Management Driven Structured Reporting in Ovarian Cancer

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Abstract

Since majority (80%) of ovarian cancer patients present at an advanced stage, imaging performed on these patients have numerous findings. The combination of multiple findings on imaging, complexity of anatomical structures which are involved in ovarian cancer, and the need to perceive certain subtle imaging features which would impact management often makes it challenging to systematically review images of these patients. Similarly, it is difficult to effectively communicate these findings in radiology reports. Structured reporting that is geared toward clinical decision-making has been an area of recognized need. An understanding of the review areas, which aid clinical decision-making in a multidisciplinary team setting at our institution led us to the proposed structured reporting template for ovarian cancer. Through this review, the authors would like to share this reporting template with examples.

Keywords
- ovarian cancer
- structured reporting
- computed tomography
- magnetic imaging resonance
- cross-sectional imaging

Introduction

Developments in the understanding of ovarian cancer biology, immunohistochemistry, and genetics, which are geared toward better reproducibility and prognostication of the disease led to the revised International Federation of Gynecology and Obstetrics (FIGO) classification of ovarian cancer in 2014. This has significant implications to radiologists interpreting images of ovarian cancer patients. One of the most important concepts relevant to radiologists is the fact that ovarian, fallopian tube, and primary peritoneal cancer have been unified for the purposes of staging. Hence, there is no need to separate these entities on imaging investigations. Epithelial ovarian cancer (EOC) is the most common histological type of ovarian cancer and accounts for 90% of them.[1] The histological types of ovarian cancer arising from sex cord stromal cells and germ cells account for the rest. Among the EOC, high-grade serous ovarian carcinomas account for 70 to 80% and present with late stage disease. This explains why the majority (80%) of patients with ovarian cancer present with stage III and above disease.[1-3] In this review, we highlight the role of radiologists in the ovarian cancer management and propose a structured reporting template, which will address the key questions pertinent to management of ovarian cancer patients.

Ovarian Cancer Concepts Relevant to Radiologists

There are five types of EOCs, which constitute 98% of ovarian cancers. They have distinct histopathology, molecular genetics, and thus prognosis and treatment. High-grade serous carcinoma (HGSC), the most common type of ovarian cancer is said to arise from neometaplasia of fimbrial tubular epithelium or epithelial cells lining the inclusion cysts in ovarian surface giving rise to serous tubular intraepithelial carcinoma (STIC) lesion.[4,5] Exfoliation of STIC lesion from the tubes to the ovaries, rapidly evolves into invasive HGSC on the ovarian

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surface and disseminates to the rest of the ovaries and the peritoneal cavity. Increasing evidence supporting this theory has led to a unified staging system for ovarian, fallopian tube, and peritoneal cancers.

On the other hand, the low-grade serous carcinoma (LGSC) and mucinous carcinomas progress in a stepwise fashion from borderline tumor to carcinoma. ►**Figs. 1** and **2** are examples of HGSC and LGSC. Endometrioid cancer and clear cell cancer are associated with endometriosis. ►**Table 1** shows a comprehensive comparison of the five types of ovarian cancers.

Staging, Prognosis, and Management Strategies

The revised version of FIGO classification system for ovarian, fallopian tube, and peritoneal cancers has been in effect since 2014. In comparison to the previous revision which came into effect in 1988, the most significant changes were in FIGO stage IC, stage III, and stage IV. ►**Table 2** summarizes the FIGO (2014) staging classification system and also shows examples of involved structures and the classification stage which is relevant to reporting radiologists.

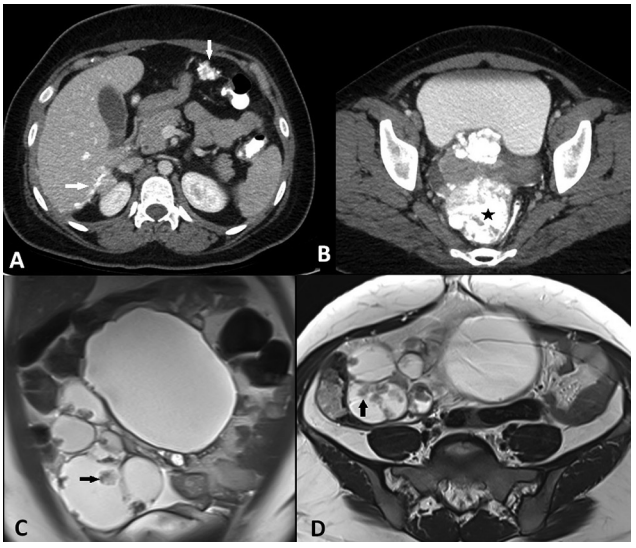

Fig. 1 Imaging findings in low-grade serous carcinoma (LGSC) of ovary in two different patients. (**A, B**) CECT of 45-year-old patient 1 showing calcified peritoneal disease along the liver surface and the pelvis (*) and calcified omental nodules (arrows). (**C, D**) MRI T2 weighted images of a 32-year-old patient 2 with LGSC shows large complex cystic ovarian mass with irregular papillary solid components (arrows).

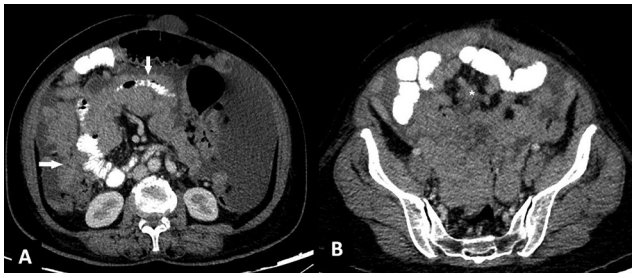

Fig. 2 CECT of a 67-year-old patient with high grade serous carcinoma (HGSC) of ovary showing soft tissue density mass in the adnexa, large volume ascites, diffuse peritoneal, omental, small bowel serosal, and mesenteric disease (**A**; arrows). Positive oral contrast in the small bowel helps in identifying serosal disease causing bowel encasement, luminal distortion, and differentiate mesenteric disease (*) from collapsed bowel loops (**B**).

The most important determinant of prognosis is the stage of disease. The 5-year overall survival rate being over 90% for stage 1 disease to less than 20% for stage IV disease. Although the majority of patients (70%) present with stage III and IV disease, a good 23% present with stage 1 disease, and 7% present with stage II disease.[8] When we have a closer look at the stage 1 disease, the 5-year overall survival is 95% for stage 1A disease and it is around 85% for stage 1C disease, and the 5-year disease-free survival is 98% for stage 1A disease and lowers to 75 to 80% for stage 1C disease. The chance of metastases ranges between 30 and 33% for patients with stage 1C disease.[9-11] Radiologists are often the first point of contact for these patients with potential stage 1 ovarian cancer. We need to understand the prognostic implications of intraperitoneal spill of contents of a malignant adnexal mass during an inadvertent image guided aspiration. Thus, image guided diagnostic needle aspirations of potentially malignant adnexal masses should be deferred and such patients must be referred to a gynecological oncologist for their specialist input. On the other hand, image guided biopsy is valuable in a patient with advanced stage III and IV ovarian cancer who are being considered for neoadjuvant chemotherapy or palliative chemotherapy.

The treatment strategies for ovarian cancer include primary cytoreductive surgery, interval debulking surgery following neoadjuvant chemotherapy, cytoreductive surgery with hyperthermic intraperitoneal chemotherapy (HIPEC), and palliative chemotherapy. Treatment pathway is decided based on FIGO stage, imaging assessment of operability, and patient's general condition and comorbidities. The only factor which has a significant favorable impact on the overall and disease-free survival of patients with advanced ovarian cancer in the setting of both primary cytoreduction or interval debulking is complete cytoreduction.[12] On the other hand, there was no significant difference between the survival outcomes of patients with suboptimal cytoreductive surgery or chemotherapy.[12] The term complete cytoreduction is used when all visible disease is removed at surgery, which is often described as CC0 or R0 resection. Cytoreductive surgery is considered optimal (CC1 or R1) when <1 cm of visible disease remains after surgery and suboptimal (CC2 or R2 and above) when more than 1 cm of visible disease is left behind after the surgery. Thus, the purpose of cytoreductive surgery is to be able to achieve complete cytoreduction. Cytoreductive surgery usually involves a large midline laparotomy, total abdominal hysterectomy, bilateral salpingo-oophorectomy, omentectomy, and peritonectomy including striping of peritoneum from the diaphragmatic surface and removal of viscera, such as spleen, stomach etc. to varying extent depending on the spread of disease. Such an extensive surgery has long operating time ranging from 9 to 16 hours and has considerable morbidity (19–34%), mortality (0.7–2.8%), and cost.[13,14] In real practice, the decision to operate often depends on the surgical skill set and the multidisciplinary set-up available.

Table 1 Five main types of ovarian carcinomas, genetic mutations, precursors, morphology, treatment, and prognosis (adapted from Prat J et al's "Ovarian carcinomas: at least five different diseases with distinct histological features and molecular genetics')[6]

	HGSC	LGSC	Mucinous	Endometrioid	Clear cell
Incidence	70%	<5%	3%	10%	10%
Precursor lesion	STIC lesion (neometaplasia in tubal cells or ovarian inclusion cells)	Serous borderline tumor	Adenoma–borderline tumor–carcinoma sequence	Endometriosis	Endometriosis
Genetic risks and mutations	Risk: BRCA1/2 BRCA, TP53	B-RAF, K-RAS	K-RAS and ERBB2	Risk: HNPCC PTEN, CTNNB1, ARID1A, PIK3CA, KRAS, MI	HNF-1 β ARID1A PTEN, PIK3CA
Presentation	Advanced stage	Advanced or early	Early	Early	Early
Morphology	Bilateral solid cystic ovarian masses, massive ascites, diffuse peritoneal metastases	Solid papillary architecture is maintained. 8 to 16% calcification	Large multiloculated complex cystic mass, unilateral	Complex cystic mass with mural nodules and thick septa; ipsilateral ovarian or pelvic endometriosis in 42%; with endometrial cancer in 15 to 20%	No distinct morphology
Platinum response	Good	Intermediate	Poor	Intermediate	Intermediate
Prognosis	Poor	Favorable	Favorable	Favorable	Intermediate

Abbreviations: HGSC, high grade serous carcinoma; LGSC, low grade serous carcinoma; STIC, serous tubal intraepithelial carcinoma.

There have been many attempts to preoperatively predict possibility of complete cytoreduction based on imaging findings and laparoscopy.[15-22] In a recent two center study, age over 60 years, cancer antigen (CA) 125 levels >550 IU/L and peritoneal cancer index of >16 were identified as significant factors associated with suboptimal cytoreduction at interval debulking.[23] It is vital for radiologists to develop an understanding of the practices surrounding the management of patients with ovarian cancer in their own centers and deliver reports that caters to such decision-making.

Imaging for Staging Ovarian Cancer

Of the different imaging modalities available in our armamentarium, contrast-enhanced computed tomography (CECT) is the primary modality of choice for staging of ovarian cancer with over 90% accuracy for staging.[24] The recommended imaging protocol is CECT of the thorax, abdomen, and pelvis, in arterial and venous phase; with positive or neutral oral contrast; reconstructed as 3 mm sections; images reviewed in axial and coronal planes.[20] Nearly 30% of patients with pleural effusion can have mediastinal nodes, pleural or lung metastases, and thus it is useful to include thorax in the imaging protocol.[25] There are mixed opinions regarding the use of positive oral contrast. We use positive oral contrast to enhance the visibility of subtle small bowel serosal and mesenteric nodules (►**Fig. 2**). Though calcified mesenteric and serosal nodules of low-grade serous carcinomas may be better seen with neutral oral contrast, they are less common and seen in less than 20% of an already uncommon subtype of ovarian cancer. Also, it is difficult to differentiate mural enhancement of a collapsed bowel from a small soft-tissue density serosal nodule when no positive oral contrast is given. We also follow a split bolus technique (►**Fig. 7**) of intravenous contrast administration to opacify the ureters and demonstrate its relationship to pelvic masses. In this technique, we initially administer 40 mL of contrast intravenously at a rate of 2 mL/sec followed 10 minutes later by intravenous injection of another 70 to 80 mL of contrast at 4 mL/sec and acquire images at venous phase from the dome of the diaphragm to the pubic symphysis.

Magnetic resonance imaging (MRI) is more appropriate as a problem solving tool. For example, gadolinium-enhanced MRI obtained at 2 to 3 minutes postcontrast and diffusion-weighted imaging (DWI) is a valuable add on imaging investigation in patients with indeterminate CT findings of small bowel and mesenteric disease and are being considered for primary cytoreductive surgery (►**Fig. 3**). Fluorodeoxyglucose positron emission tomography/computed tomography (FDG-PET/CT) is not recommended as a primary staging modality not only because of less availability and cost, but also because all ovarian cancers are not FDG-avid and PET-CT is less sensitive for identifying peritoneal nodules less than 1cm, small bowel serosal, and mesenteric disease. However, PET-CT has a role in diagnosing recurrent ovarian cancer and for identifying extraperitoneal metastases.[24,26]

Structured Reporting Template

The key questions posed to radiologists interpreting images of ovarian cancer patients presenting with pelvic mass include the following and a structured report should address these.

- Are we dealing with primary ovarian cancer?
- If ovarian cancer, what is the FIGO stage?

Table 2 FIGO 2014 staging system for ovarian, fallopian tube, and peritoneal cancer[7]

FIGO	A	B	C
(I) Tumor confined to the ovaries or fallopian tube(s)	Tumor confined to one ovary or fallopian tube with intact capsule	Tumor limited to both ovaries (capsules intact) or fallopian tubes	Tumor limited to one or both ovaries or fallopian tubes with: IC1—intraoperative spill IC2—preoperative spill or tumor on the surface of the ovary or fallopian tubes IC3—positive peritoneal washings or ascites
(II) Tumor with pelvic extension (below pelvic brim)	Extension and/or implants on the uterus and/or fallopian tubes and/or ovaries	Extension to other pelvic intraperitoneal tissues e.g., rectum, bladder, sigmoid colon, and distal ureters	–
(III) Tumor with microscopically confirmed spread to the peritoneum outside the pelvis or metastasis to the retroperitoneal lymph nodes	IIIA1 (i) Positive retroperitoneal lymph nodes <10 mm IIIA1 (ii) Positive retroperitoneal lymph nodes >10 mm IIIA2 (iii) Microscopic extrapelvic (above pelvic brim) peritoneal involvement	Macroscopic peritoneal metastasis beyond the pelvic brim 2 cm or less in greatest dimension e.g., peritoneal nodule; liver or splenic surface disease; and small bowel or mesenteric serosal disease 2 cm or less	Macroscopic peritoneal metastasis beyond the pelvis more than 2 cm in greatest dimension e.g., diffuse peritoneal thickening, liver or splenic surface disease, and small bowel or mesenteric serosal disease >2 cm
(IV) Distant metastasis excluding peritoneal metastases	Pleural effusion with positive cytology	Metastases to extra-abdominal organs e.g., lung, liver, splenic, brain metastases, inguinal or cardiophrenic nodes, umbilical nodule, and transmural bowel infiltration outside pelvis	–

Abbreviation: FIGO, Federation of Gynecology and Obstetrics;

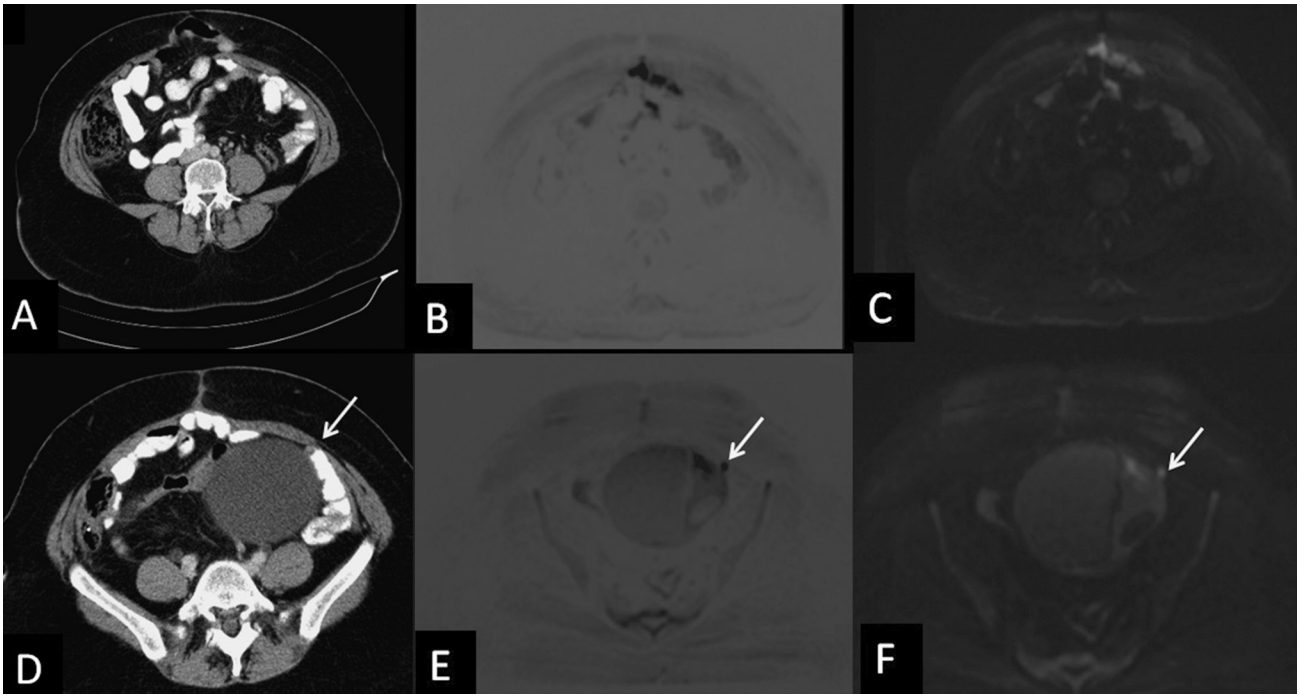

Fig. 3 A 48-year-old patient with recurrent ovarian cancer being considered for cytoreductive surgery and hyperthermic intraperitoneal chemotherapy (HIPEC). CECT and whole body diffusion weighted imaging (DWI-WB) shows (**A–C**) small bowel serosal disease along the anterior abdomen missed by CT and (**D–F**) a small nodule in the bowel serosa which was seen on CT and DWI-WB, but more conspicuous on the later.

- Can complete or optimal primary cytoreductive surgery be done? In other words, are there sites that are involved which make this less likely?
- If being planned for neoadjuvant chemotherapy and interval debulking, what are the best suggested site and the modality for image guided biopsy?

Primary

The first task of a radiologist reporting mass in the female pelvis with clinically suspected ovarian cancer is to ascertain the origin of the pelvic mass and then decide if one is dealing with a primary ovarian malignancy or a Krukenberg's metastases. Lee at al described "ovarian vascular pedicle" sign to identify the origin of pelvic masses. Ovarian vascular pedicle sign is demonstration of dilated gonadal vein directly joining the pelvic mass. This sign was shown to be present in 91% of patients with ovarian mass and 13% of masses of uterine origin.[27] Subsequent studies have shown that the size of gonadal vein was proportional to the size of the solid component of the pelvic mass of gynecological origin, and visualizing the wrapped appearance of gonadal vein around the pelvic mass was seen in 70% of ovarian masses and gonadal vein was seen to abruptly end at the margin of a mass of uterine origin in 71% of patients.[28]

Morphological appearance of the ovarian mass is often helpful in differentiating primary ovarian malignancy from Krukenberg's tumor. While the majority of primary ovarian cancer present with variable sized irregular bilateral ovarian masses with an exception of a small percentage of less common ovarian cancers such as mucinous ovarian carcinoma, germ cell, and sex cord stromal cell tumors which are unilateral. ►**Table 1** summarizes the morphological appearance of the five main types of ovarian cancer.

Krukenberg's ovarian (►**Fig. 4**) metastases are most commonly seen as smoothly lobulated or bosselated, oval, bilateral, and solid ovarian masses.[29,30] However, 20% of Krukenberg's tumors are unilateral and 20% of them are cystic in nature. Over 90% of Krukenberg's tumors are from gastric and colorectal primaries with signet ring cell adenocarcinoma being the most common histology. Other primaries include breast, appendix, gallbladder, biliary tree, pancreas, cervix, and urachus.[31] These constitute important review areas in every patient with ovarian mass on imaging.

Also in our context, it is important to consider the possibility of abdominal tuberculosis in patients with diffuse peritoneal condition. As opposed to irregular nodular nonuniform peritoneal thickening in patients with peritoneal carcinomatosis, there is smooth uniform peritoneal thickening and enhancement involving both the visceral and parietal peritoneum in infectious peritonitis and abdominal tuberculosis (►**Fig. 5**). In addition, omental thickening is grosser with soft tissue density nodules in malignant peritoneal conditions. Similar to the uniform peritoneal thickening in abdominal tuberculosis, the tubo-ovarian masses from tuberculosis have thin uniform walls. Abdominal tuberculosis may also have necrotic nodes, hepatosplenomegaly and there may be additional findings of pulmonary tuberculosis to support the diagnosis.

Local Extent of Disease

Though spread of ovarian cancer to other structures in the pelvis such as uterus, rectum, bladder, distal ureter, and sigmoid colon below the level of the pelvic brim (►**Fig. 6**) constitutes FIGO stage II disease, knowing which of these structures are directly involved helps greatly with patient counselling, surgical planning, and deciding on the need for involving multiple surgical disciplines during the operation.

Infiltration of the pelvic side walls and iliac vessels constitutes advanced disease (stage IV) with little chance of complete cytoreduction. Pelvic side wall infiltration is defined as <3 mm distance between the disease and the pelvic sidewall muscles,

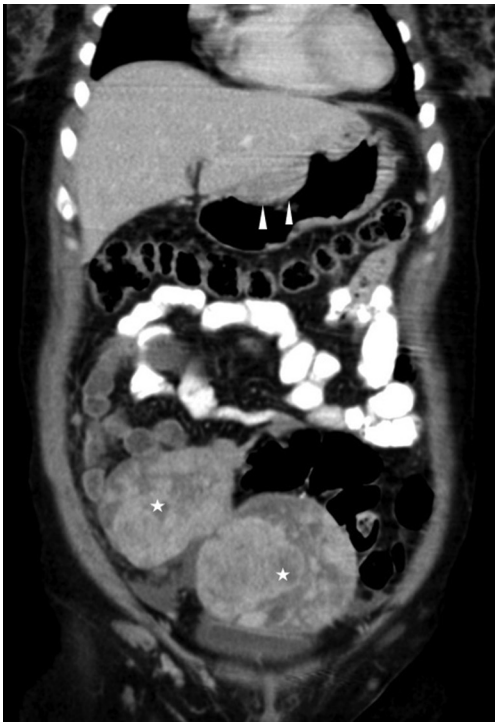

Fig. 4 CECT coronal reconstructed image of 46-year-old patient shows bilateral solid smoothly lobulated ovarian masses from Krukenberg's ovarian metastases from a gastric (arrow heads) primary.

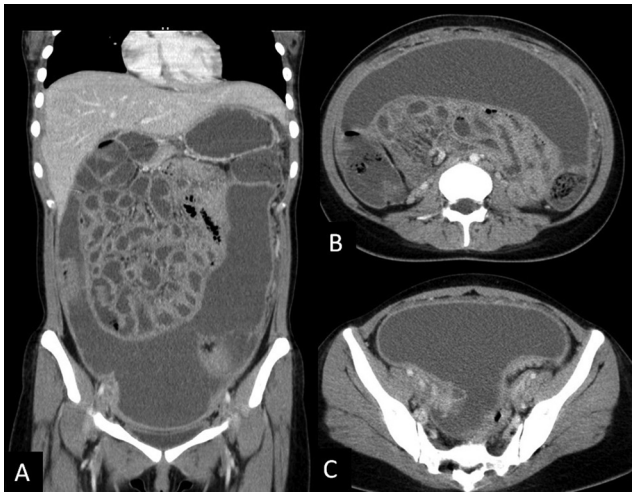

Fig. 5 CECT coronal and axial images (A–C) of 29-year-old patient with abdominal tuberculosis show diffuse smooth uniform thickening of the visceral and parietal peritoneum.

such as ileo-psoas, obturator internus (►**Fig. 7**). Imaging findings suggestive of iliac vessel infiltration such as encasement of the iliac vessels by ≥180 degrees (►**Fig. 7**), direct extension of the tumor into the vessel lumen and vessel wall irregularity also constitute pelvic sidewall infiltration.[25]

Extrapelvic Intraperitoneal Disease Burden

Spread of ovarian cancer to the peritoneal surfaces is through direct spread of cancer cells along the direction of flow of peritoneal fluid. Thus, there is greatest predilection for the most dependent portions of the peritoneal cavity, which is the pelvis, right lower abdomen, and right subphrenic space. The high phagocytic capacity of the greater omentum to engulf the cancer cells makes greater omental involvement very common in ovarian cancer. Extensive seeding of the peritoneal cavity is associated with ascites. We use the term mild ascites on our reports when there is fluid in the peritoneal cavity but not seen on all the cuts; moderate ascites when there is fluid in all the images, but abdomen is not distended and large volume ascites when there is fluid in all the images and there is abdominal distension. Large-volume malignant ascites is known to indicate high tumor burden and worse prognosis.

Peritoneal cancer index is a surgical index designed to estimate the tumor burden in the peritoneal cavity and can be adapted for use on imaging.[32] Peritoneal cancer index is the sum of scores given to the peritoneal disease based on its size in 13 different sites within the peritoneal cavity with a potential score ranging from 0 to 39. A score of 1, 2, and 3 is given to lesions <0.5 cm, 0.5 to 5 cm, and > 5 cm or confluent disease > 5 cm or continuous peritoneal thickening > 5 cm, respectively. Peritoneal cancer index (PCI) of > 13 was found to predict suboptimal cytoreduction.[33] ►**Table 3** shows surgical PCI adapted for imaging interpretation. Key point of note is that the greater omentum irrespective of its bulk and span is considered only a part of region 0 disease and can only have a maximum score of 3. In a setting of ovarian cancer, ovarian masses are not considered while calculating PCI. For the purpose of assessing the four small bowel and mesenteric sites, the peritoneal cavity is divided into four equal quadrants by a vertical line along the midline and a transverse line along the umbilicus. The left upper, left lower, right upper and right lower quadrants are considered to have proximal jejunum, distal jejunum, proximal ileum, and distal ileum, respectively.

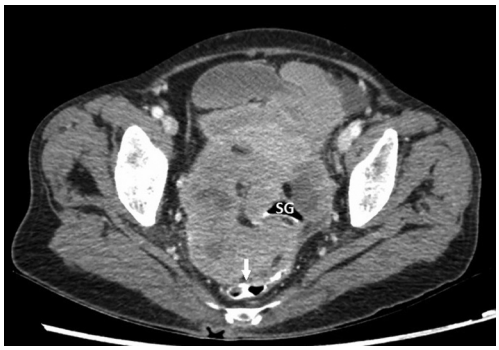

Fig. 6 CT axial image showing encasement of pelvic portion of sigmoid colon (SG) with indentation and lost plane with the rectum (arrow) suggestive of FIGO IIB features.

Unfavorable Sites of Involvement

Spread of ovarian cancer to certain key anatomic structures would either increase the complexity of surgery or prelude cytoreductive surgery since complete cytoreduction becomes unlikely.[15,18,20,25] In a setting of ovarian cancer or primary peritoneal cancer, these include thick (> 2 cm) sheet like subphrenic disease, disease in the fissures for falciform ligament and ligamentum teres, infiltrating liver and splenic surface deposits >2 cm, lesser sac, porta hepatis and porto-caval space, biliary obstruction, lesser omentum, perigastric disease encasing the stomach and the left gastric artery, disease in the root of mesentery, small bowel serosal disease, retroperitoneal spread to perinephric and paranephric space, presacral space, pelvic side wall infiltration, and large paramedian abdominal wall disease (►**Table 4**, ►**Figs. 7**–**11**).

Mesenteric disease and small bowel serosal disease, which is visible on imaging, is usually a sign of advanced involvement of these structures. Mesenteric disease is seen as mesenteric nodules, mesenteric fold thickening, tethered mesentery, and stellate mesentery. Small bowel serosal disease is seen as bowel wall thickening, luminal distortion, and kinking of bowel loops and as nodules indenting the small bowel. Small bowel obstruction can either be a sign of extensive serosal disease or transmural bowel infiltration. Identifying these features on imaging is very important to prevent attempts to perform cytoreductive surgery since this

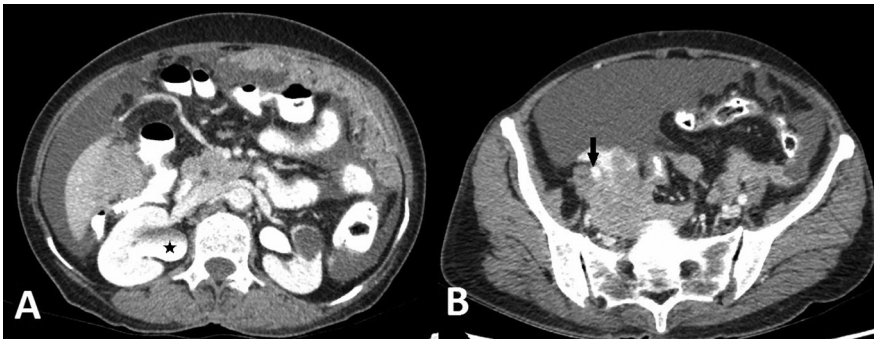

Fig. 7 A 65-year-old patient with HGSC of ovaries with CECT done using a split bolus technique. (**A**) Note the right hydronephrosis (*) from encasement of right ureter by the pelvic mass (black arrow in B). (**B**) More than 180 degrees of encasement of right iliac vessels suggestive of right pelvic side wall infiltration.

Table 3 Peritoneal cancer index adapted from Jacquet P and Sugarbaker PH[32]

No.	Location in the peritoneal cavity
0	Entire greater omentum, transverse colon, and transverse mesocolon
1	Right subphrenic space
2	Epigastric region including lesser omentum, lesser sac, and intersegmental fissures
3	Left subphrenic space, tail of pancreas, spleen, and perigastric region
4	Left paracolic gutter and descending colon
5	Left pelvic side wall lateral to sigmoid colon and sigmoid colon
6	Ovaries[a], tubes[a], uterus, bladder, rectum, sigmoid below pelvic brim, and pouch of Douglas
7	Right pelvic side wall lateral to cecum, cecum and appendix
8	Right paracolic gutter and ascending colon
9	Upper jejunum and its mesentery (bowel in left upper quadrant)
10	Lower jejunum and its mesentery (bowel in left lower quadrant)
11	Upper ileum and its mesentery (bowel in right upper quadrant)
12	Lower ileum and its mesentery (bowel in right lower quadrant)

[a]Primary is not included while calculating peritoneal cancer index.

Table 4 Structured reporting template for ovarian cancer

Structured reporting template—ovarian cancer
Ovarian mass: – Is this an ovarian mass? (yes/no) – Unilateral/bilateral – Solid/solid cystic/predominantly cystic – Margins: irregular papillary/smoothly lobulated or bosselated surface – Calcification – Abuts/loses plane/infiltrates—uterus, rectum, sigmoid colon, and distal ureters
Extent of peritoneal spread: – Ascites: mild/moderate/large – Omental disease: stranding/nodules/caking – Size of largest peritoneal disease: <2 cm/>2 cm – Radiological peritoneal cancer index (rPCI)
Unfavorable sites of involvement which makes complete cytoreduction less likely: – Thick plaque like subdiaphragmatic disease (yes/no) – Disease involving intersegmental fissures of the liver, porta, GB fossa, and lesser omentum (yes/no) – Disease encasing stomach and left gastric artery (yes/no) – Small bowel obstruction (yes/no) – Root of mesentery (yes/no) – Small bowel mesentery (yes/no) – Para-aortic nodes above the renal vessels (yes/no) – Hydronephrosis (yes/no) – Pelvic side wall infiltration (yes/no) – Iliac vessel encasement (yes/o) – Pre-sacral disease (yes/no) – Abdominal wall disease (yes/no), if yes midline/paramedian, size _____ cm
Metastases: – Nodes[a]: inguinal/cardio-phrenic/celiac/axillary/mediastinal/supraclavicular (yes/no) – Umbilical metastases (yes/no) – Pleural effusion (yes/no) – Liver, spleen, lungs, and brain (yes/no)
Are there any other primaries? (yes/no) – Stomach, colon, appendix, gallbladder, pancreas, urachus
CT-FIGO stage:

Abbreviation: CT-FIGO, computed tomography- Federation of Gynecology and Obstetrics.
[a]Size cutoff for significant nodes is as follows: cardio-phrenic >7 mm, retrocrural >6 mm, all others > 10 mm.

will result in—suboptimal debulking. CT has poor sensitivity ranging between 25 to 50% for detecting small bowel and mesenteric disease.[34] Similarly, sensitivity of multidetector row CT (MDCT) is only 65.5% for nodules < 1 cm and will miss miliary metastases.[35] Despite this, MDCT is very useful first line investigation to triage patients with advanced ovarian cancer and can be used effectively to advise against cytoreductive surgery when unfavorable sites are involved with disease.[20]

Metastases

Malignant pleural effusion is stage IVA disease (►**Fig. 12**). Thus, pleural effusion demonstrated on imaging must be aspirated with a view to determine its nature. Parenchymal metastases to liver, spleen, lungs, bones, and brain are IVB disease. Liver and splenic metastases must be differentiated from surface deposits which are stage IIIB/C disease. While subcapsular parenchymal lesions make acute angle of contact with the liver (►**Fig. 13A**) and splenic parenchyma, infiltrating extracapsular lesions make obtuse angle of contact with the parenchyma (►**Fig. 13B**). Abdominal wall metastasis (►**Fig. 14**) or umbilical nodule is also considered stage IVB. Small midline nodules can be excised at surgery but paramedian abdominal wall disease and large nodules in the abdominal wall will increase morbidity due to compromised abdominal wall vascularity and may be impossible to close the abdomen following laparotomy. Nonregional para-aortic nodes above the renal hilum, inguinal nodes, cardio-phrenic nodes >7 mm (►**Figs. 12, 15**), retrocrural (> 6 mm), axillary, mediastinal, and supraclavicular nodes are also a part of stage IVB disease.

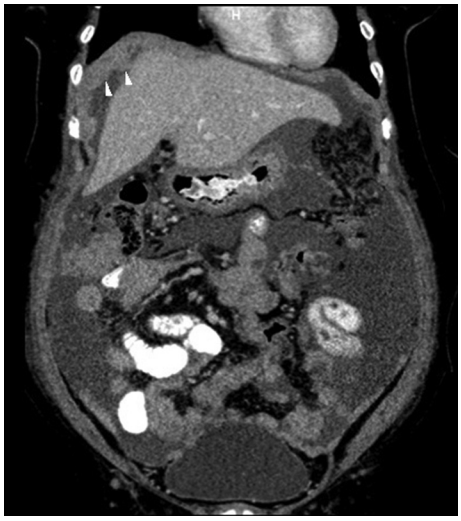

Fig. 8 Coronal CT images show extensive thick (> 2 cm) plaque right subphrenic disease (arrow heads).

FIGO Stage (►Table 2) and Site of Biopsy

If patient has early ovarian cancer, biopsy or aspirations must be avoided at any cost. However, at the request of the treating surgeon or oncologist, biopsy of advanced ovarian cancer can be performed to obtain tissue diagnosis prior

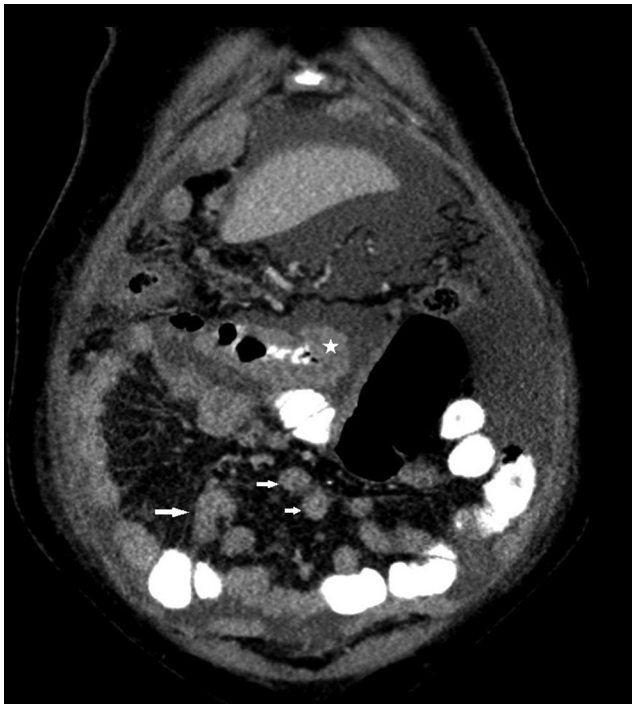

Fig. 10 Coronally reconstructed CECT with positive oral contrast of a patient with ovarian cancer shows multiple mesenteric nodules (arrows) and small bowel serosal disease (*). Note the abnormal mural thickening (*) of a small bowel loop in the upper abdomen opacified by positive oral contrast.

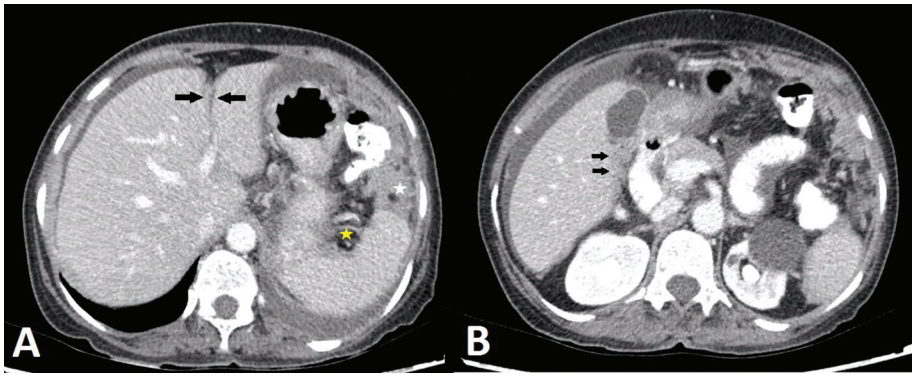

Fig. 9 CECT axial section of a patient with advanced ovarian cancer. (**A**) Shows disease along the falciform ligament (black arrows), gastrosplenic (yellow asterisk) and spleno-colic ligaments (white asterisk). (**B**) Shows disease in the gallbladder fossa (black arrows).

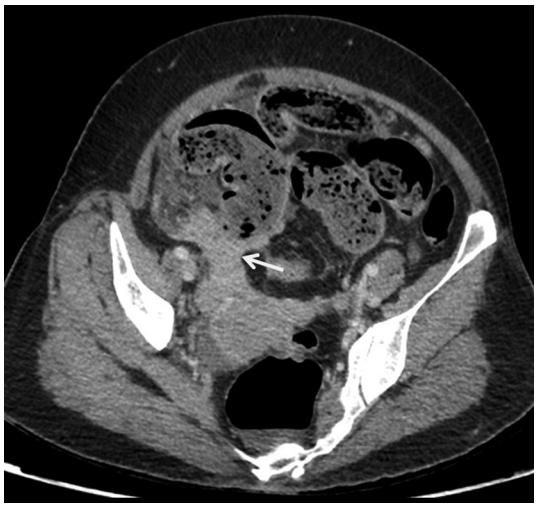

Fig. 11 Axial CECT shows dilated small bowel loops with positive small bowel feces sign suggestive of small bowel obstruction due to direct transmural infiltration of the small bowel (arrow) by the adnexal mass. This finding constitutes a stage IVB disease.

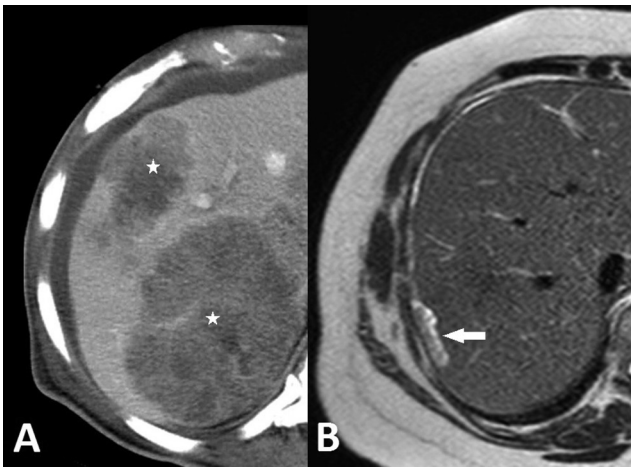

Fig. 13 Images showing difference between liver metastases and liver serosal disease. (**A**) CECT axial image of patient 1 shows subcapsular liver metastases, which make acute angles of contact with the liver parenchyma. (**B**) Axial T2 weighted MRI of patient 2 shows infiltrating liver serosal disease which makes obtuse angle of contact with the liver parenchyma.

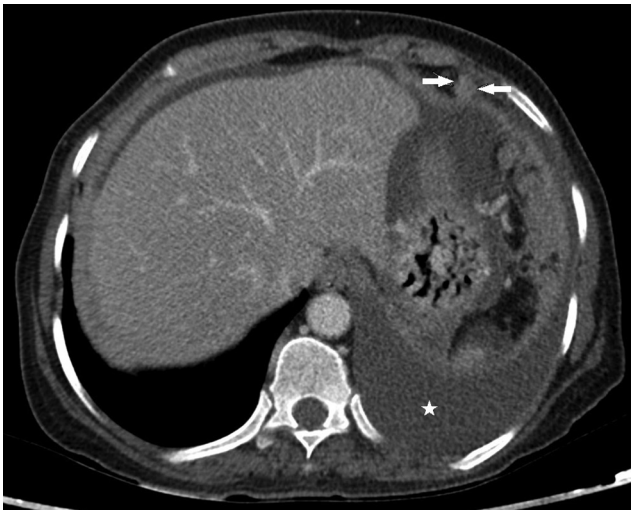

Fig. 12 Axial CT image through the lung base shows left pleural effusion (*) and left anterior cardio-phrenic node (arrows).

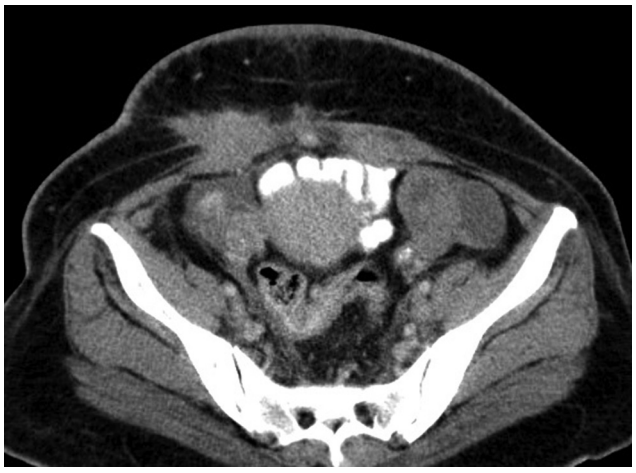

Fig. 14 Axial CECT image of a large right paramedian abdominal wall metastasis which infiltrates right rectus abdominis muscle. This is a finding suggestive of FIGO stage IVB.

to start of chemotherapy. ►**Table 4** provides a structured reporting template which can be used for CT staging of ovarian cancer.

Conclusion

Imaging plays a central role in the staging and deciding the treatment pathway in patients with ovarian cancer. Contrast-enhanced CT is the recommended noninvasive staging investigation of choice. FIGO 2014 version has unified the staging of ovarian, fallopian tube, and primary peritoneal malignancies. Structured reporting in ovarian cancer addressing key questions relevant to management will help in clinical decision-making, aid effective communication of

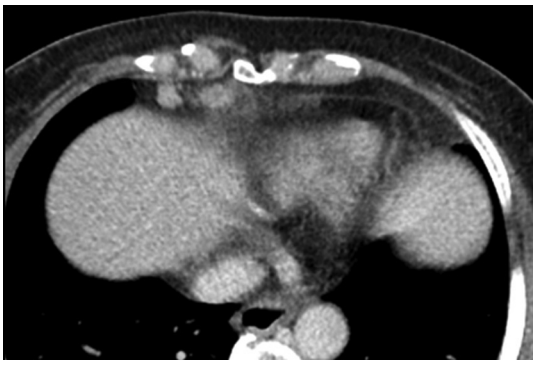

Fig. 15 Cropped axial CECT image at the level of the epicardial fat showing significant (>7 mm) cardio-phrenic nodes.

findings, and help with objective reporting which will help with clinical research.

Conflict of Interest
None declared.

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