Imaging for Peritoneal Metastases

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KEYWORDS

• Peritoneal tumor • Appendiceal cancer • MRI • PET-CT • Peritoneal cancer index

KEY POINTS

- Of the choices for peritoneal imaging, MRI provides superior depiction of small-volume peritoneal tumor compared with computed tomography (CT) and PET.
- The preoperative magnetic resonance peritoneal cancer index score is reasonably accurate in categorizing the volume of tumor found at surgical exploration.
- Patient selection using preoperative imaging requires accurate assessment of tumor volume and location with attention to the small bowel and mesentery.
- PET-CT is most beneficial if conventional imaging is inconclusive and there is high suspicion of disease, or to rule out extraabdominal metastases.
- Following heated intraperitoneal chemotherapy, patient surveillance with MRI can detect early tumor recurrence before an increase in serum tumor markers.

INTRODUCTION

Imaging of peritoneal metastases plays an essential role in the diagnosis and management of patients with peritoneal malignancy being considered for cytoreductive surgery (CRS) and heated intraperitoneal chemotherapy (HIPEC). Abdominal and pelvic imaging contributes valuable information to initial diagnosis, preoperative staging, patient selection, detection of postoperative complications, and patient surveillance following successful treatment.[1–10]

The combination of complex peritoneal anatomy and small size of peritoneal metastases makes peritoneal tumor imaging arguably the most difficult challenge facing the abdominal imager. Imaging options include computed tomography (CT), MRI, and PET-CT.[6,8,11–27] CT provides strictly cross-sectional anatomic imaging, whereas MRI provides a combination of cross-sectional anatomic imaging and tumor functional imaging. CT and MRI are based on uniquely different imaging principles that determine the characteristic strengths and weaknesses of each test. PET imaging of

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peritoneal tumor provides functional imaging based on an assessment of the tumor's metabolism of glucose.[27]

This article discusses the technical issues surrounding peritoneal imaging, including patient preparation and (magnetic resonance) MR scanning protocols. Image interpretation in the preoperative and surveillance setting is discussed. Comparisons of MRI, CT, and PET and their clinical utility for preoperative assessment of peritoneal cancer index (PCI) and for surveillance of patients following CRS and HIPEC are described.

IMAGING CHOICE FOR PERITONEAL TUMOR IMAGING

In practice, the challenges of depicting small peritoneal metastases in the complex anatomy of the peritoneal cavity have often led to disappointing results.[1–5] In particular, the depiction of very small peritoneal tumors or subtle sheets of tumor coating the peritoneum and mesentery has been limited, leading to misdiagnosis and gross understaging. Despite preoperative imaging, open-close laparotomies continue to be a too common occurrence, highlighting the need for better anatomic and functional imaging of peritoneal metastases.

CT has superior spatial resolution and speed, producing highly detailed anatomic images of the abdomen and pelvis in a matter of seconds. In the cooperative patient, motion artifact is limited. Reformatted coronal and sagittal images allow for multiplanar imaging without any additional imaging time. However, CT is limited to assessing attenuation of x-rays by soft tissues or bone. This 1-dimensional (D) basis for image generation leads to its Achilles heel, which is a very limited soft tissue contrast resolution. The challenges of limited CT soft tissue contrast result in poor CT depiction of small peritoneal tumors, which are often indistinguishable from adjacent bowel, mesentery, ascites, and mucin.[3,5,10] The poor sensitivity of CT for detecting small peritoneal tumors limits its accuracy in determining a patient's preoperative PCI score[5] (**Fig. 1**).

MRI uses multiple contrast mechanisms to improve its sensitivity for depicting small peritoneal tumors. Initial experience confirmed that peritoneal tumors show marked enhancement on images obtained 5 minutes after administration of gadolinium contrast material.[11,12] The increased conspicuity of these enhancing peritoneal tumors improved detection of small and microscopic tumors that are often missed on CT scans and PET. The addition of diffusion MRI further improves peritoneal tumor depiction because most tumors cause restricted diffusion, producing high signal on diffusion-weighted imaging (DWI)[20–26] (**Fig. 2**).

Limitations of MR for peritoneal tumor imaging include longer examination time, which is typically 30 to 45 minutes, and increased motion artifact in the uncooperative patient. The MR examination also requires more attention to detail because it can be performed in many different ways, with different pulse sequences and parameters, which can vary results. Patient preparation with bowel contrast is an essential element, as is the use of pharmacologic agents, to decrease peristalsis. Finally, the interpretation of peritoneal MRI requires additional training for the radiologist.[10]

PET with 2-(fluorine 18 [18F]) fluoro-2-deoxy-D-glucose (FDG) localizes malignant tissue by their increased FDG tracer uptake relative to metabolically normal cells. PET equates to greater sensitivity compared with anatomic imaging techniques but has low specificity. The anatomic imaging of CT was integrated with PET's functional data to increase FDG PET-CT sensitivity and specificity compared with PET or CT alone.[27]