An unusual colo-ovarian fistula of advanced colorectal carcinoma: A case report and literature review

VALENTIN NICOLAE VARLAS[1,2] and AL-ALOUL ADNAN[3,4]

[1]Department of Obstetrics and Gynecology, Filantropia Clinical Hospital, 011132 Bucharest, Romania; [2]Department of Obstetrics and Gynecology, Faculty of Dentistry, 'Carol Davila' University of Medicine and Pharmacy, 010221 Bucharest, Romania; [3]Department of Visceral Surgery, Ramnicu Sarat Municipal Hospital, 125300 Buzau, Romania; [4]Department of General Surgery, Bioterra University, Faculty of Nursing, 013724 Bucharest, Romania

Received September 1, 2024; Accepted June 29, 2026

DOI: 10.3892/mco.2026.2975

Abstract. In colorectal cancer, the invasion of the colon is not unusual, but the perforation of all layers of the colon or rectum and the presentation of the patient with generalized peritonitis is rare. Colo-ovarian fistulas have as their starting point either in the sigmoid colon, rectum, appendix or, more frequently, as a benign or malignant ovarian tumor. The present study reports an extremely rare case of colorectal cancer with perforation at the rectosigmoid junction into a metastatic ovarian tumor. Intraoperatively, a colo-ovarian fistula with diffuse peritonitis was diagnosed. The treatment consisted of a hysterectomy with bilateral salpingo-oophorectomy, and the resection of the colo-ovarian fistula was performed using the Hartmann procedure. The prognosis was poor due to the advanced stage of colorectal cancer and complications from peritonitis. Due to the rarity of this pathology, an extensive electronic search and an analytical review of studies published in the PubMed and Web of Science databases was performed, identifying 21 eligible studies on malignant colo-ovarian fistula (11 cases due to advanced stages of primary ovarian cancer and 10 cases of malignant transformation of cystic teratoma) and no case in which the primary tumor was of colorectal origin. Based on the literature review, the current case report aimed to obtain and present a better understanding of the pathology, differential diagnosis, therapeutic strategy and prognosis of the condition.

Introduction

The fistula produced between the lower gastrointestinal tract and the ovary is an extremely rare condition, with few cases presented in the literature (1-20); therefore, there is no consensus regarding its diagnosis, therapeutic strategy and prognosis. The establishment of therapeutic management depends on the topography of the fistula, the benign or malignant nature of the tumor, the primary tumor (digestive or ovarian), the type and grade of the tumor, and the patient's age and comorbidities. Due to the rare occurrence of spontaneous colo-ovarian fistulas caused by malignant tumors, clinical and imaging findings [ultrasound (US), computed tomography (CT), magnetic resonance imaging (MRI), colonoscopy and barium enema] make it difficult to establish its existence preoperatively (15,21). The most frequent causes of the appearance of colo-ovarian fistulas are determined by the evolution of primary ovarian cancers or the malignant transformation of mature cystic teratomas (MCTs), with extremely rare cases being due to colorectal or appendicular cancer (12).

In the evolution of advanced stages of ovarian cancer [stages III-IV according to the International Federation of Gynecology and Obstetrics (FIGO) classification], either intestinal obstructive syndromes or, more rarely, fistulas between the ovary and adjacent structures can be observed (22). In a number of cases, the poor prognosis of ovarian cancer is due to late detection in advanced stages in the absence of symptoms, with the invasion of the muscular serous layer of the colon by extrinsic tumor compression (8,13).

Colorectal cancer can be complicated by spontaneous perforation in advanced stages in ~12% of cases, with fistulization being found in 20% of cases in sigmoid colon cancer secondary to local necrosis after chronic inflammatory processes (23).

There is no known data on the incidence of spontaneous colo-ovarian perforations in the case of malignant tumors, with a reported incidence of 0.7% due to benign ovarian cystic tumors or 1-2% due to malignant transformation of MCTs (9,24). Patients may be asymptomatic and may experience bleeding or obstructive episodes depending on the topography of the fistula and the organ involved. The pathogenesis of the fistula formation is based on the local inflammatory process of the intestinal wall and the tumor invasion adjacent to the organ. Histologically, features of the fistulas, including necrotic,

Correspondence to: Dr Al-Aloul Adnan, Department of Visceral Surgery, Ramnicu Sarat Municipal Hospital, 2 Nicolae Bălcescu Street, 125300 Buzau, Romania
E-mail: adnanalaloul@yahoo.com

Key words: colo-ovarian fistula, colorectal cancer, ovarian metastatic tumor

ulcerative, malignant infiltrative and chronic inflammatory areas, can be observed (21).

The current study aims to present the extremely rare case of a patient with high-grade mucinous colorectal carcinoma with perforation at the level of the rectosigmoid junction into the metastatic ovarian tumor and to review the literature related to cases with colo-ovarian fistulas caused by the evolution of colorectal tumors, ovarian cancer or malignant transformed MCTs.

Case report

Patient. A 68-year-old woman presented to the Emergency Department, at Ramnicu Sarat Municipal Hospital (Buzau, Romania) in May 2024 with abdominal pain that had started suddenly 10 days ago and had increased in intensity and become sharp in the last 3 days. This pain was associated with vomiting, nausea, constipation and loss of appetite. The patient had known for 2 years about a right ovarian tumor with no suspicious ultrasound characteristics, but at that time, had refused further investigations and surgery, as well as neglecting the recommended periodic monitoring. According to the patient's medical history, the patient was undergoing antihypertensive treatment.

In April 2024, at the same hospital, the patient underwent a colonoscopy, which, upon withdrawal of the colonoscope, revealed a sessile polyp with modified mucosa, ~1.5 cm in size, located 8 cm from the anal orifice. Furthermore, a 2-cm exulcerated, vegetative tumor formation was visualized 7 cm from the anal orifice, bleeding when touched with the colonoscope. At the beginning of May 2024, MRI of the pelvis with contrast medium revealed a formation with polycyclic contour, heterogeneous structure, and areas of necrosis and hemorrhage, with maximum axial diameters of 100/96 mm and cranio-caudal diameters of 90 mm, with apparent origin at the level of the right ovarian lodge. The structure had a multicystic appearance, delimited by irregular walls, with solid nodules and hemorrhagic areas with horizontal level included. The mass described covered adjacent intestinal loops, with infiltration of their walls and the associated mesentery. It was closely adjacent to the urinary bladder, raising the suspicion of invasion of the right half of the posterior wall. The mass also involved the distal sigmoid colon and rectosigmoid junction, with evidence of mural invasion. The appearance was suggestive of a pelvic tumor block with apparent origin at the level of the right ovary, with bladder, enteral and colonic invasion. A right external iliac adenopathy with a diameter of 12 mm was also noted.

Upon the current admission, at the clinical examination, the patient presented with tachycardia and hypotension; the abdomen was distended, diffusely tender, and had a palpable mass in the lower region up to the umbilicus. Rectal and vaginal examinations revealed fingertip tenderness. Blood tests revealed the following results: Hemoglobin, 10.2 g/dl (normal range, 11.7-16.1 g/dl); white blood cells, $18x10^3$ μl (normal range, 4-$10x10^3$ μl); 90% neutrophils (normal range, 45-80%); and platelets, $160x10^3$ μl (normal range, 150-$450x10^3$ μl). Further results included the following: Oxygen saturation, 90% (room air); creatinine, 2.1 mg/dl (normal range, 0.55-1.02 mg/dl); blood-urea-nitrogen, 102 mg/dl (normal range, 6-24 mg/dl); random blood sugar, 119 mg/dl (normal range, 80-130 mg/dl); C-reactive protein, 62 mg/dl (normal value, <0.5 mg/dl); and negative blood cultures. No specific changes were observed in the electrocardiography.

The preoperative abdominal US showed a tumor mass with a complex echoic structure measuring 17x14 cm in the lower abdomen, with a small amount of fluid in the pouch of Douglas (Fig. 1A). The CT scan without contrast revealed a pelvic tumor mass involving the sigmoid colon loop, an ovarian tumor, ascites and multiple gas foci, indicating a possible fistula between the two adjacent structures (Fig. 1B and C). Furthermore, the axial CT examination highlighted the presence of an intrauterine device (IUD) (Fig. 1D).

Informed consent for investigations and treatment was obtained from the patient at admission. After the preoperative preparation of the patient, an emergency median laparotomy under general anesthesia was performed.

Intraoperative abdominal cavity inspection revealed ~400 ml of cloudy free fluid, a retro-uterine pelvic abscess towards the right iliac fossa, a right giant ovarian tumor attached to the rectosigmoid junction with perforation at its level, and intimate adherent to the small intestines, the apex of the appendix and the bladder (Fig. 2A-C). Macroscopic examination of the surgical specimen identified the fistulous tract on the resected rectosigmoid with an area of adjacent ovarian tissue (Fig. 2D).

A sample of peritoneal fluid was collected for culture and cytological examination. Further surgical procedures performed on the patient included a total hysterectomy with bilateral adnexectomy, appendectomy, omentectomy, rectosigmoid junction resection with the Hartmann procedure, partial cystectomy and intraperitoneal drainage.

Postoperatively, the patient was admitted to the Intensive Care Unit for 5 days and received intravenous broad-spectrum antibiotics consisting of meropenem at a dose of 1 g every 8 h and metronidazole at a dose of 500 mg every 8 h for 5 days to control intra-abdominal sepsis. After 17 days, the patient was discharged with a colostomy and urinary catheter for 6 weeks. In the current case, intraperitoneal hyperthermic chemotherapy was not performed as the infusion machine was not available.

The histopathological aspect of the examined sections suggested a mucinous-type malignant tumor proliferation. Surgical specimens were fixed in 10% neutral buffered formalin (~4% formaldehyde) at room temperature (20-25˚C) for 24 h, processed routinely and embedded in paraffin. Next, 3-4-μm thick sections were prepared and stained at room temperature with hematoxylin for 5 min, followed by eosin-ethanol for 2 min. Slides were examined using an Olympus BX43 optical microscope (Olympus Corporation) at original magnifications of x100, x200 and x400. The corresponding magnification and scale bar are provided in the legend of each figure. To accurately establish the tumor histotype (primary tumor of the digestive tract, appendix or rectum, or primary ovarian tumor), immunohistochemistry tests were required, which highlighted the diagnosis of high-grade carcinoma with 'signet ring' cells of digestive origin (Fig. 3A-F).

The immunohistochemical result revealed that the tumor tissue was positive for cytokeratin 20 (CK20), homeobox protein CDX-2 (CDX2) and CK7, and negative for special AT-rich sequence-binding protein-2 (SATB2) and paired

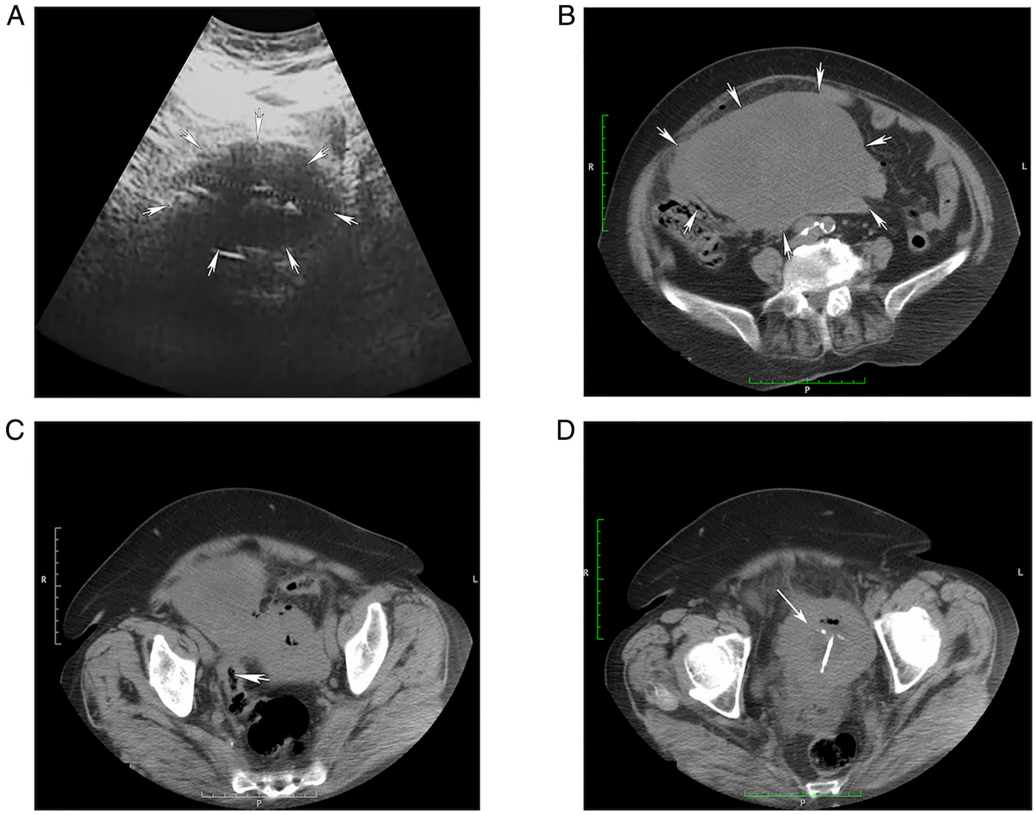

Figure 1. Preoperative imagistic findings. (A) Ultrasound showing a cystic mass with a complex echoic structure. (B) Axial CT image in the soft-tissue window showing a homogeneous pelvic mass (white arrows). (C) CT scan revealing a loop of sigmoid colon forming a common body with the ovarian tumor and multiple foci of gas, indicating a possible fistulous path between the two adjacent structures (white arrow). (D) CT evaluation revealing the intrauterine presence of an intrauterine device (white arrow). CT, computed tomography.

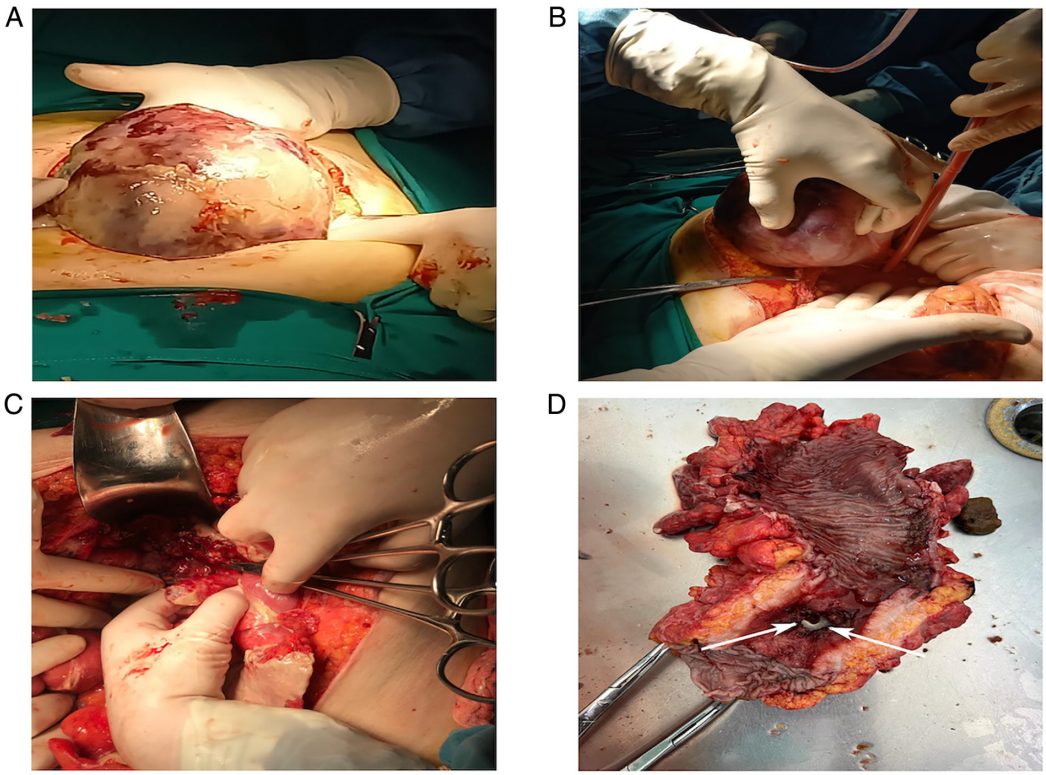

Figure 2. Surgical findings. (A) Intraoperative giant right ovarian tumor. (B) Aspiration of cloudy free liquid from the peritoneal cavity near the perforation. (C) The site of the perforation, including the appendix with false membranes with detritus on the serosa of the intestinal loops in the immediate vicinity. (D) Gross postoperative appearance of the resected specimen showing the ovarian metastatic mass involving the rectosigmoid junction. The arrows indicate the margins of the fistulous opening.

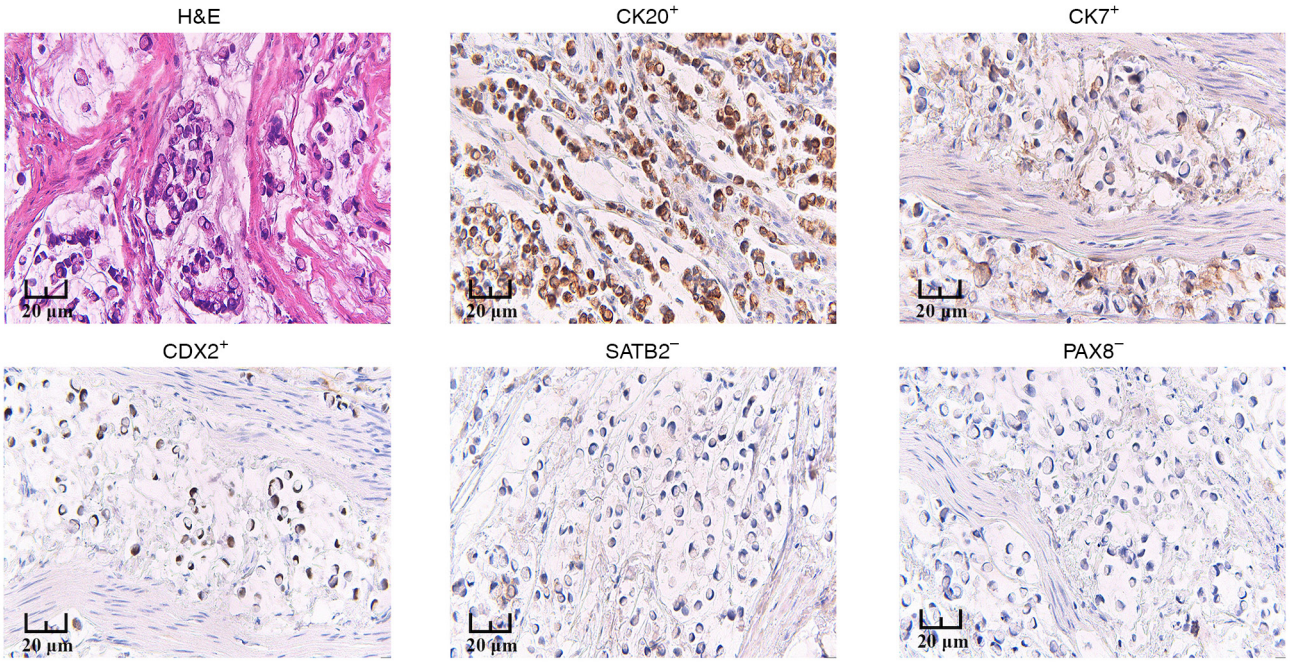

Figure 3. H&E and immunohistochemical staining. The histological and immunohistochemical examination showed that the tumor confirmed the diagnosis of carcinoma, with 'signet ring' cells of digestive origin (H&E staining, x400 magnification), positive diffuse cytoplasmic and membranous CK20 staining (x400 magnification), isolated cytoplasmic and membrane positive CK7 staining in rare tumor cells (x400 magnification), diffuse nuclear positive CDX2 staining (x400 magnification), and a lack of SATB2 (x400 magnification) and PAX8 (x400 magnification) staining in the tumor cells. H&E, hematoxylin and eosin; CK, cytokeratin; CDX2, homeobox protein CDX-2; SATB2, special AT-rich sequence-binding protein-2; PAX8, paired box protein Pax-8.

box protein Pax-8 (PAX8), which established the colorectal origin of the tumor. The samples were fixed in 10% neutral buffered formalin at room temperature for 40 min, followed by dehydration and routine cleaning before inclusion in paraffin. The tissue blocks were sectioned at a thickness of 4 μm and mounted on glass slides. The antibodies used and their specifications are presented in Table I. After incubation with primary antibodies, the sections were treated with antibody detection systems. All sections were examined under an Olympus BX43 light microscope (Olympus Corporation) at a total magnification of x100, x200 and x400, as appropriate.

Histological examination of the colonic wall fragments revealed infiltrative tumor proliferation involving the full thickness of the wall, and extending to the serosa. Extracellular mucin pools occupied ~70% of the tumor area in the examined fragment. Within these mucin pools, the tumor cells were arranged in islands and cords or dispersed individually. The cells were small and round to polygonal, exhibiting 'signet ring' morphology and marked pleomorphism. They contained clear intracytoplasmic vacuoles and eccentrically located hyperchromatic nuclei. Numerous typical and atypical mitotic figures were identified. Only small, focal areas showed a desmoplastic stromal reaction, accompanied by a sparse chronic inflammatory infiltrate. Lymphovascular and perineural invasion were present (Fig. 4A-E).

At 2 months post-surgery, the patient presented to the Emergency Room at Ramnicu Sarat Municipal Hospital with nausea, vomiting and suspicion of an intestinal obstruction. MRI examination of the abdomen and pelvis with intravenous contrast revealed dilated bowel loops, suspected carcinomatosis and a small amount of intraperitoneal free fluid (Fig. 5). The CA125 level was 645 IU/ml (reference range, 0-35 U/ml), the CEA level was 4 ng/ml (reference range, 0-5 ng/ml) and the CA19-9 level was 26 U/ml (reference range, 0-37 U/ml). On the same day, an emergency laparotomy was performed, which revealed a frozen pelvis and diffused peritoneal carcinomatosis over the intestine, colon, spleen, liver and diaphragm. Intraoperatively, the intestine could not be released from the pelvis, requiring an ileostomy as a palliative procedure.

The patient was discharged with an improved condition. Due to the advanced stage of colorectal cancer and the unfavorable evolution in a short time, it was determined that the patient would not benefit from palliative chemotherapy. A total of 10 days after surgery, the patient's condition quickly deteriorated and they succumbed to their condition.

Immunohistochemical analysis

Tissue preparation and antigen retrieval. Tissue microarray sections were cut at a thickness of 4 μm, mounted onto glass slides, and incubated in an oven for 1 h. Target retrieval was performed using the PT-Link automated system (Dako; Agilent Technologies, Inc.) at a high pH. The slides were incubated at 97˚C for 30 min. Once the temperature cooled to 65˚C, the slides were removed, immersed in a wash buffer for 10 min, and allowed to equilibrate to ambient room temperature.

Staining, detection systems and antibody incubation. Endogenous peroxidase activity was blocked by treating the sections with a blocking peroxidase solution for 5 min, followed by three sequential rinses in wash buffer. The primary antibodies (CK7, CK20, CDX2, SATB2, or PAX8), all in ready-to-use formats, were applied to the sections and incubated for 20 min. Following three successive washes in wash buffer, target visualization was achieved using automated secondary detection systems matched by

Table I. Technical specifications of the antibodies and detection systems utilized.

Antibody	Clone	Dilution	Pretreatment	Manufacturer	Secondary Detection System	External/ Internal Control
CK7	OV-TL 12/30	RtU	Dako PT Link	Bio SB, Inc.	Bio SB Poly Detector HRP	Lung or breast carcinoma tissue
CK20	EP23/Ks20.8	RtU	Dako PT Link	Bio SB, Inc.	Bio SB Poly Detector HRP	Colorectal adenocarcinoma tissue
CDX2	DAK-CDX2	RtU	Dako PT Link	Dako; Agilent Technologies, Inc.	Dako EnVision FLEX HRP	Duodenal epithelium/ Colon tissue
SATB2	EP281	RtU	Dako PT Link	Bio SB, Inc.	Bio SB Poly Detector HRP	Appendix or colorectal tissue
PAX8	ZR-1	RtU	Dako PT Link	Bio SB, Inc.	Bio SB Poly Detector HRP	Thyroid or ovarian tissue

CK, cytokeratin; CDX2, caudal type homeobox 2; SATB2, special AT-rich sequence-binding protein 2; PAX8, paired box 8; RtU, ready-to-use; HRP, horseradish Peroxidase.

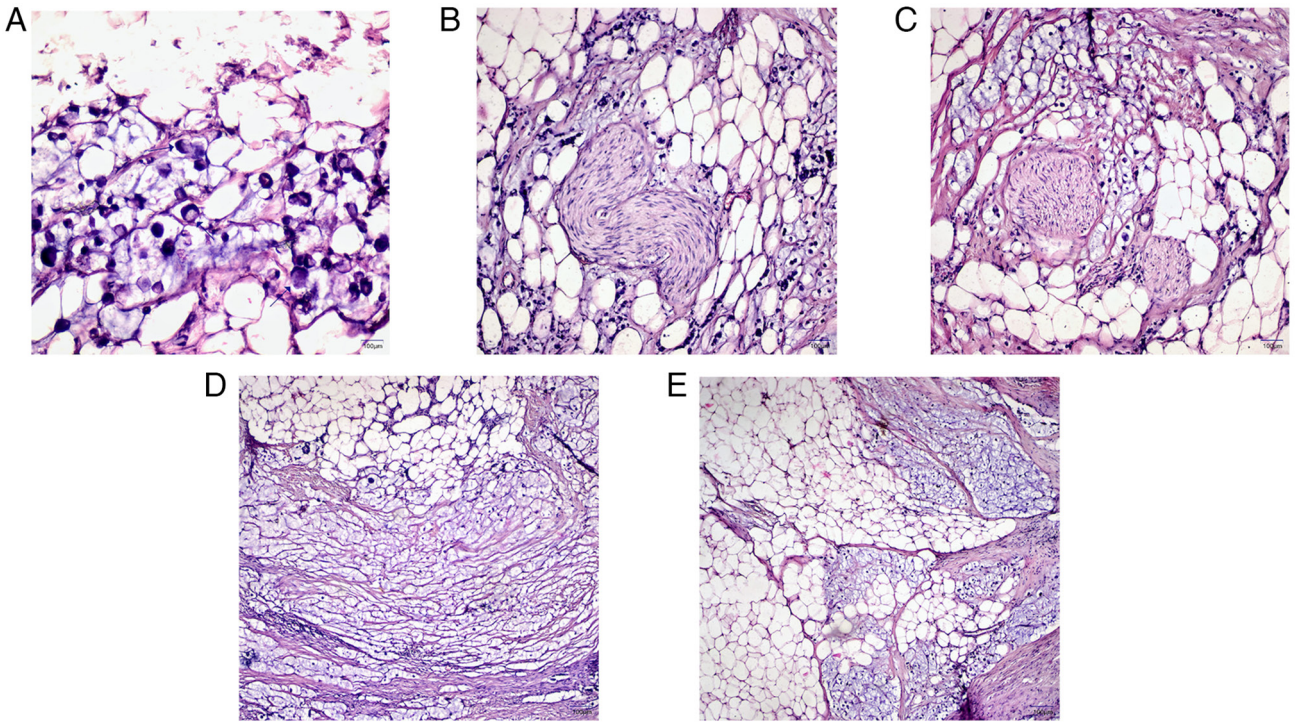

Figure 4. Histological findings. (A) 'Signet ring' cells (H&E; x400 magnification). (B) Perineural invasion and pericolonic adipose tissue (H&E; x200 magnification). (C) Perineural invasion (H&E; x200 magnification). (D) Extracellular mucus lakes, tumor cells floating in mucus lakes and discrete desmoplastic reaction (H&E; x100 magnification). (E) Invasion of pericolonic adipose tissue (H&E; x100 magnification).

manufacturer specification. For the Dako primary antibody (CDX2), the Dako EnVision FLEX HRP polymer detection system (Dako; Agilent Technologies, Inc.) was applied. For the Bio SB primary antibodies (CK7, CK20, SATB2 and PAX8), the micro-polymer-based Bio SB PolyDetector HRP detection system (Bio SB, Inc.) was utilized. Sections were incubated with the respective horseradish peroxidase polymer for 20 min. After another 20-min interval and three additional washes in wash buffer, the signal was developed by incubating the slides with 3,3'-diaminobenzidine substrate for 5 min. The slides were then rinsed three times in wash buffer.

Counterstaining and examination. The sections were counterstained with hematoxylin for 1 min. Dehydration was carried out through systematic immersion in a graded alcohol series, ranging from 96 to 100% alcohol. Finally, the slides were cleared with three changes of xylene, loaded into an automated glass coverslipper and prepared for optical microscopy. Within the panel, CK7 and CK20 served as cytoplasmic markers to evaluate specific epithelial lineages, CDX2 and

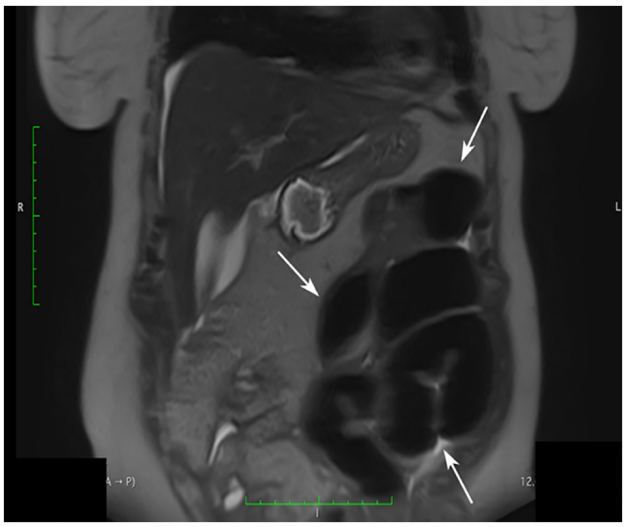

Figure 5. Follow-up abdominal and pelvic MRI showing suspected bowel obstruction. Subsequent abdominal and pelvic coronal magnetic imaging 2 months after the first operation identified the presence of dilated bowel loops on the left side of the abdomen, highlighting a possible obstruction (white arrows).

SATB2 served as nuclear markers to identify gastrointestinal and colorectal differentiation, and PAX8 was used as a nuclear marker to delineate Müllerian lineages.

Discussion

In patients with advanced stages of colorectal or ovarian cancer, intestinal obstructive syndromes may occur more frequently, with fistulas rarely occurring between the ovary and adjacent structures (14). Colonic fistulas of malignant origin are also rare and are reported most frequently in association with the bladder (colo-vesical) (25), vagina (colo-vaginal) (26), uterus (colo-uterine) (27), small intestine (colo-enteral) (28) and skin (colo-cutaneous) (29), but rarely with the ovary (colo-ovarian) (30).

Due to the rarity of this pathology, an electronic search from inception was performed in the PubMed (https://pubmed.ncbi.nlm.nih.gov) and Web of Science (https://webofscience.com/wos/woscc) databases, regardless of language. The key medical subject heading terms used in the electronic search technique were 'colo-ovarian fistula', 'colorectal carcinoma', 'ovarian carcinoma' and 'malignant cystic teratoma'. As a result, 20 studies were identified that presented 21 cases of colo-ovarian fistula occurrence as a complication of malignancy, of which 10 cases were reported as the consequence of the evolution of advanced stages of ovarian cancer (11-20), 10 cases were reported with malignant transformation of MCT (1-10) and 1 case was reported with uncertain localization (colorectal or ovarian) (31), with no cases of certain colorectal origin. According to histopathological analysis, the distribution of the 11 cases with primary ovarian cancer was as follows: 5 cases with serous cystadenocarcinoma (11,12,16,18,20), 1 case with mucinous cystadenocarcinoma (14), 1 case with a mixed germ cell tumor (13), 1 case with serous cystadenoma of low malignant potential (13), 2 cases with clear cell adenocarcinoma (15,17) and 1 case with squamous cell carcinoma (19) (Table II).

Previous reports documenting the evolution of advanced colorectal cancer to a large bowel fistula with the involvement of a metastatic ovarian tumor are extremely rare. In this context, the present study reports a specific case of colorectal mucinous adenocarcinoma perforating a metastatic ovarian tumor at the level of the rectosigmoid junction. In addition, it is worth noting that fistulas in the recto-sigmoid region can also be more frequently associated with benign ovarian tumors, predominantly teratomas (32,33).

The clinical manifestation of ovarian or colorectal cancer is polymorphic, with the majority of patients being asymptomatic, but with others presenting with gastrointestinal symptoms (vomiting, nausea, constipation, diarrhea, bloating, early satiety and rectal bleeding), urinary frequency, abdominal or pelvic discomfort, abdominal pain and an abdominal mass (9). Patients may also exhibit pleural effusion or bowel occlusion syndrome in advanced stages. Full-thickness extension into the bowel mucosa, resulting in fistula formation, is an exceedingly rare event (34).

MCTs can undergo a malignant transformation in 1-2% of cases, most frequently in menopausal patients in the fifth and sixth decades of life, with the histopathological forms encountered being small-cell carcinoma and adenocarcinoma (mucinous with a poor prognosis) (9,35,36). From the review of the literature, clear differences were observed in terms of mean age between the group with MCTs, at 66.9 years (range, 48-90 years) and the group with ovarian carcinomas, at 58.5 years (range, 27-77 years). No differences were observed in terms of the mean maximum diameter of the ovarian tumor in the group with MCTs (14.4 cm) and that of the group with ovarian carcinomas (15.1 cm), with this parameter being independent regarding the prognosis of these patients.

The mechanism of fistula formation in an MCT is initiated by the chronic inflammatory reaction of its contents to the adjacent organs. Furthermore, sepsis, torsion or vascular changes favor the breakthrough of the cyst into the peritoneal cavity, and malignant transformation of MCT is not a determining factor (33,37).

In ovarian cancer, the appearance of a primary fistula is due to the progression of the implants on the ovarian serosa, and the size and the stage of the tumor, unlike the appearance of a secondary fistula, which appears as a late complication after surgery or after chemotherapy and radiotherapy (4,38). In advanced stages of ovarian cancer, fistula formation may result from direct malignant invasion of adjacent structures. Tumor spread usually occurs by contiguous extension, initially involving the colonic seroasa and muscularis propria, while mucosal infiltration and full-thickness bowel perforation are extremely rare. Another possible cause of fistulization can be the evolution of inflammatory phenomena from endometriosis (17).

A peculiarity in the present case is the presence of an IUD discovered on the CT scan years after the onset of menopause. It is well known that using an IUD for long periods can lead to pelvic actinomycosis, a granulomatous disease that can cause a chronic inflammatory process with the formation of granulation tissue, fibrous tissue, necrosis and abscesses. The diagnosis of this pathology is a challenge due to the non-specific clinical manifestations, being characterized by nausea, vomiting, weight loss, transit disorders, fever, or

Table II. Synopsis of literature studies regarding the differential diagnosis and therapeutic management of colo-ovarian fistulas in patients with colorectal carcinomas, primary ovarian carcinomas or malignant transformation of MCTs.

A, Colo-ovarian fistula in malignant transformation of MCTs

First author, year	Age, years	Clinical findings	Imaging technique	Tumor size, cm	CA125/ CA19-9, UI/l	Surgical procedure	Tumor histology	Site of the fistula	Follow-up/ prognosis	(Refs.)
Figiel, 1966	57	Abdominal pain, fever, vomiting	Abdominal X-ray	18	-	Resection of the mass and fistula, with the sigmoidal end closed	MCT with G2 SqCC	Sigmoid	N/A	(1)
Jewel, 1977	50	-	N/A	-	-	Resection of the mass, left transverse colostomy	MCT	Recto-sigmoid jonction	Died 2 months later	(2)
Mitui, 1983	72	Diarrhea containing hair	Barium enema, colonoscopy	8	-	Resection of the mass, procto-sigmoidectomy, end-to-end anastomosis of the ileum, colostomy	MCT with SqCC	Ileo-sigmoid	Adjuvant chemotherapy; died 7 months later	(3)
Okada, 2005	54	Abdominal pain and watery diarrhea	Abdominal X-ray, CT	N/A	-	N/A	Dermoid cyst with SqCC in the cyst wall	Small bowel	Chemotherapy; died of peritoneal metastases 10 months after surgery	(4)
Chong, 2011	85	Fever, weight loss, severe abdominal distension, pain, constipation	Abdominal X-ray, CE-CT	N/A	-	En bloc resection of the lesion with the colonic segment, colostomy	Poorly differentiated SqCC, arising from MCT	Sigmoid, descending colon	Died 4 months after surgery	(5)
Song 2012	73	Abdominal pain, constipation	CT	24	-	Resection of the mass, fistula and small bowel	Well-differentiated SqCC arise from MCT	Small bowel	No evidence of disease 7 months after surgery	(6)

Table II. Continued.

A, Colo-ovarian fistula in malignant transformation of MCTs

First author, year	Age, years	Clinical findings	Imaging technique	Tumor size, cm	CA125/ CA19-9, UI/l	Surgical procedure	Tumor histology	Site of the fistula	Follow-up/ prognosis	(Refs.)
Yarmohammadi, 2014	48	Nausea, small bowel obstruction, ascites, diarrhea, vomiting, abdominal mass	CE-CT	10.3	Mildly elevate	Hysterectomy left pelvic lymph node dissection, left periaortic lymph node dissection, omentectomy	G3 MCT with malignant adenocarcinoma component, SqCC, FIGO IIIC stage	Small bowel	-	(7)
Ilyas, 2018	81	Abdominal distension, constipation, nausea, vomiting, weight loss	CE-CT, MRI	7.5	Normal range	En bloc resection of the mass with ileocolectomy	Moderately differentiated keratinizing SqCC arising within MCT, FIGO IVB stage	Cecum	N/A	(8)
Esterson, 2019	59	Abdominal mass	US, CT	21	-	Hysterectomy, bilateral salpingo-oophorectomy, omentectomy, primary small bowel reanastomosis	G3 squamous cell carcinoma arising in an MCT	Ileum	N/A	(9)
Accardo, 2022	90	Fever, severe abdominal pain, nausea,	CT	12	-	En bloc, cyst excision with left colon (Hartmann procedure), left salpingo-oophorectomy	MCT infiltrating a sigmoid with stage I primitive large B-cell lymphoma	Sigmoid colon	Favorable	(10)

Table II. Continued.

B, Colo-ovarian fistula in primary ovarian carcinomas

First author, year	Age, years	Clinical findings	Imaging technique	Tumor size, cm	CA125/ CA19-9, UI/l	Surgical procedure	Tumor histology	Site of the fistula	Follow-up/ prognosis	(Refs.)
Honda, 1990	62	Abdominal discomfort, weight loss	Double-contrast barium enema	10	-	Mass excision and wedge resection	Cystadeno carcinoma	Sigmoid	Favorable	(11)
Skipper, 1994	57	Anorexia, abdominal pain and distension	CT	N/A	-	Subtotal colectomy, bilateral ovarian cystectomy, pelvic close of the rectal stump, right iliac fossa terminal ileostomy	Papillary cystadeno-carcinoma	Sigmoid	Died 10 days after surgery	(12)
Imamura, 1997	27	Abdominal pain and distension, nausea	Abdominal X-ray, US, CT	N/A	CA125-180	Left salpingo-oophorectomy, partial colectomy, followed by primary anastomosis	Mixed germ cell tumor, FIGO stage IIIc (pT3c-NxMo)	Transverse colon	Adjuvant chemotherapy, died 11 months after the initial surgery	(13)
	56	Abdominal pain	N/A	20-30	-	Right salpingo-oophorectomy, rectal defect repair, resection of the transverse colon	Serous cysta-denoma of low malignant potential	Rectum	Chemotherapy, favorable follow-up at 2 years	
Jeon, 1999	57	Abdominal pain and constipation	Barium enema, CT	13	CA125-1512	En bloc resection of the mass and fistula tract, colorectal anastomosis, ileocolostomy	Ovarian transi-tional cell carcinoma with mucinous differen-tiation	Fistula tract between recto-sigmoid colon and terminal ileum	Uneventful recovery	(14)
Kim, 1999	61	Abdominal discomfort, fatigue, a total weight loss of 6 kg over several months	Barium enema, CT	14	CA125-4719	Tumor resection, partial resection of the ileum and uterus, sigmoidectomy	Clear-cell carcinoma	Ileum, sigmoid	Recurrence with peritonitis. Carcinoma-tosis at 14 months	(15)

Table II. Continued.

B, Colo-ovarian fistula in primary ovarian carcinomas

First author, year	Age, years	Clinical findings	Imaging technique	Tumor size, cm	CA125/ CA19-9, UI/l	Surgical procedure	Tumor histology	Site of the fistula	Follow-up/ prognosis	(Refs.)
Bats, 2010	62	Lower abdominal pain, loss of appetite, vomiting, diarrhea	US, CT, MRI	9	CA125-615	En bloc resection of the mass, uterus, adnexa, rectosigmoid, peritoneal washings, small bowel resection, infracolic omentectomy, colostomy, appendicectomy	High-grade serous ovarian carcinoma, FIGO stage IIB	Recto-sigmoid colon	Died 2 weeks later from pneumonia	(16)
Yahagi, 2011	61	Abdominal mass and distension, anemia, bloody bowel discharge	CT	26	CA125-39.5/ CA19-9-553	Left salpingo-oophorectomy, sigmoidectomy	Clear-cell carcinoma	Small intestine, sigmoid	Follow-up 10 months	(17)
Shai, 2013	57	Fever, lower abdominal pain	US, CT	14	CA125-1073	Hysterectomy, bilateral salpingo-oophorectomy, omentectomy, conservative management for an entero-adnexal fistula	Adeno-carcinoma	Small bowel	Initial chemo-therapy, free of disease at 9 months after surgery	(18)
Min, 2015	67	Hematochezia, tenderness in the left lower quadrant	CT, colonoscopy	9.8	-	En bloc resection of the sigmoid colon and left ovary	Well-differen-tiated SqCC	Sigmoid	Chemotherapy, radiotherapy. Died a year and a half after surgery	(19)
Srinivas, 2017	77	Asymptomatic	CT, PET-CT	-	Rising CA125	Segmental resection of the colon	Adeno-carcinoma	Splenic flexure of the colon	-	(20)

Table II. Continued.

C, Colo-ovarian fistula in colorectal carcinomas

First author, year	Age, years	Clinical findings	Imaging technique	Tumor size, cm	CA125/ CA19-9, UI/l	Surgical procedure	Tumor histology	Site of the fistula	Follow-up/ prognosis	(Refs.)
Present case	68	Abdominal pain, nausea, vomiting, loss of appetite, constipation	US, CT, MRI	17	CA125-645	Hysterectomy, bilateral salpingo-oophorectomy, appendectomy, omentectomy, recto-sigmoid junction resection (Hartmann procedure), partial cystectomy	High-grade colorectal carcinoma	Recto-sigmoid jonction	Uneventful recovery for 2 months; after that developed an occlusive syndrome (ileostomy), the patient dying after 10 days	-

CE-CT, contrast-enhanced computed tomography; MRI, magnetic resonance imaging; US, ultrasonography; PET-CT, positron emission tomography-computed tomography; MCT, mature cystic teratoma; SqCC, squamous cell carcinoma; FIGO, International Federation of Gynecology and Obstetrics.

imaging identification of a tumor mass or fistula. Thus, in many cases, it easily mimics a colonic neoplasia. Cultures are usually negative, and the histopathological diagnosis is performed by identifying actinomycotic structures (39).

In patients with ovarian cancer experiencing sepsis and an acute abdomen, it is crucial to consider the possibility of recto-sigmoid colon perforation. A quick diagnosis and emergency surgical intervention are important in managing this condition. US examination may yield inconclusive results due to the presence of gaseous interposition. Therefore, a pelvic CT scan assumes paramount importance, revealing the presence of air within the adnexal mass. The imaging diagnosis of the fistula can identify either an extravasation of barium on the X-ray examination or the presence of gas bubbles at the tumor level on the CT scan. A colonoscopy can identify the area of interest that can be biopsied on direct inspection. The presence of the fistula cannot specify the diagnosis of the primary tumor, this being all the more difficult to achieve when an ovarian mass is evident on imaging (21).

Achieving an early diagnosis of the perforation followed by urgent surgical intervention is also important for the patient's prognosis. The X-ray examination of the abdomen can highlight a possible air collection in ~50% of cases, and as a result, it has been gradually replaced by CT evaluations. Routine US cannot achieve a correct imaging assessment of the case regarding perforation, but it can evaluate ovarian/colorectal tumor formation. CT, contrast enhanced CT and MRI increase the detection rate of fistulas, and evaluate the ovarian/colorectal tumor and the preoperative and postoperative imaging balance (15). Colonoscopy is used only in selected cases, as it usually does not provide data on the presence of fistulas, a possible alternative that is provided by 3.0-Tesla MR colonography (40).

Establishing the origin of the primary tumor is important regarding therapeutic management. The initial differentiation is essential between ovarian and digestive tumors and later between colorectal and appendicular tumors if these tissues have a degree of infiltration. Sometimes, it is difficult to make the differential diagnosis between ovarian and colon carcinomas, especially in advanced stages with peritoneal carcinomatosis or metastatic disease.

At presentation in the current study, serum CA125, CA19-9 and CEA levels were measured as part of a targeted diagnostic evaluation. This combination is not routinely required for all adnexal masses: CA125 is generally the principal initial serum marker, whereas CA19-9 and CEA are added selectively when a mucinous ovarian neoplasm or gastrointestinal origin is suspected. Later, performing immunohistochemical staining with CK7, CK20, CDX2, SATB2 and PAX-8 allowed the differentiation of the primary ovarian origin from that of a tumor of the lower intestinal tract.

To distinguish between a primary ovarian carcinoma and a metastatic colorectal carcinoma of the ovary, the CK7 marker is used (41). CK7 is positive in 96% of ovarian adenocarcinomas and 25% of ovarian metastases of colorectal cancer, especially high-grade tumors and those located on the right side (42). CK7+ colorectal tumors have a negative prognosis, with a lower survival rate compared to CK7-tumors, regardless of tumor location, grade or stage (43), as in the case of the present patient. Meagher *et al* (44) revealed use of a

new marker SATB2, which, together with CK7, completes the immunohistochemical profile of primary mucinous ovarian tumors ($CK7^+/CK20^-/PAX8^+/SATB2^-$) of colorectal carcinomas, to improve the prognosis and ensure a correct chemotherapy scheme (Table III).

The differentiation between colorectal and appendicular origin is difficult, this being based less on the evaluation of the operative specimen and more on next-generation sequencing of the APC gene mutations that are more frequent in colorectal cancer and the activation of KRAS-mediated signaling pathways and GNAS in appendiceal cancer (45).

The differential diagnosis of suspected colo-ovarian fistula when CT reveals a gas-containing adnexal mass includes tubo-ovarian abscess, infected or fistulizing ovarian neoplasm, and colo-vesical or colo-uterine fistula. Sigmoid volvulus, Meckel's diverticulum and enteric duplication cysts are considered more accurate radiological mimics of a gas-containing abdominal or pelvic lesion than direct differential diagnoses of a confirmed colo-ovarian fistula (11,46). Therapeutic approaches may vary depending on the patient's condition. Conservative measures such as fasting, intravenous fluids and antibiotics may be successful. Alternatively, direct surgical drainage of the abscess or ultrasound/CT-guided percutaneous drainage may be considered temporarily (47). However, a surgical approach remains the preferred choice, allowing for both fistula treatment and maximal tumor cytoreduction (16). This may involve en bloc resection of the tumor, uterus, ovaries, fallopian tubes and perforated rectosigmoid colon, with the possibility of primary colorectal anastomosis, with or without a protective stoma (colostomy) or a Hartmann procedure, depending on the location of the colorectal perforation (48). In the review of the literature, it was identified that conservative treatment of the fistula was carried out in only 1 case (18), with the rest being solved surgically.

The goal of surgery for colorectal cancer complicated by a colo-ovarian fistula is complete en bloc oncological resection of the primary tumor and all directly involved adjacent structures. In the present case, Hartmann's procedure was selected to achieve tumor resection and adequate source control while avoiding a high-risk primary anastomosis. A complete margin-negative (R0) resection was achieved, representing the prognostically relevant surgical outcome, rather than the use of Hartmann's procedure itself.

Postoperative survival is, in most cases with an inauspicious prognosis, influenced by age, preoperative preparation, tumor size, the degree of anaplasia, the stage of the disease, preoperative CA125 levels, the degree of sepsis, chemotherapy, the extent of the surgical debulking, comorbidities, metastatic disease, and the extent and curative aspect of the surgical intervention. Although an en bloc resection of the lesion is often performed, this is mainly palliative and less curative regarding the extension and evolution of metastatic ovarian disease (14).

In conclusion, the current study reported an extremely rare presentation of a case of primary colorectal cancer with perforation at the level of the rectosigmoid junction, with a colo-ovarian fistula and diffuse peritonitis, which was suspected on computed tomography and diagnosed intraoperatively. Due to the peritonitis and the intestinal resection, chemotherapy, although necessary, was delayed, contributing to an unfavorable prognosis. These cases continue to represent

Table III. Panel of immunostaining for differentiating ovarian or low gastrointestinal tumors (41,43,44,49).

	Rate of marker expression, %									
	CK7 (positivity cutoff >10%)		CK20 (positivity cutoff >25%)		CDX2 (positivity cutoff >5%)		SATB2 (positivity cutoff >10%)		PAX8 (positivity cutoff >5%)	
Cancer type	Focally	Diffusely	Focally	Diffusely	Focally	Diffusely	Focally	Diffusely	Focally	Diffusely
Ovarian	3.8	95.2[a]	41.9[a]	41.9[a]	38.1[a]	23.8[a]	7.6	5.7	36.2[a]	10.5[a]
Colorectal	6.5	4.1	21.1[a]	69.1[a]	9.8[a]	89.4[a]	15.4[a]	76.4[a]	0.0	0.0
Appendiceal	16.8[a]	12.1[a]	11.2[a]	72.0[a]	5.6[a]	91.6[a]	3.7	84.1[a]	0.0	5.6[a]

[a]Positively expressed markers. CK, cytokeratin; CDX2, homeobox protein CDX-2; SATB2, special AT-rich sequence-binding protein-2; PAX8, paired box protein PAX-8.

a real diagnostic and therapeutic challenge due to the very low incidence of colo-ovarian fistulas, the initial intraoperative difficulties in specifying the primary tumor (colorectal or ovarian cancer), the histological and therapeutic challenges, the increased morbidity, the associated prognostic complications and the lack of specific protocols.

Acknowledgements

The authors would like to express their sincere gratitude to Dr Raluca Chirculescu (Department of Pathology, Filantropia Clinical Hospital, Bucharest, Romania) for valuable contributions to the histopathological evaluation and interpretation of the specimens.

Funding

No funding was received.

Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

VNV and AAA contributed to the study conception. VNV was responsible for the methodology, software, data collection, validation and formal analysis. The original draft of the manuscript was written by AAA and VNV. The literature review and final manuscript preparation were performed by VNV and AAA. Both authors have read and approved the final version of the manuscript. VNV and AAA confirm the authenticity of all the raw data.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Ramnicu Sarat Municipal Hospital (599/12.01.2024). Informed consent was obtained for participation in the study.

Patient consent for publication

The patient provided written informed consent for the publication of the present case report and associated images.

Competing interests

The authors declare that they have no competing interests.

References

1. Figiel LS and Figiel SJ: Report of two cases of sigmoidal fistula complicating tubo-ovarian disease. Dis Colon Rectum 9: 107-108, 1996.
2. Jewel KL: Malignant teratoma with fistulous communication to the rectosigmoid. Am J Proctol 28: 51-55, 1977.
3. Mitui AH, Fujita R, Sugata F, Kienebuchi M, Suzuki K and Sagawa F: A case of ovarian dermoid cyst with malignant transformation perforated into the rectosigmoid colon and small intestine. Endoscopy 15: 331-333, 1983.
4. Okada S, Ohaki Y, Inoue K, Nakajo H, Kawamata H and Kumazaki T: A case of dermoid cyst of the ovary with malignant transformation complicated with small intestinal fistula formation. Radiat Med 23: 443-446, 2005.
5. Chong HMD, Lee FYJ, Lo A and Li CMJ: A giant gas-filled abdominal mass in an elderly female: A case report. World J Gastroenterol 17: 3659-3662, 2011.
6. Song W and Conner M: Squamous cell carcinoma arising within a mature cystic teratoma with invasion into the adjacent small intestine: A case report. Int J Gynecol Pathol 31: 272-275, 2012.
7. Yarmohammadi H, Mansoori B, Wong V, Tacher V, Wilkins L, Pavlidakey P and Haaga J: Squamous cell carcinoma arising from ovarian mature cystic teratoma and causing small bowel obstruction. J Cancer Res Ther 10: 770-772, 2014.
8. Ilyas G, Laskar DB and Banihashemi A: A rare cause of cecal fistula. Gastroenterology 154: e12-e13, 2018.
9. Esterson YB, Gaballah M, Grimaldi GM, Raj MH and Pellerito JS: Ovarian dermoid cyst complicated by small bowel obstruction, entero-ovarian fistula formation, and malignant degeneration. Clin Imaging 56: 47-51, 2019.
10. Accardo C, Ardu M, Di Candido F, Epifani G, Cassini D, Bono F and Baldazzi G: Fistula between a primary sigmoid large B-cell lymphoma and an ovarian teratoma. ACG Case Rep J 9: e00794, 2022.
11. Honda H, Lu CH, Barloon TJ and Hashimoto K: Sigmoid colon fistula complicating ovarian cystadenocarcinoma: A rare finding. Gastrointest Radiol 15: 78-81, 1990.
12. Skipper D, Moran B, Dormandy JA and Heald RJ: Two cases of colo-ovarian cyst fistula. Int J Colorectal Dis 10: 70-72, 1995.
13. Imamura K, Nishimura H, Takao M, Maruuchi T, Ogou Y, Kiyozuka Y, Muraoka Y and Yakushiji M: Ovarian tumor complicated by a colo-ovarian fistula. Oncol Rep 4: 1277-1279, 1997.
14. Jeon HM, Kim JS, Oh ST, Kim KH, Ahn BY and Lee EJ: Ileo-rectal fistula complicating advanced ovarian carcinoma. Oncol Rep 6: 1243-1247, 1999.
15. Kim SJ, Kimoto Y, Nakamura H, Taguchi T, Tanji Y, Izukura M, Shiba E and Takai S: Ovarian carcinoma with fistula formation to the sigmoid colon and ileum: Report of a case. Surg Today 29: 449-452, 1999.
16. Bats AS, Rockall AG, Singh N, Reznek RH and Jeyarajah A: Perforation of a malignant ovarian tumor into the recto-sigmoid colon. Acta Obstet Gynecol Scand 89: 1362-1363, 2010.
17. Yahagi N, Kobayashi Y, Ohara T, Suzuki N, Kiguchi K and Ishizuka B: Ovarian carcinoma complicated by sigmoid colon fistula formation: A case report and review of the literature. J Obstet Gynaecol Res 37: 250-253, 2011.
18. Shai A, Grikshtas E, Segev Y, Moskovitz M, Bitterman A, Steiner M and Lavie O: Conservative management for an entero-adnexal fistula at initial presentation of advanced ovarian carcinoma. Curr Oncol 20: e44-e47, 2013.
19. Min KW, Lee SJ, Jung HY, Han HS, Lee SY, Seong MK, Sung IK and Kim WY: Squamous cell carcinoma arising in a mature cystic teratoma exposed through a colo-ovarian fistula. J Obstet Gynaecol 35: 763-764, 2015.
20. K G S, Mirza AA, Swamy S, S A and Ks G: Metachronous synchronous sternal and colonic metastasis with asymptomatic colo-colic fistula from carcinoma ovary rare presentation of ovarian cancer. Indian J Surg Oncol 8: 615-618, 2017.
21. Narayanan P, Nobbenhuis M, Reynolds KM, Sahdev A, Reznek RH and Rockall AG: Fistulas in malignant gynecologic disease: Etiology, imaging, and management. Radiographics 29: 1073-1083, 2009.
22. Prat J, D'Angelo E and Espinosa I: Ovarian carcinomas: Clinicopathologic and molecular features with comments on 2014 FIGO staging. Am J Surg Pathol 49: e1-e14, 2025.
23. Noronha GP, Hiremath R, K C A, Tippani D and C R A: Malignant colojejunal fistula first discovered on CT: A case report. J Clin Diagn Res 8: RD01-RD03, 2014.
24. Stern JL, Buscema J, Rosenshein NB and Woodruff JD: Spontaneous rupture of benign cystic teratomas. Obstet Gynecol 57: 363-366, 1981.
25. Dong C, Pan X, Wei L, Man X, Zhou Z, Huang Y, Wang X, Qi L, Xue F and Li Y: Colon cancer with colovesical fistula: A report of four cases and a literature review. Oncol Lett 25: 158, 2023.
26. Monroig HG, Monroig HG, Rivera FL, Diaz JC, Marino JS and Hernandez RR: Unorthodox presentation of colorectal cancer with multiple fistulas and multiple abscesses. J Med Cases 9: 29-33, 2018.

27. Aggarwal R, Indiran V and Maduraimuthu P: Different etiologies of an unusual disease: Colouterine fistula-report of two cases. Indian J Radiol Imaging 28: 37-40, 2018.
28. Ishiyama Y, Ito M, Akuta S, Yoshizawa M, Yamato M, Tanaka H, Fujii T, Okazaki N, Hiranuma C, Deguchi K and Hirano Y: Small bowel fistula with colorectal cancer and mesenteric lymph node metastasis: A report of two cases. J Surg Case Rep 2023: rjad675, 2023.
29. Basukala S, Khand Y, Pahari S, Mainali P, Gurung N and Gurung S: Colorectal carcinoma presenting as spontaneous colocutaneous fistula-A rare case report and review of literature. Int J Surg Case Rep 96: 107346, 2022.
30. Walsh S, Evoy D, Cantwell CP, Kroon N, Sheahan K, Gibbons D and McDermott EW: Perforation of colon cancer into a benign ovarian cyst. J Obstet Gynaecol 32: 316-317, 2012.
31. Shapey IM, Mahmood K and Solkar MH: Malignant sigmoido-duodenal fistula. Int J Surg Case Rep 5: 995-997, 2014.
32. Landmann DD and Lewis RW: Benign cystic ovarian teratoma with colorectal involvement. Report of a case and review of the literature. Dis Colon Rectum 31: 808-813, 1988.
33. Cebesoy FB, Baskonus I, Mete A, Kutlar I and Aybasti N: Benign ovarian dermoid cyst complicated with rectal fistula formation: An unusual case. Arch Gynecol Obstet 279: 179-181, 2009.
34. Rosenzweig M, Marshall J, White RA, Tismenetsky M and Shembde D: Colo-ovarian fistula. J Surg Case Rep 2017: rjx228, 2017.
35. Dos Santos L, Mok E, Iasonos A, Park K, Soslow RA, Aghajanian C, Alektiar K, Barakat RR and Abu-Rustum NR: Squamous cell carcinoma arising in mature cystic teratoma of the ovary: A case series and review of the literature. Gynecol Oncol 105: 321-324, 2007.
36. Al Wazzan A, Popowich S, Dean E, Robinson C, Lotocki R and Altman AD: Malignant transformation of mature cystic teratoma of the ovary: 30-year experience of a single tertiary care center. Eur J Gynaecol Oncol 37: 809-813, 2016.
37. Kizaki Y, Nagai T, Ohara K, Gomi Y, Akahori T, Ono Y, Matsunaga S, Takai Y, Saito M, Baba K and Seki H: Ovarian mature cystic teratoma with fistula formation into the rectum: A case report. Springerplus 5: 1700, 2016.
38. von-Walter AR and Nelken RS: Benign cystic ovarian teratoma with a fistula into the small and large bowel. Obstet Gynecol 119: 434-436, 2012.
39. Yilmaz M, Akbulut S, Samdanci ET and Yilmaz S: Abdominopelvic actinomycosis associated with an intrauterine device and presenting with a rectal mass and hydronephrosis: A troublesome condition for the clinician. Int Surg 97: 254-259, 2012.
40. Rimola J, Rodríguez S, García-Bosch O, Ricart E, Pagès M, Pellisé M, Ayuso C and Panés J: Role of 3.0-T MR colonography in the evaluation of inflammatory bowel disease. Radiographics 29: 701-719, 2009.
41. Nishizuka S, Chen ST, Gwadry FG, Alexander J, Major SM, Scherf U, Reinhold WC, Waltham M, Charboneau L, Young L, *et al*: Diagnostic markers that distinguish colon and ovarian adenocarcinomas: Identification by genomic, proteomic, and tissue array profiling. Cancer Res 63: 5243-5250, 2003.
42. Kriplani D and Patel MM: Immunohistochemistry: A diagnostic aid in differentiating primary epithelial ovarian tumors and tumors metastatic to the ovary. South Asian J Cancer 2: 254-258, 2013.
43. Hrudka J, Fišerová H, Jelínková K, Matěj R and Waldauf P: Cytokeratin 7 expression as a predictor of an unfavorable prognosis in colorectal carcinoma. Sci Rep 11: 17863, 2021.
44. Meagher NS, Wang L, Rambau PF, Intermaggio MP, Huntsman DG, Wilkens LR, El-Bahrawy MA, Ness RB, Odunsi K, Steed H, *et al*: A combination of the immunohistochemical markers CK7 and SATB2 is highly sensitive and specific for distinguishing primary ovarian mucinous tumors from colorectal and appendiceal metastases. Mod Pathol 32: 1834-1846, 2019.
45. Liu G, Xiao X, Xia Y, Huang W, Chen W, Xu J, Chen S, Wang H, Wei J, Li H, *et al*: Organoids from mucinous appendiceal adenocarcinomas as high-fidelity models for individual therapy. Front Med (Lausanne) 9: 829033, 2022.
46. Tou LC, Mieles M, Harper J and Biggs K: Colo-ovarian fistula masquerading as tubo-ovarian abscess: A case report. AME Case Rep 9: 125, 2025.
47. Quintela C, Santos C, Silva AC, Barbosa E, Silva AR and Silva A: Colo-ovarian Fistula complicating acute diverticulitis: Two cases and literature review. Int J Surg Case Rep 77: 476-482, 2020.
48. Pisano M, Zorcolo L, Merli C, Cimbanassi S, Poiasina E, Ceresoli M, Agresta F, Allievi N, Bellanova G, Coccolini F, *et al*: 2017 WSES guidelines on colon and rectal cancer emergencies: Obstruction and perforation. World J Emerg Surg 13: 36, 2018.