (21.6 %) and did not require additional treatment.

Conclusions. Incorporating diagnostic laparoscopy and mediastinoscopy into the colorectal cancer staging algorithm yields high diagnostic accuracy, supporting personalized treatment planning. The application of minimally invasive methods reduces unnecessary surgical interventions, shortens the time to initiation of systemic therapy, and may improve prognosis in patients with advanced disease.

Keywords
colorectal cancer, diagnostic laparoscopy, carcinomatosis, mediastinoscopy, staging, metastasis, NCCN.

ARTICLE • Received 2025-09-01 • Received in revised form 2025-09-18 • Published 2025-10-30

Colorectal cancer (CRC) is one of the most prevalent malignant neoplasms and a leading cause of cancer-related mortality worldwide [10]. Prognosis is closely linked to the stage at diagnosis. Early-stage detection is associated with improved survival rates and the potential for radical treatment, whereas distant metastases significantly reduce the likelihood of favourable outcomes [10]. The National Comprehensive Cancer Network (NCCN) guidelines for Colon and Rectal Cancer (version 2.2024) underscore the importance of accurate staging in selecting optimal therapeutic strategies [1]. Digital imaging modalities, including computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography combined with computed tomography (PET-CT), are routinely used to assess primary tumour size, regional lymph node involvement and the presence of distant metastases. Despite their widespread use, these imaging techniques have limited sensitivity for detecting microscopic lesions, such as occult peritoneal

carcinomatosis, and for evaluating non-regional lymph nodes, including mediastinal lymph node involvement [5, 10]. CT scanning, in particular, has low sensitivity for identifying peritoneal metastases < 5 mm in diameter [11]. Furthermore, hypermetabolically active mediastinal lymph nodes observed on PET-CT may be reactive, resulting in false-positive findings [4]. Tumours have traditionally been considered the primary consumers of glucose in the body, a concept that underpins PET-CT tumour visualization using a radioactive glucose tracer to identify regions of elevated glucose metabolism. However, recent studies indicate that tumours are highly heterogeneous and consist of various cell types. Research conducted by a team of American investigators has shown that immune cells, specifically macrophages and T cells, are the primary consumers of glucose within tumours, rather than malignant cells. In contrast, tumour cells utilize glutamine and fatty acids as their principal energy sources. This finding represents a significant advancement and may substantially influence future approaches to cancer diagnosis and treatment [6].

The primary disadvantage of PET-CT includes undetected (false negative) peritoneal carcinomatosis in patients with CRC, potentially resulting in exploratory or palliative surgery. Conversely, a false positive PET-CT result may prevent patients from receiving potentially beneficial radical bowel resection. In these controversial cases, morphological verification of suspicious changes is required [5].

The NCCN guidelines recommend the use of minimally invasive diagnostic techniques when imaging data are inconclusive [1]. Specifically, diagnostic laparoscopy with peritoneal lavage for cytology is advised for suspected peritoneal carcinomatosis, while mediastinoscopy is recommended for patients with CRC who present with enlarged mediastinal lymph nodes [1]. These procedures provide direct morphological verification. Laparoscopy enables assessment of the macroscopic condition of the peritoneum and collection of peritoneal lavage samples for cytology and biopsy. Mediastinoscopy facilitates the acquisition of histological samples from a suspicious lymph node. Previous studies have shown that in localized CRC, positive peritoneal lavage cytology serves as an independent negative prognostic marker associated with a high risk of peritoneal recurrence [3]. Incidental confirmation of mediastinal metastases by imaging alone has been reported only in isolated clinical cases [2], underscoring the necessity for histological confirmation.

Figure 1. **Enlarged paratracheal lymph nodes**

This study examined the impact of diagnostic laparoscopy with cytological analysis and mediastinoscopy with targeted lymph node biopsy on initial treatment planning and the consistency between clinical and morphological data.

Objective – to improve staging accuracy and optimize therapeutic strategies in patients with colorectal cancer by performing minimally invasive diagnostic procedures, specifically diagnostic laparoscopy with peritoneal lavage and cytological examination, and mediastinoscopy with targeted lymph node biopsy, in cases where conventional imaging methods (computed tomography [CT], magnetic resonance imaging [MRI], positron emission tomography combined with computed tomography [PET-CT]) yield equivocal or inconclusive results.

Materials and methods

Study design. This retrospective-prospective clinical study was conducted from 2023 to 2025 and included 37 patients with colorectal cancer (CRC).

The inclusion criteria for patients in this study required the presence of suspicious radiological signs indicating potential metastasis to the peritoneum or mediastinal lymph nodes. Specifically, these signs included ascites, peritoneal thickening, or enlarged (> 11 mm) mediastinal lymph nodes of undetermined origin (Fig. 1).

Methods. All patients underwent standard imaging, which included CT of the chest, abdomen, and pelvis. Intravenous contrast was administered when indicated. If imaging results suggested possible peritoneal carcinomatosis or mediastinal lymph node involvement, a minimally invasive procedure was performed (diagnostic laparoscopy or mediastinoscopy, respectively). Patients were then preliminarily divided into two groups: those with suspected peritoneal carcinomatosis (n = 22) and those with suspected mediastinal lymph node involvement (n = 15).

All procedures were conducted under general anaesthesia. For suspected peritoneal carcinomatosis, diagnostic laparoscopy with peritoneal lavage or ascites

aspiration was performed. When ascites volume exceeded 500 ml (Fig. 2), aspiration was followed by cytological examination of the fluid. In the absence of ascites, 400 ml of saline was injected and then aspirated, as recommended by cytologists. The collected washings were analyzed using standard cytological techniques to detect tumour cells in the peritoneal fluid.

Patients with suspected mediastinal lymph node involvement underwent standard mediastinoscopy by the technique of Carlens.

Following mediastinal examination, targeted biopsies were obtained from all enlarged lymph nodes (> 11 mm) or those deemed suspicious. The biopsy specimens were submitted for histological analysis.

Outcomes Evaluation. The main endpoints included: (1) changes in treatment strategy after obtaining cytology/histology data (e.g., transition from possible (according to non-invasive diagnostic methods) radical surgery to palliative therapy or vice versa); (2) correlation between cytology/histology results and primary imaging data (confirmation or refutation of initial clinical suspicion); (3) safety of procedures (frequency and severity of complications).

Statistical analysis was performed using descriptive statistical methods, including the number and percentage for categorical variables and the arithmetic mean with standard deviation for continuous values.

The study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Informed consent was obtained from all participants.

Results

Histological and/or cytological analysis confirmed metastatic peritoneal involvement in 19 of 22 patients (86.4 %) who were diagnosed with peritoneal carcinomatosis using non-invasive diagnostic techniques (Fig. 3). Morphological confirmation of metastasis to mediastinal lymph nodes was achieved in 11 (73.3 %) of 15 (86.4 %) patients with mediastinal lymphadenopathy identified by CT or PET-CT.

The findings allowed for personalized adjustment of further treatment strategies. Specifically, 27 (72.9 %) patients who underwent diagnostic laparoscopy or mediastinoscopy and were confirmed to have stage IV disease received chemotherapy, since surgical intervention was inappropriate. The remaining patients, who didn't present with metastases in the mediastinal lymph nodes and peritoneal carcinomatosis, underwent radical surgery. In two (5.4 %) cases, palliative intestinal resection was performed for urgent indications (acute intestinal obstruction). One (2.7 %) patient declined further treatment.

No intraoperative complications occurred during laparoscopy or mediastinoscopy. The duration of hospital observation ranged from 24 to 48 hours. Mild postoperative pain, isolated seromas at the surgical wound site, and a transient increase in body temperature to 37.8 °C were observed in 8 (21.6 %) patients.

A summary of the study results is presented in Table.

Discussion

The study demonstrates that minimally invasive techniques, including diagnostic laparoscopy with peritoneal biopsy and cytological analysis of fluids and mediastinoscopy with biopsy, provide high diagnostic efficiency and clinical value in patients with suspected peritoneal carcinomatosis or metastatic involvement of mediastinal lymph nodes in CRC. Among patients with suspected peritoneal carcinomatosis (n = 22), cytology and histology did not confirm the lesion in 3 patients (13.6 %), allowing for safe radical surgery and avoiding unnecessary palliative interventions and PCT. In contrast, 19 patients (86.4 %) with confirmed peritoneal carcinomatosis required systemic therapy. For patients with suspected mediastinal lymph node involvement (n = 15), 4

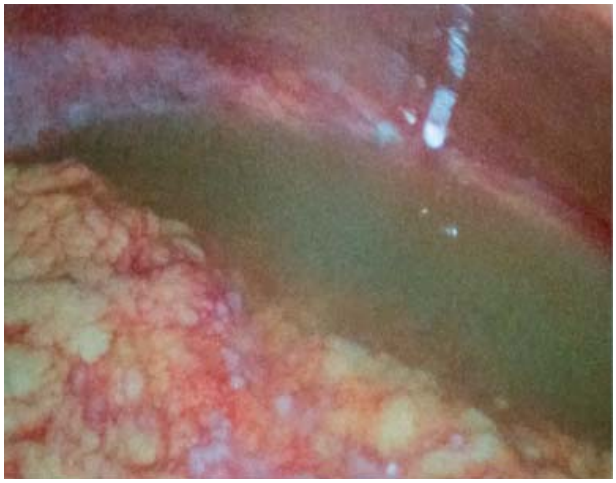

Figure 2. **Ascites in the abdominal cavity (> 500 ml)**

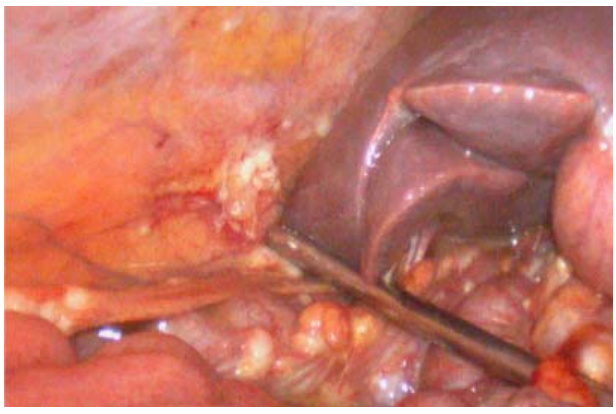

Figure 3. **Confirmed peritoneal carcinomatosis**

Table. **Clinical results of the study**

Group	n	Procedure	Result
Suspected peritoneal carcinomatosis (Group A)	19 (86.4 %)	Laparoscopy + histological examination + peritoneal lavage/ascites aspiration (fluid cytology)	Confirmed carcinomatosis. Scheduled or palliative polychemotherapy (PCT) (n = 17) and palliative surgery (n = 2) were prescribed.
Suspected peritoneal carcinomatosis (Group B)	3 (13.6 %)	Laparoscopy + histological examination + peritoneal lavage/ascites aspiration (fluid cytology)	Carcinomatosis was not confirmed. Planned radical surgery was performed (left or right hemicolectomy depending on the location of the tumour).
Suspected metastatic involvement of mediastinal lymph nodes (Group C)	11 (73.3 %)	Mediastinoscopy + biopsy	Metastatic involvement of mediastinal lymph nodes was confirmed. Systemic chemotherapy was prescribed (n = 10). One patient declined treatment.
Suspected metastatic involvement of mediastinal lymph nodes (Group D)	4 (26.7 %)	Mediastinoscopy + biopsy	Metastatic involvement of mediastinal lymph nodes was not confirmed. Planned radical surgery (left or right hemicolectomy depending on tumour location) was performed

patients (26.7 %) showed no metastatic cells in their histological samples, allowing for radical surgical treatment. In the remaining patients (73.3 %), histological confirmation of metastases resulted in upstaging to stage IV and necessitated PCT.

The present findings are consistent with previous research, which supports both financial and clinical feasibility of laparoscopy and mediastinoscopy for staging colorectal cancer. Notably, multicenter studies have shown that positive cytology of peritoneal washings serves as an independent negative prognostic marker, correlating with a higher risk of peritoneal recurrence and reduced survival [3]. The reported 20–30 % frequency of false-positive PET-CT results in the mediastinum (20–30 %) highlights the need for histological verification in cases of mediastinal lymphadenopathy [11].

The safety of these procedures was confirmed by the absence of serious complications: patients underwent laparoscopy and mediastinoscopy without significant adverse events, which is consistent with the literature data on the low risk of postoperative complications in minimally invasive interventions [7]. Furthermore, these methods offer the advantage of direct visualization and assessment of lesions, a benefit not achievable through digital imaging techniques alone.

The primary limitations of this study include a relatively small sample size and a mixed retrospective-prospective design, which may limit the generalizability of the results. Nevertheless, the findings confirm the practical diagnostic value of minimally invasive techniques for cancer staging and establish a foundation for further multicenter studies to evaluate their impact on long-term survival and patient quality of life.

Conclusions

Diagnostic laparoscopy with histological examination, peritoneal lavage followed by cytological analysis, and mediastinoscopy with biopsy provide valuable and informative adjuncts to standard imaging modalities in the diagnosis of colorectal cancer.

The application of these techniques enhances the accuracy of clinical cancer staging, particularly in cases with suspected metastatic tumour spread.

Negative findings from these studies support the feasibility of safe radical surgery, whereas positive findings facilitate timely referral to systemic therapy for stage IV disease.

The implementation of an integrated approach reduces the risk of unnecessary surgical interventions and addresses potential limitations in existing treatment strategies. This approach is consistent with current recommendations from the National Comprehensive Cancer Network (NCCN) and the European Society for Medical Oncology (ESMO) for optimizing CRC treatment.

The findings support wider adoption of minimally invasive procedures within CRC detection protocols and promote the development of improved recommendations grounded in multidisciplinary diagnostic strategies.

Declaration of interests

The authors declare that they have no conflicts of interest.
Funding. No external funding was received for this study.

Authors contributions

O.A. Danylenko: concept and design, methodology, clinical data collection, participation in minimally invasive diagnostic procedures, statistical analysis, drafting of the manuscript; O.O. Piskorsky: scientific guidance and

methodological support, clinical coordination, analysis and interpretation of the findings, participation in minimally invasive diagnostic procedures, critical revision of the manuscript.

References

1. Cervantes A, Adam R, Roselló S, et al. Metastatic colorectal cancer: ESMO Clinical Practice Guideline for diagnosis, treatment and follow-up. Ann Oncol. 2023;34(1):10-32. doi: 10.1016/j.annonc.2022.10.003.
2. Clinical Outcomes of Surgical Therapy Study Group; Nelson H, Sargent DJ, Wieand HS, et al. A comparison of laparoscopically assisted and open colectomy for colon cancer. N Engl J Med. 2004 May 13;350(20):2050-9. doi: 10.1056/NEJMoa032651.
3. Kobayashi H, Kotake K, Maeda K, et al. Peritoneal lavage cytology in patients with curative resection for stage II and III colorectal cancer: a multi-institutional prospective study. Ann Gastroenterol Surg. 2024;8(5):807-816. doi: 10.1002/ags3.12825.
4. Labianca R, Nordlinger B, Beretta GD, et al. Early colon cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment and follow-up. Ann Oncol. 2013;24(suppl 6):vi64-vi72. doi: 10.1093/annonc/mdt354.
5. Lafaro KJ, Roumanis P, Demirjian AN, et al. Gd-EOB-DTPA-Enhanced MRI for Detection of Liver Metastases from Colorectal Cancer: A Surgeon's Perspective. Int J Hepatol. 2013;2013:572307. doi: 10.1155/2013/572307.
6. Reinfeld BI, Madden MZ, Wolf MM, et al. Cell-programmed nutrient partitioning in the tumour microenvironment. Nature. 2021 May;593(7858):282-288. doi: 10.1038/s41586-021-03442-1.
7. Schena CA, Laterza V, De Sio D, et al. The Role of Staging Laparoscopy for Gastric Cancer Patients: Current Evidence and Future Perspectives. Cancers (Basel). 2023 Jun 30;15(13):3425. doi: 10.3390/cancers15133425.
8. Schmoll HJ, Van Cutsem E, Stein A, et al. ESMO Consensus Guidelines for management of patients with colon and rectal cancer. a personalized approach to clinical decision making. Ann Oncol. 2012 Oct;23(10):2479-2516. doi: 10.1093/annonc/mds236.
9. Sugarbaker PH. Peritoneal Carcinomatosis: Principles of Management. Berlin: Springer; 1996. 256 p.
10. Sung H, Ferlay J, Siegel RL, Laversanne M, et al. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin. 2021 May;71(3):209-249. doi: 10.3322/caac.21660.
11. Tsukada T, Nakano T, Matoba M, Sasaki S, Higashi K. False-Positive Mediastinal Lymphadenopathy on 18F-Fluorodeoxyglucose Positron Emission Tomography and Computed Tomography after Rectal Cancer Resection: A Case Report of Thoracoscopic Surgery in the Prone Position. Case Rep Oncol. 2011 Sep;4(3):569-75. doi: 10.1159/000335017. Epub 2011 Dec 7.
12. Van Cutsem E, Cervantes A, Adam R, et al. ESMO Consensus Guidelines for the Management of Patients with Metastatic Colorectal Cancer. Ann Oncol. 2016;27(8):1386-1422. doi: 10.1093/annonc/mdw235.
13. Vandecaveye V, Rousset P, Nougaret S, et al. ; European Society of Gastrointestinal and Abdominal Radiology (ESGAR); European Society of Urogenital Radiology (ESUR); Peritoneal Surface Oncology Group International (PSOGI); European Association of Nuclear Medicine (EANM). Imaging of peritoneal metastases of ovarian and colorectal cancer: joint recommendations of ESGAR, ESUR, PSOGI, and EANM. Eur Radiol. 2025 May;35(5):2712-2722. doi: 10.1007/s00330-024-11124-5.
14. Yamamoto S, Akasu T, Fujita S, Moriya Y. Long-term prognostic value of conventional peritoneal cytology after curative resection for colorectal carcinoma. Jpn J Clin Oncol. 2003 Jan;33(1):33-7. doi: 10.1093/jjco/hyg007. PMID: 12604722.

Роль малоінвазивних діагностичних методик в оптимізації лікувальної тактики у хворих на колоректальний рак

О. А. Даниленко, О.О. Піскорський

Національний медичний університет імені О. О. Богомольця, Київ

Мета — підвищити точність стадіювання та оптимізувати лікувальну тактику у пацієнтів з колоректальним раком шляхом застосування малоінвазивних діагностичних втручань — діагностичної лапароскопії з перитонеальним лаважем і цитологічним дослідженням, а також медіастиноскопії з прицільною біопсією лімфатичних вузлів при сумнівних або непереконливих результатах візуалізаційних методів обстеження КТ (комп'ютерна томографія), МРТ (магнітно-резонансна томографія), ПЕТ-КТ (позитронно-емісійна томографія, поєднана з комп'ютерною томографією).

Матеріали та методи. Це ретроспективно-проспективне дослідження 2023—2025 років, залучено 37 пацієнтів із колоректальним раком, у яких стандартні методи візуалізації не дали змоги однозначно визначити наявність віддалених метастазів або перитонеального канцероматозу. Пацієнтів розділено на дві групи: 22 хворих із підозрою на канцероматоз очеревини, яким виконано діагностичну лапароскопію з лаважем черевної порожнини, біопсією очеревини та цитологічним аналізом; 15 хворих із підозрою на ураження медіастинальних лімфатичних вузлів, яким проведено цервікальну медіастиноскопію з прицільною біопсією. Оцінювали діагностичну точність, вплив отриманих результатів на подальшу лікувальну тактику та безпечність виконаних процедур.

Результати. Перитонеальний канцероматоз морфологічно підтверджено у 19 із 22 (86,4 %) пацієнтів, метастатичне ураження медіастинальних лімфатичних вузлів — у 11 із 15 (73,3 %) пацієнтів. За результатами верифікації патологічного процесу лікувальна тактика була змінена у 29 (78,4 %) пацієнтів: 27 (72,9 %) отримали системну хіміотерапію, 7 (18,9 %) — радикальні оперативні втручання, у 2 (5,4 %) виконано паліативну резекцію, 1 (2,7 %) відмовився від подальшого лікування. Серйозних інтраопераційних ускладнень не зафіксовано; незначні післяопераційні явища (біль у ділянці проколу, підшкірна емфізема, короткочасна лихоманка) спостерігалися у 8 (21,6 %) пацієнтів і не потребували додаткового лікування.

Висновки. Включення діагностичної лапароскопії та медіастиноскопії до алгоритму визначення стадії колоректального раку забезпечує високу діагностичну інформативність і сприяє персоналізації лікування. Застосування малоінвазивних методів дозволяє уникнути необґрунтованих хірургічних втручань, скоротити час до початку системної терапії та покращити прогноз у пацієнтів із поширеними формами хвороби.

Ключові слова: колоректальний рак, діагностична лапароскопія, канцероматоз, медіастиноскопія, стадія, метастазування, NCCN.

FOR CITATION

Danylenko OA, Piskorskyi OO. The role of minimally invasive diagnostic techniques in optimizing treatment strategies in patients with colorectal cancer. General Surgery (Ukraine). 2025;(3):43-47. http://doi.org/10.30978/GS-2025-3-43.