Mesenteric involvement in ovarian cancer: what to look for on CT examination?

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Learning objectives

To review the imaging findings suggestive of mesenteric involvement/infiltration in post-contrast computed tomography (CT) scan examination.

To help Radiologists in correctly recognize and classify mesenteric involvement/infiltration in patients with advanced ovarian cancer in order to select the best therapeutic approach.

Background

Ovarian carcinoma is the most common cause of death due to gynecologic malignancy. Intraperitoneal spread is the most common modality of diffusion in ovarian cancer. Peritoneal involvement is present in approximately 70% of patients at the time of initial diagnosis. A detailed knowledge of the complex peritoneal anatomy, directionality of flow of peritoneal fluid, and specific disease sites that are likely to present particular difficulties with regard to surgical access and technique is required.

Recent studies showed that neoadjuvant chemotherapy (NACT) followed by interval debulking surgery (IDS) has emerged as a valuable therapeutic option in cases not suitable for complete (removal of all visible lesions) primary debulking surgery (PDS). The recent introduction of upper abdominal surgery in the surgical skills of gynecologic oncologists has ensured a complete cytoreduction to a higher percentage of women with advanced epithelial ovarian cancer (AEOC).

Even if no clear consensus on criteria of resectability was assessed an initial surgical approach is precluded to patients with extensive small bowel involvement or mesenteric root infiltration.

In this context, it is crucial to properly identify those patients not suitable for complete PDS, thus early starting NACT.

Staging-laparoscopy (S-LPS) was introduced as a method for assessing the resectability of AEOC, to achieve this goal, a laparoscopy-based predictive index model, has been developed. In a recent study an updated LPS-PI has been developed to predict complete PDS in patients with AEOC, after the introduction of upper abdominal surgery; in this study the probability of achieving a complete PDS in patients with a PI value # 10 is null. However, some anatomic sites are "blind spots" that are inaccessible or difficult to assess at laparoscopy. Bowel infiltration is the most difficult laparoscopic parameter to assess; the difficulty to accurately explore the entire large and small bowel segments can be explained by the extensive diffusion of the disease, and the presence of adhesions.
For these reasons, it is crucial to focus much more attention on non-invasive radiological criteria able to accurately identify those patients with mesenteric retraction, or diffuse involvement of small bowel serosa. It is important that the radiologist report any evidence of disease in these sites.

CT is the most frequently used imaging modality for the preoperative evaluation of ovarian cancer and has been proved an accurate method for predicting the outcome of PDS. The most important role of the radiologist is to alert clinicians to the presence of disease that may complicate surgery or may preclude optimal or complete PDS.

Structured reporting of key findings at CT or magnetic resonance imaging performed for preoperative staging of ovarian cancer is strongly recommended. Guidelines for reporting and characterizing the most important CT findings are provided in Figure 1.

For these reasons, we have retrospectively reviewed the CT-scan findings in a series of women with AEOC, who were considered non-resectable at laparoscopy due to mesenteric retraction and/or diffuse involvement of the small bowel, in order to describe and to classify the CT signs suggestive of non-resectable mesenteric involvement.

**Images for this section:**
Fig. 1: Important preoperative CT-findings of advanced-stage ovarian cancer

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Findings and procedure details

Normal Anatomy

The small bowel mesentery (SBM) is a voluminous, fat-laden fold of peritoneum that suspends the loops of the jejunum and ileum from the posterior abdominal wall. The two layers of peritoneal reflection forming the mesentery contain a variable amount of fat through which run the major arteries, veins, and lymphatics of the small intestine.

Pathways of intraperitoneal spreading

The SBM is a frequent avenue of spread for malignant neoplasms through the peritoneal cavity and between the peritoneal spaces and the retroperitoneum. Tumors spread to the mesentery by four major routes: direct extension along the mesenteric vessels and surrounding fat, extension through the mesenteric lymphatics, embolic hematogenous spread and intraperitoneal seeding.

The major pattern of mesenteric spread of ovarian cancer is the intraperitoneal seeding. The ovary is covered by a single layer of surface epithelium. Ovarian cancer cells with low adhesive properties exfoliate from the affected epithelium and are disseminated in peritoneal fluid. The normal peritoneal cavity contains a small volume of sterile fluid. The clearance of this physiologic fluid is potentiated by upward circulation to the subphrenic spaces. Figure 2 shows the pathways along which tumor cells spread throughout the peritoneal cavity, these pathways reflect dynamics of flow of peritoneal fluid, driven by gravity and diaphragmatic pressure gradients. Peritoneal implants usually form in locations where ascites pools and in the site of maximal resorption. Following the flow dynamics of peritoneal fluid, ascites that pools in the SBM eventually collects in the right lower quadrant, near the terminal ileum. Evidence of peritoneal metastases therefore should be sought in this critical area.

We subdivided SMB in three portions: mesenteric root, medial SBM (mSBM) and distal SBM (dSBM) according to the different surgical relevance of their involvement.

The mesenteric root, which is approximately 15 cm long, is a bare area that is contiguous with the pararenal spaces and runs diagonally from its origin at the ligament of Treitz inferiorly and to the right toward the ileocecal valve. In its course, it passes from left to right, successively in front of the horizontal part of the duodenum, the aorta, the inferior vena cava, the right ureter and the right psoas muscle. The root of the SBM contains two major vessels, the superior mesenteric artery (SMA) and superior mesenteric vein (SMV).

The SBM is fan-shaped with a 6-to 7- m periphery, which covers the entire length of the jejunum and ileum. The intestinal border of mesentery is highly folded in order to fit into the body cavity. The jejunum constitutes about two-fifths of the small intestine and mainly occupies the left upper and central abdomen, while the ileum constitutes about
three-fifths and mainly occupies the central and right lower abdomen and pelvis. The average length of the mesentery, from its vertebral to its intestinal attachment, is from 20 to 25 cm. The mesentery consists of two layers of peritoneum between which lie the jejunal and ileal branches of the superior mesenteric artery and their accompanying veins, nerves, lymphatics and lymph nodes (from 130 to 150). The jejunal and ileal arteries arise from the convex side of the superior mesenteric artery and they are usually from 12 to 15 in number. They run nearly parallel with one another, each vessel dividing into two branches, which unite with adjacent branches, forming a series of arches (arterial arcades), the convexities of which are directed toward the intestine. In the short, upper part of the mesentery only one set of arches exists, but as the depth of the mesentery increases, second, third, fourth, or even fifth groups are developed. From the arterial arcades branches arise, which unite with similar branches from above and below and thus another set of arches is formed. From the terminal arches numerous small straight vessels (vasa recta) arise which encircle the intestine, upon which they are distributed.

We considered as mSBM, the largest portion of SBM, from its root to the terminal arterial arcade; while we considered as dSBM, the distal portion of SBM, within it are the vasa recta, which includes the bowel loops and the serosa (Figure 3).

CT patterns of SBM involvement

We tried to classify the different CT patterns of mesenteric involvement in patients that underwent laparoscopy, with laparoscopic assessments of mesenteric retraction or miliary carcinomatosis on the serosa of the small bowel.

The imaging appearances of mesenteric disease may vary greatly, from generalized infiltration or clustered small ovoid soft-tissue densities (nodules or plaque lesions) to confluent large irregular soft-tissue masses. Serosal implants on mesentery could be solid, cystic or mixed. In all types of categories calcifications can be present or not, these implants can present with different patterns:

- **Micronodular pattern**: Tiny 1-5 mm spots of peritoneal implants diffusely involving the tunica serosa and subserosal fat.
- **Nodular pattern**: Nodules with a diameter > 5 mm diffusely involving the tunica serosa and subserosal fat. Nodules have an oval shape with rounded contours or may present a star-shaped appearance and speculated margins.
- **Plaque-like**: Confluence of multiple nodular implants forms irregular soft-tissue thickenings of inconstant extension that coat abdominal viscera and peritoneal walls.
- **Mass-like**: Confluence of multiple nodular implants, usually in the pelvis, leads to formation of tissue mass that can reach sizes of several centimeters. When a single mass is approximately 10 cm in diameter or larger, it is called a bulky tumor.
Carcinomatous peritoneal nodules, plaques, and masses may coexist in the same patient. Peritoneal implants on mesentery are characteristically distributed around the mesenteric vessels.

The detection of small implants, with a diameter lesser than 5 mm, on serosa, mesentery or peritoneum at CT scan may be difficult, particularly in the absence of ascites and of adequate bowel distention. In our Institution CT examinations were obtained after bowel distension was obtained through the oral administration of 1000 ml of positive contrast medium (2% Gastrografin solution).

In the **mesenteric root** mesenteric disease may present as all the described patterns, even if serosal implants often appear as nodules located near superior mesenteric vessels (SMA and SMV) (Figure 4).

In the **mSBM** we can have several patterns of disease, mesentery with subtle soft-tissue infiltration or reticulonodular lesions could appear with increased density of mesenteric fat; a diffuse thickening, which results in vessels rigidity and produces a "stellate pattern" with or without "pleated appearance"; nodules or masses ill or well-defined, localized or diffuse or a combination of the above.

The pathological increase in mesenteric fat attenuation at CT is defined as fat stranding is an aspecific sign. Abdominal fat stranding can produce various appearances from a subtle hazy increased attenuation of the fat defined "ground glass like" to loss of the interfaces between vessels and fat. The terms "misty mesentery" was coined to describe a regional increase in mesenteric fat density at CT. An increased attenuation of the mesenteric fat may be caused by several pathological conditions, including oedema, inflammation, haemorrhage, neoplastic infiltration or sclerosing mesenteritis. Documenting the presence of early-stage mesenteric involvement can be a challenge because the signs are subtle and easily missed.

As soft-tissue tumor infiltrates the small bowel mesentery and replaces normal mesenteric fat, the mesentery becomes stiff, loses its normal undulations and the small bowel loops becomes fixed in position. A generalized infiltration or extensive mesenteric involvement causes rigidity resulting straightening of the mesenteric vasculature and thereby producing characteristic patterns.

A typical pattern is the *stellate pattern* is produced when tumor infiltrates and thickens perivascular spaces, when viewed in cross-section straightened blood vessels held rigid by the thickened mesentery look like stars in the sky.

Another characteristic pattern is the *pleated appearance*, it occurs when mesenteric vessels are straightened with a linear orientation, tumor infiltrate the leaves of the mesentery and the small bowel segments may have a curved, arc-like orientation on axial images (Figure 5).
The linear orientation of straightened blood vessels held rigid by the thickened mesentery causes mesenteric retraction, drawing the bowel loops together, which may appear in a typical disposition that we called "bouquet sign" on coronal images (Figure 6).

Nodular pattern and round masses, with a characteristic distribution around the jejunal and ileal vessels, are the most frequently encountered patterns of serosal implants in the mSBM. Nodular serosal implants are indistinguishable from lymphnodes (Figure 7).

dSBM Imaging features of dSBM infiltration with carcinomatosis in ovarian cancer may include diffuse serosal infiltration; focal nodules; segmental or diffuse mural thickening; plaque-like or mass-like lesions involving both the serosa and the adjacent mesentery and all these patterns of disease may eventuate in rigidity, retraction or distortion of the bowel loops.

We can subvide CT findings of dSBM involvement in primary and secondary findings. Primary findings are discrete nodules, plaque-like and mass-like lesions; while secondary findings include bowel distortion, bowel-wall thickening and bowel obstruction.

Because of the natural flow of fluid in the peritoneal cavity, the portion of mesentery close to the terminal ileum in the right lower quadrant, at the lower end of the SBM, is a common site of intraperitoneal tumor seeding. As the seeded growths become larger they may displace adjacent bowel loops usually from the mesenteric border. Solid mass may be associated or not with linear strands radiating into surrounding mesenteric fat and with a desmoplastic response that causes bowel loops fixation and angulation. Neoplastic tissue may infiltrate the bowel loops and sometimes may causes bowel obstruction (Figures 8 and 9).

Small bowel loops could appear completely enveloped by a thickened layer of visceral peritoneum that covers the bowel loops as a sleeve, a condition called "Teca aspect" (Figure 10). Sometimes, neoplastic tissue that completely coated the small bowel loops causes small bowel obstruction with consequent dilatation of proximal loops a condition called "ileal freezing".

Surgical approach

The mesenteric root infiltration is considered as absolute criterion of non-resectability.

The mSBM involvement could be surgically resected, it depends on the cases and on the extent of involvement.

The dSBM involvement has the same meaning of bowel serosal deposits, it may be surgically resected. The involvement of the bowel loops and the serosa, both considered as the distal portion of mesentery, should be quantified where their extensive involvement is related to non-resectable disease.
Extensive bowel resections (eg, total colectomy or a small-bowel resection leaving less than 1 meter of residual small bowel) are not recommended because of the high incidence of functional complications.

Images for this section:

Fig. 2: Coronal image obtained at CT in a woman with advanced-stage peritoneal carcinomatosis shows pathways of ascitic fluid and sites of pooling and seeding. Peritoneal fluid, driven by gravity, pools in pelvic recesses while diaphragmatic pressure gradients directs fluid upward along paracolic gutters. Peritoneal fluid pools at the ileo-cecal junction (1), at the recesses of the SBM (2) and at the sigmoid mesocolon (3) and then overflows into the pelvis (4). From the pelvis, fluid ascends the right paracolic gutter to the right subhepatic (5) and subphrenic spaces (6). The falciform ligament prevents diffusion to the left subphrenic space.

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Fig. 3: Drawings of the anatomy of the small bowel mesentery: its root (the red area), its medial portion (mSBM, the green area) and its distal one (dSBM, the yellow area), which includes the bowel loops and the serosa.

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**Fig. 4:** Axial contrast-enhanced CT images (a and b) and coronal contrast-enhanced CT image (c) obtained in a 60-year-old woman showing an ill-defined soft-tissue (green arrows) infiltrating the mesenteric root and nodules located along superior mesenteric vessels.

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Fig. 5: Axial contrast-enhanced CT images of the midabdomen of four different women with mesenteric retraction due to AEOC. The bowel loops appear in a parallel configuration, with infiltrating soft tissue tumor along mesenteric margins, creating the so-called "pleated appearance", a stellate pattern coexists.

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Fig. 6: Coronal contrast enhanced CT images of three different women with diffuse and generalized mSBM infiltration due to ovarian cancer showing the so-called "bouquet sign" for the typical small bowel loops disposition.

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Fig. 7: Axial contrast-enhanced CT images obtained in a 63-year-old woman with AEOC show multiple 4-5 mm nodules along mesenteric vessels diffusely involving both mSBM and dSBM.

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**Fig. 8:** Axial contrast enhanced CT images obtained in a 63-year-old woman with AEOC showing a mass-like lesion infiltrating bowel loops without bowel obstruction (green arrow in a); nodules and mass-like lesions in the SBM with associated linear bands of soft-tissue attenuation run through the mesenteric fat to the bowel surface (thin green arrows in b); plaque-like lesions in the pelvis, in particular in the right lower quadrant, at the lower end of the SBM, involving ileal loops.

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**Fig. 9:** Coronal MPR (a) and MIP (b) images obtained in the same patient showing extensive, diffuse and generalized dSBM infiltration, with nodules and masses in the mesenteric border of bowel loops. Both coronal images depict the extent of mesenteric involvement more clearly than the axial image (Figure 8), with the findings being most conspicuous in b.

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Fig. 10: Axial contrast-enhanced CT images showing small bowel loops completely coated by a thickened visceral peritoneum a condition called "Teca Aspect", with no small bowel obstruction.

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Conclusion

Radiologists should consider the described CT signs to obtain a correct pre-operative assessment that is crucial in deciding the best therapeutic approach.

Personal information

References


by the Arbeitsgemeinschaft Gynaekologische Onkologie Studiengruppe Ovarialkarzinom (AGO-OVAR) and the Groupe d'Investigateurs Nationaux Pour les Etudes des Cancers de l'Ovaire (GINECO). Cancer 2009;115: 1234-1244.


[35] 20th edition of *Gray's Anatomy*


