Radiological Imaging of Colorectal Cancer

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Colon cancers are staged using CT as follows: oral administration of 1 l water to delineate the small and large bowel and 100–150 ml intravenous iodinated contrast medium injected at 3–4 ml/s. Multidetector CT scans are acquired at 20–25 s (chest) and 70–80 s (abdomen and pelvis) post-injection with sections acquired at 1.25–2.5 mm section thickness and reformatted in the axial, sagittal and coronal planes at 2–5 mm for viewing. The image analysis is performed on a workstation with three-dimensional reconstruction software. This enables the images to be viewed in the coronal and sagittal planes and also allows rotation of the images for optimum comprehensive analysis.

4.1 Staging of Colon Cancers Using CT

A meta-analysis showed that the sensitivity and specificity of differentiating between T1/T2 vs. T3/T4 was 86% and 78%, respectively, using multidetector CT techniques, the pooled sensitivity and specificity for detecting tumour invasion in studies was 93% and 86%, respectively [1].

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Y. Du (ed.), *PET/CT in Colorectal Cancer*, Clinicians' Guides to Radionuclide Hybrid Imaging - PET/CT, DOI 10.1007/978-3-319-54837-1_4

- Tumours are only classified as having poor prognosis if tumour extension is 5 mm beyond the muscularis propria. For colon cancers applying the TNM classification system, tumours are grouped on the following basis: good prognosis tumours are T1/T2, T3a and T3b (>80% 3 year DFS), whereas poor prognosis tumours are T3c, T3d and T4 and have significantly poorer DFS [2].
- **T1, T2 and early T3 tumours.** According to the TNM staging system, T1 and T2 tumours are defined as follows: T1, tumour limited to the mucosa; T2, tumour extending to the submucosa, but not involving the muscularis propria. On CT scans, T1 tumours produce an intraluminal projection or focal mass without any visible distortion of the bowel wall layers. T2 tumours are tumours with greater asymmetrical thickening projecting intraluminally but with preservation of smooth muscle coat.

Tumours can be best confirmed as early stage on the multiplanar reformatted sections, where the lack of infiltration through the bowel wall can be appreciated.

- **T3 tumours** are those that infiltrate beyond the muscularis propria. The features on CT suggestive of poor prognosis T3 infiltration (T3c and T3d) include smooth or nodular extension of a discrete mass of tumour tissue beyond the contour of the bowel wall with extension into pericolic fat >5 mm [3].
- **Retroperitoneal fascia invasion.** Further high-risk features include infiltration of the retroperitoneal fascia; this is the posterior surgical resection margin for the tumours lying in the ascending and descending colon, and unless colonic dissection is extended, such patients are at risk of incomplete resection.
- **T4 tumours.** CT features to identify a T4 tumour include the presence of nodular penetration of the tumour through the peritonealised areas of the muscle coat or an advancing edge of the tumour penetrating adjacent organs. Peritoneal infiltration is an independent prognostic factor, and its presence worsens the patient's prognosis [4–5].
- **Nodal stage.** The accurate detection of nodal status has always been difficult using CT. The limitation of CT to detect micro-metastasis in the nodes leads to poor accuracy. The sensitivities and specificities for detection of nodal status range from 66 to 83% and 35 to 81%, respectively. It is not recommended that CT is used to assess the likelihood of nodal malignancy due to substantial overlap between benign enlarged inflammatory nodes and malignant nodes.
- Extramural venous invasion is an independent prognostic factor in colorectal cancers. EMVI can be seen using CT as definite enhancing tumour spread along a large vein, e.g. the ileocolic vein, superior rectal vein, etc [6].

4.2 Assessment of Rectal Cancers

Imaging is essential for both primary and recurrent rectal cancer, for baseline staging and tumour response assessment. MRI has become the optimal modality for the local staging of primary tumours. There are several advantages over alternative

techniques; it enables risk stratification of tumours depending on the presence of high-risk features and characteristics (T and N stages, CRM and EMVI status) that are proven to influence disease-free and overall survival rates [7–9]. In recurrent rectal cancer, MRI enables delineation of tumour extent within the pelvic compartments, assesses the pattern of local recurrence and predicts resectability of the tumour. According to global standards, patients with locally advanced tumours should receive preoperative therapy (usually, radiotherapy in combination with chemotherapy). MRI has also been shown to be a reliable tool in assessment of tumour response to preoperative treatment [10].

4.3 Summary of Rectal MRI Assessment Standards for Reporting

4.3.1 Baseline and Post-treatment Assessment of Rectal Cancer MRI

Confirm high-resolution scan using correct parameters (in plane resolution 0.6 × 0.6 mm, voxel size 1.1 mm^3), correct scan planes orthogonal to long axis of tumour and adequate coverage that includes the mesorectum up to L5/S1.

4.3.2 Minimum Standards for Reporting:

1. **Description of primary tumour morphology:**
   - **Morphologic types:** annular/semi-annular/ulcerating/polypoidal/mucinous mass
   - **Description of the invasive border** of the tumour: nodular infiltrating vs. smooth "pushing" border
2. **Assessment of height:**
   - **Height from anal verge** (defined as lower border of internal sphincter fibres)
   - **Assessment of height of tumour above the sphincter complex** (defined as the upper border of puborectalis sling)
   - **Relationship of tumour to the anterior peritoneal reflection** (below/at/above)
   - **Quadrant** and extent of the invading border
3. **Depth of spread** beyond the muscularis propria of tumour spread (millimetres).
4. **T substage:** T1 (sm1/sm2/sm3); T2 inner fibres/full thickness; T3a (<1 mm spread), T3b (1–5 mm), T3c (5–15 mm) and T3d >15 mm; T4 visceral invasion or T4 peritoneal infiltration.
5. **Relationship of tumour to the intersphincteric plane for tumours arising 6 cm or less from the anal verge.**

- Tumour confined to the submucosal layer or only part thickness of muscularis propria indicates that the intersphincteric plane/mesorectal plane is safe and intersphincteric APE or ultralow TME would be possible.
- Tumour extending through the full thickness of the muscularis propria at or below the puborectalis sling indicates that intersphincteric plane/mesorectal plane is unsafe; in such patients, extralevator APE is required for radial clearance.
- Tumour extending into the intersphincteric plane means that the intersphincteric plane/mesorectal plane is unsafe; therefore, an extralevator APE is also indicated for radial clearance.
- Tumour extends into the external sphincter: intersphincteric plane/mesorectal plane is unsafe, and extralevator APE is indicated for radial clearance.
- Tumour extending into adjacent prostate/vagina/bladder/sacrum indicates that an exenterative procedure would be required.

6. **Lymph node** assessment should not be based on the diameter of the node but instead based on assessment of heterogeneity or irregularity of border to assess risk of malignancy. Smooth-bordered and uniform signal nodes are defined as benign based on MRI criteria.
7. **Extramural venous invasion:** tumour extension into veins either contiguous with the main tumour or discontinuous—characterised by irregular expansion of the calibre of the vessel by tumour signal.
8. **CRM is assessed** by measuring the closest distance of tumour to the mesorectal fascia by tumour in millimetres and stating the location of the potential margin and the cause (tumour, vascular invasion or tumour deposit)**.** The potential CRM is defined as involved if the measured distance to the mesorectal fascia is 1 mm or less. A distance >1 mm indicates that the potential CRM is clear.
9. **Peritoneal dissemination:** an assessment of the pelvic cavity is undertaken to search for potential peritoneal deposits; this is particularly important for anterior tumours that have infiltrated beyond the peritoneal membrane.
10. **Pelvic side wall lymph nodes** can be assessed by evaluating the common sites of lateral spread, i.e. the obturator fossa, external iliac nodes and internal iliac nodes. Assessment should not be based on the diameter of the node but instead based on assessment of heterogeneity or irregularity of border to assess risk of malignancy. Smooth-bordered and uniform signal nodes are defined as benign based on MRI criteria.

Summary of stage should be given—this should include mrT substage, mrN status, CRM EMVI and assessment of the pelvic side wall nodes.

Tumours with <5 mm extramural spread, safe CRM and absence of EMVI do not present a risk of local recurrence and are thus eligible for primary surgery.

Poor prognosis tumours (T3c or greater, EMVI positive or CRM positive) are eligible for preoperative chemoradiotherapy.

Following treatment, the same assessment is undertaken measuring areas of residual tumour signal and the same definitions as pretreatment scans.

In addition, an mrTRG assessment is undertaken:

- If the treated tumour shows no fibrosis, this is classified as mrTRG5.
- If the treated tumour shows minimal fibrosis and predominant tumour signal, this is defined as mrTRG4.
- If there is predominant fibrosis but macroscopic tumour remains, mrTRG 3.
- If there is fibrosis, with minimal or no tumour signal intensity, mrTRG2 (near-complete response).
- If there is low signal fibrosis, linear scar only and no intermediate tumour signal, this is mrTRG1 (radiologic complete response)

Key Points

- The sensitivity and specificity of differentiating between T1/T2 and T3/T4 was 86% and 78%, respectively, using multidetector CT techniques.
- The pooled sensitivity and specificity of CT for detecting tumour invasion in studies is 93% and 86%, respectively.
- Tumours are only classified as having poor prognosis if tumour extension is 5 mm beyond the muscularis propria.
- Colon cancers with good prognosis are T1/T2, T3a and T3b tumours (>80% 3-year DFS).
- Colon cancers with poor prognosis are T3c, T3d and T4 tumours and have significantly poorer DFS.
- The accurate detection of nodal status has always been difficult using CT. The limitation of CT to detect micro-metastasis in the nodes leads to poor accuracy.
- Sensitivities and specificities for detection of nodal status range from 66 to 83% and 35 to 81%, respectively.
- It is not recommended that CT is used to assess the likelihood of nodal malignancy due to substantial overlap between benign enlarged inflammatory nodes and malignant nodes.
- Extramural venous invasion is an independent prognostic factor in colorectal cancers.
- Imaging is essential for both primary and recurrent rectal cancer, for baseline staging and tumour response assessment. MRI has become the optimal modality for the local staging of primary tumours.

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