Oncology Treatment Discovery, 2025, Volume 3, Issue 2
http://ojs.bbwpublisher.com/index.php/OTD
Online ISSN: 2981-8079

Research Progress on Malignant Peritoneal Effusion in Gastrointestinal Tumors

Hongli Cao[1], Gangling Zhang[2], Yizheng Cui[2], Rancen Tao[2], Jie Li[2]

[1]Baotou Medical College of Inner Mongolia University of Science and Technology, Baotou 014040, Inner Mongolia, China
[2]Baotou Cancer Hospital, Baotou 014030, Inner Mongolia, China

Abstract: Malignant Peritoneal Effusion (MPE) in gastrointestinal tumors can affect the prognosis of patients with advanced cancer. It is associated with multiple factors such as abnormal angiogenesis, a damaged lymphatic system, and an inflammatory response. After the onset of the disease, tumor cells invade the peritoneum, and changes in the peritoneal microenvironment can increase vascular permeability. Additionally, factors such as the high number of neovascularizations in patients with malignant tumors, lymphatic circulation disorders, and intensified inflammatory responses in the body create a vicious cycle, leading to increased production of ascites. Clinically, imaging techniques, cytological techniques, and biomarker detection techniques are commonly used to diagnose MPE, and treatment options and prognostic factors are explored through clinical practice. This study analyzes the diagnosis and treatment methods of MPE from multiple perspectives, providing a basis for summarizing new diagnosis and treatment methods for MPE in the later stage.

Keywords: Gastrointestinal tumors; Malignant peritoneal effusion; Diagnostic methods; Treatment methods

Online publication: July 8, 2025

1. Introduction

MPE is a common complication of advanced gastrointestinal tumors (such as gastric cancer, colorectal cancer, pancreatic cancer, etc.), with about 15%-50% of patients with advanced disease developing peritoneal effusion [1]. This type of effusion grows rapidly and can cause symptoms such as abdominal pain, abdominal distension, oliguria, and dyspnea. It may also lead to serious complications such as water and electrolyte imbalance, infection, and pulmonary embolism. The appearance of MPE indicates that the disease has entered its terminal stage, with a median survival time of only 3-6 months for patients. With the advancement of molecular biology and imaging technology, significant progress has been made in the diagnosis and treatment of MPE, but challenges such as high drug resistance still exist. Therefore, in-depth research on MPE is extremely important for developing new treatment strategies, relieving patient symptoms, and improving prognosis. This article aims to systematically review the research results on the pathophysiological mechanism, diagnostic methods, treatment strategies, prognostic factors, and palliative and supportive treatment of malignant peritoneal effusion

in gastrointestinal tumors, providing references for clinical treatment and further research.

2. Current research status of malignant peritoneal effusion in gastrointestinal tumors

In recent years, domestic and foreign research has focused on exploring the molecular mechanisms of MPE and developing precision treatment strategies. For example, Hua Chan Su injection reduces the production of ascites in colon cancer by inhibiting Vasculogenic Mimicry (VM), with a clinical effective rate of 61.5% [2]. In targeted therapy, anti-VEGF drugs (such as Bevacizumab) combined with hyperthermic intraperitoneal chemotherapy (HIPEC) significantly reduce serum VEGF levels in patients with ovarian cancer and ascites. Immunotherapy, such as PD-1 inhibitors, can achieve a response rate of 20%-30% in gastric cancer ascites [3]. Additionally, liquid biopsy techniques (such as circulating tumor cell detection) have shown potential in the early diagnosis and efficacy monitoring of MPE.

3. Pathophysiological mechanisms of malignant peritoneal effusion in gastrointestinal tumors

3.1. Interaction between tumor cells and the peritoneal microenvironment

3.1.1. Characteristics of tumor cells and peritoneal metastasis

Gastrointestinal tumor cells exhibit strong invasion and metastasis capabilities. Through epithelial-mesenchymal transition (EMT), these cells acquire invasiveness, expressing adhesion molecules like integrin αvβ3 and CD44, which facilitate peritoneal implantation. The tumor cells can also secrete a series of cytokines that promote the production and maturation of the extracellular matrix. Inflammatory factors can enhance their adhesion and implantation abilities, ultimately enabling them to reach the abdominal cavity via lymphatic or blood circulation, adhere, proliferate, and form metastases. For instance, ovarian cancer cells can secrete MMP-2/9 to degrade the extracellular matrix, leading to the formation of metastatic lesions.

3.1.2. Impact of the peritoneal microenvironment on tumor cells

The peritoneal microenvironment, consisting of various cellular components, extracellular matrix, and specific local physicochemical properties, forms a complex but relatively stable environment. In this setting, multiple cell types can be induced by cancer cells, participating in and facilitating tumor growth, invasion, and peritoneal metastasis. For example, tumor-associated macrophages (TAMs) secrete IL-10 and TGF-β to suppress immune responses and release VEGF to promote vascular leakage [4], thereby enhancing tumor cell proliferation and metastasis. Caspase-1, by cleaving the PPARγ protein, induces TAM lipid metabolism reprogramming, exacerbating ascites formation.

3.2. Angiogenesis, lymphatic system, and inflammatory responses

3.2.1. Role of angiogenesis in the formation of peritoneal effusion

In the formation of malignant peritoneal effusion, angiogenesis is abnormally active. The newly formed tumor vessels are immature and have increased permeability, providing rich nutrient supply and oxygen support to tumor cells. Vascular endothelial growth factor (VEGF) promotes increased vascular permeability, extracellular matrix denaturation, vascular endothelial cell migration, proliferation, and angiogenesis. For instance, VEGF-A

upregulates vascular permeability, allowing plasma proteins to infiltrate into the abdominal cavity, while VEGF-C/D drives lymphatic hyperplasia, leading to lymphatic return dysfunction. ANGPT2 acts synergistically with VEGF to promote vascular leakage [5].

3.2.2. Lymphatic system dysfunction and peritoneal effusion

Under normal circumstances, the lymphatic system absorbs excess fluid and macromolecular substances, returning them to the blood circulation to prevent edema. In malignant peritoneal effusion, the lymphatic system function is often impaired, leading to fluid accumulation. Additionally, tumors can secrete certain factors that interfere with the normal function of the lymphatic system, further exacerbating the formation of peritoneal effusion.

3.2.3. Inflammatory responses and peritoneal effusion

Inflammation alters the tumor microenvironment (TME) through various mechanisms, affecting the production of cytokines and proinflammatory mediators, angiogenesis, and tissue remodeling, thereby participating in tumor development [6]. For example, inflammatory factors such as tumor necrosis factor-α (TNF-α) and interleukin-6 (IL-6) are elevated in malignant peritoneal effusion, closely related to its formation and progression.

4. Diagnostic methods for malignant peritoneal effusion in gastrointestinal cancer

4.1. Imaging examination

Computed tomography (CT) and positron emission tomography-computed tomography (PET-CT) can clearly show tumor lesions, the amount of effusion, and tumor metastasis in the abdominal cavity. Ultrasonography is economical, convenient, and noninvasive, making it a useful tool for initial screening. Additionally, ultrasound fusion techniques (such as US-CT/MRI), which combine real-time dynamic imaging with high-resolution tomography, can accurately locate peritoneal metastases. Enhanced magnetic resonance imaging (MRI) can detect small amounts of ascites (< 100 mL) and peritoneal thickening.

4.2. Cytological examination

Cytological examination is one of the gold standards for diagnosing malignant peritoneal effusion. It mainly includes abdominal paracentesis and cell smear examination. Furthermore, the examination of free cancer cells in the abdominal cavity and peritoneal lavage fluid can also improve diagnostic accuracy. However, cytological examination has low sensitivity, and multiple examinations may be required for some patients.

4.3. Biomarker detection

Biomarkers include tumor markers, inflammatory factors, and other related indicators. Serum tumor markers such as CEA, carbohydrate antigen 125 (CA125) [25], and carbohydrate antigen 19-9 (CA19-9) can suggest the possibility of tumor metastasis and peritoneal effusion. For example, elevated levels of CEA and CA19-9 in the serum of patients with colorectal cancer may indicate the presence of tumor metastasis and peritoneal effusion. Additionally, some emerging biomarkers, such as circulating tumor cells (CTC) and exosomes, have shown potential diagnostic value in research [7].

5. Treatment progress of malignant peritoneal effusion in gastrointestinal cancer

5.1. Systemic chemotherapy

Commonly used chemotherapy drugs include cisplatin, fluorouracil, oxaliplatin, and paclitaxel. Systemic chemotherapy can cover multiple tumor lesions in the body. However, it also has significant limitations, such as low drug concentration in the abdominal cavity, which makes it difficult to effectively control local lesions. Due to limitations in chemotherapy drug dosage and side effects, such as the peritoneal-plasma barrier, intravenous chemotherapy cannot effectively control the occurrence and progression of free cancer cells (FCC) in the abdominal cavity.

5.2. Paracentesis for ascites drainage and intraperitoneal drug administration

Paracentesis for ascites drainage is a commonly used method for treating malignant peritoneal effusion (MPE) with proven efficacy. However, simply draining the ascites can lead to its recurrence in a short period of time, and repeated drainage can cause hypoproteinemia, electrolyte imbalance, peritonitis, and hypovolemic shock in patients. Through technical improvements, paracentesis catheter drainage can achieve one-time puncture and multiple drainage of ascites, reducing patient discomfort and facilitating intraperitoneal drug administration for the treatment of MPE.

5.3. Hyperthermic Intraperitoneal Chemotherapy (HIPEC)

HIPEC can directly target intra-abdominal lesions while providing local chemotherapy, hyperthermia, and peritoneal lavage for residual tumor nodules, micrometastases, and free cancer cells. This technique has become a mature clinical application and has unique efficacy in preventing peritoneal metastasis and associated malignant peritoneal effusion in abdominal malignancies such as colorectal cancer, gastric cancer, liver cancer, and pancreatic cancer. A recent study has shown that HIPEC can significantly improve the median survival time in patients with terminal gastrointestinal tumors [8].

5.4. Targeted therapy and immunotherapy

Targeted therapy acts specifically on particular molecular targets on tumor cells, such as VEGF receptors and EGFR, enabling more precise inhibition of tumor growth and angiogenesis. Representative drugs include bevacizumab and cetuximab. For instance, the ToGA trial demonstrated that trastuzumab, as a first-line treatment, can improve survival rates in patients with advanced gastric cancer [9]. Immunotherapy, which activates the body's own immune system to fight cancer, has gained significant attention in recent years.

6. Factors influencing the prognosis of malignant peritoneal effusion in gastrointestinal tumors

6.1. Tumor-related factors

The type, stage, metastasis, and biological characteristics of the tumor cells significantly impact the prognosis. Generally, early-stage gastrointestinal tumors have a better prognosis if detected and treated effectively. However, advanced tumors, especially those with peritoneal metastasis, have a poorer prognosis.

6.2. Patient's general condition

Factors such as age, physical condition, nutritional status, and comorbidities also affect the prognosis. For example, patients with malnutrition or chronic diseases may have poor tolerance to treatment, thereby affecting the overall efficacy [10].

7. Palliative and supportive treatment for malignant peritoneal effusion in gastrointestinal tumors

7.1. Symptom control

For patients with malignant peritoneal effusion due to gastrointestinal tumors, symptom relief is a crucial aspect of palliative care. Currently, ascites drainage is the primary clinical method to control ascites, rapidly alleviating symptoms caused by ascites compression. For patients with significant pain, the appropriate use of analgesic drugs is essential. For some patients who cannot achieve symptom relief through medication or interventional therapy, palliative surgery (such as peritoneal drainage) can effectively reduce symptoms and improve quality of life.

7.2. Improvement of physical and mental conditions

For patients with ascites caused by hypoproteinemia, strict control of sodium and water intake is essential, along with planning a daily diet and intravenous infusion of albumin to increase plasma colloidal osmotic pressure. Additionally, psychological support, pain management, and rehabilitation exercises cannot be ignored. Patients with malignant intraperitoneal fluid often suffer from psychological issues such as anxiety and depression, making psychological intervention and social support crucial components of palliative care.

7.3. Multidisciplinary Treatment Model (MDT)

The Multidisciplinary Treatment Model (MDT) offers significant advantages in the palliative care of patients with advanced cancer. By integrating resources from various disciplines such as surgery, internal medicine, traditional Chinese medicine, and nursing, MDT provides individualized treatment plans for patients.

8. Conclusion

Malignant peritoneal effusion in gastrointestinal tumors is a severe complication in the late stages of the disease, significantly impacting patients' quality of life and survival prognosis. Although recent research has made progress in understanding its pathophysiology, diagnostic methods, and treatment strategies, leading to better diagnosis and treatment options, many challenges remain. In terms of diagnosis, there is a need to further improve accuracy and sensitivity. Regarding treatment, each approach has limitations, necessitating the exploration of more effective integrated treatment plans.

In the future, more intensive research should be conducted on the pathogenesis of malignant peritoneal effusion in gastrointestinal tumors to identify new therapeutic targets. Additionally, multi-center, large-sample clinical studies should be carried out to provide high-level, evidence-based medical evidence for various treatment methods and optimize treatment plans. Furthermore, with the development of precision medicine and artificial intelligence technology, personalized treatment is expected to be achieved, further improving patients' survival rates and quality of life.

Disclosure statement

The authors declare no conflict of interest.

References

[1] Cao C, 2016, Expression of miRNA-21 in Imatinib-Sensitive Gastrointestinal Stromal Tumors and Its Mechanism of Action Through B-lymphoma-2 Gene Locus, thesis, Southern Medical University.

[2] Wang Y, 2021, Analysis of the Optimal Population for the Treatment of Colon Cancer Ascites With Huachansu Injection and Its Mechanism of Action on VM, thesis, Beijing University of Chinese Medicine.

[3] Jin F, 2022, Research Progress on the Mechanism and Treatment of Peritoneal Metastasis in Epithelial Ovarian Cancer. Chongqing Medicine, 51(12): 2140–2144.

[4] Seimetz D, 2011, Novel Monoclonal Antibodies for Cancer Treatment: The Trifunctional Antibody Catumaxomab (Removab). J Cancer, 2: 309–316.

[5] Kim H, Yang Y, Byeon S, et al., 2021, E-Cadherin and Angiopoietin-2 as Potential Biomarkers for Colorectal Cancer With Peritoneal Carcinomatosis. Anticancer Res, 41(9): 4497–4504.

[6] Lasry A, Zinger A, Ben-Neriah Y, 2016, Inflammatory Networks Underlying Colorectal Cancer. Nat Immunol, 17(3): 230–240.

[7] Chinese Research Hospital Association Minimally Invasive Surgery Professional Committee, Laparoscopic Surgery Magazine Editorial Department, 2019, Expert Consensus on the Application of Circulating Tumor Cell Detection in Colorectal Cancer (2018). Journal of Laparoscopic Surgery, 24(1): 74–80.

[8] Yuan J, Luo W, Mo H, et al., 2024, Clinical Analysis of 189 Cases of Gastrointestinal Malignant Tumors Treated With Intraperitoneal Hyperthermic Chemotherapy. Chinese Journal of Modern Operative Surgery, 28(2): 85–90.

[9] Bang Y, Cutsem E, Feyereislova A, et al., 2010, Trastuzumab in Combination With Chemotherapy Versus Chemotherapy Alone for Treatment of HER2-Positive Advanced Gastric or Gastro-Oesophageal Junction Cancer (ToGA): A Phase 3, Open-Label, Randomised Controlled Trial. Lancet, 376(9742): 687–697.

[10] Cui J, 2019, Surgical Treatment and Prognostic Factors Analysis of Hepatolithiasis-Related Intrahepatic Cholangiocarcinoma, thesis, Chinese People's Liberation Army Military Medical University.