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Clinical Radiology
The Royal College of Radiologists

Recommendations for cross-sectional imaging in cancer management, Second edition

Colon, rectum and anal canal cancer

Faculty of Clinical Radiology

Contents

Colon cancer

Clinical background

Colorectal cancer is the second most common cause of cancer death in the UK.[1] Preoperative management of colonic cancer comprises preoperative investigation, including only colonoscopy and abdominal ultrasound or computed tomography (CT) before primary surgery and consideration for adjuvant therapy postoperatively. For the vast majority of patients, primary surgical resection will be the treatment of choice. Although there is currently no universally accepted preoperative strategy for patients with colon cancer, it is known that T4 stage, N2 stage (four or more malignant nodes), extramural venous invasion and emergency clinical presentations are independent predictors of poor patient prognosis.

The lymphatic vessels run close to the vessels in the mesocolon and beneath the peritoneum of the posterior abdominal wall. There are three main groups of lymph nodes. The first group is the paracolic lymph nodes which lie in the peritoneum close to the colon. The second group lies along the main vessels supplying blood to the colon. The third group is the para-aortic nodes which cluster around the root of the superior mesenteric artery and inferior mesenteric artery; retroperitoneal lymphadenopathy constitutes metastatic disease in colon cancer. Radiologists should be aware that the patterns of lymphatic spread are highly dependent on the primary tumour site so, for example, right colon cancers have lymphatic spread along the small bowel mesentery, and rectosigmoid tumours spread initially along the inferior mesenteric vessels.

Screening for colorectal cancer

The NHS Bowel Cancer Screening Programme offers screening every two years to all men and women aged 60 to 69. This takes the form of faecal occult blood testing (FOBT) with colonoscopy and, in some cases, CT colonoscopy offered to FOBT-positive tests. CT colonoscopy is indicated for the detection of medium or large polyps, or symptomatic cancers for patients who are unable to undergo colonoscopy, or in whom the procedure has failed.

- Screening is based primarily on FOBT.
- CT colonoscopy (CTC) is of comparable sensitivity to colonoscopy for the detection of polyps and tumours. CTC is indicated in the National Bowel Cancer screening programme for patients with contraindications to undergo colonoscopy and for failed or incomplete colonoscopy. Colonoscopy is the investigation of choice in younger patients and allows tissue diagnosis.[2]
- Barium enema is a less sensitive alternative investigation, which is largely being replaced by colonoscopy and CT colonography.[2]

Who should be staged?

All patients with colon cancer diagnosed at endoscopy or suspected following a lower gastrointestinal barium examination or assessed by virtual CT colonography.

Staging objectives

- To identify potential surgically difficult cases; for example, tumours that infiltrate into adjacent structures and those presenting with bowel perforation.
- To determine the size and local extent of tumour and to document the extent in millimetres of extramural pericolic tumour infiltration.
- To document extension of tumour into adjacent structures such as abdominal wall, peritoneum, solid organs.
- To identify complications, such as the presence of bowel obstruction or perforation.
- To note the presence and extent of local pericolic nodal involvement, extramural vascular invasion, the presence or absence of spread beyond the peritonealised colon surface and to document the presence or absence of distant metastases.
- Nodes in the retroperitoneum, pelvis and inguinal regions are considered to be metastatic.

- To state the size and segmental distribution of suspected metastatic disease in distant organs including the lungs and liver and to recommend referral to HPB MDT for review if potentially resectable metastatic disease is shown.
- CT of the thorax, abdomen and pelvis is the primary imaging investigation. Abdominal ultrasound alone is not regarded as sufficient.

Staging

CT

- Oral administration of 1 litre of water or iodinated contrast medium to delineate small and large bowel.
- 100–150 ml of intravenous iodinated contrast medium injected at 3–4 ml/sec.
- MDCT is commenced at 20–25 seconds (chest) and 70–80 seconds (abdomen and pelvis) post-injection.
- Using MDCT, slice thickness will depend on scanner capability. In general, sections are acquired at 1.25–2.5 mm and reformatted in the coronal/sagittal and axial planes at 2–5 mm for viewing.

Values of $CTDI_{vol}$ should normally be below the relevant national reference dose for the region of scan and patient group (see Appendix and Radiation protection for the patient in CT in Section 2).

Rectal cancer

Clinical background

Rectal cancers have traditionally been thought to fare worse than colonic cancers, due to higher local recurrence rates, and have had poorer overall survival rates.[3] However, with the introduction of better surgical techniques (total mesorectal excision), superior preoperative imaging (high-resolution MRI) and neoadjuvant treatments (radiotherapy and chemoradiotherapy), rectal cancer local recurrence rates have reduced and overall five-year survival rates have increased to match the traditionally more favourable colonic cancer outcomes.[3]

As with colon cancers, patients presenting with obstruction or perforation have a worse prognosis. In addition, there are several poor prognostic features that are unique to the rectal site that can be identified preoperatively by imaging. These include increasing depth of extramural tumour spread, involvement of the potential surgical resection margin, N2 nodal disease, extramural venous invasion and T4 peritoneal perforation.

For the vast majority of tumours, nodal spread is along the superior and middle rectal vessels and nodal metastases are confined to within the mesorectum. In a small percentage of cases (less than 10%),[4] nodal metastases occur outside the mesorectum via the internal iliac chain with lateral spread to the pelvic sidewall or retroperitoneal lymphadenopathy. The preoperative treatment strategy is tailored to the detailed local staging features of the primary tumour, taking into account the presence or absence of poor prognostic features, including the likelihood of achieving total mesorectal excision with clear circumferential resection margins.

Who should be imaged?

All patients with rectal adenocarcinoma. Depending on the preoperative treatment policy of the colorectal multidisciplinary team (MDT), upper rectal and sigmoid tumours may be staged using MRI.

Staging objectives

- A high-resolution MRI scan using 16 cm and 3 mm slice thickness (0.6 x 0.6 mm in plane resolution) is required to locally stage primary rectal cancer. Scans must cover the mesorectum to the L5/S1 junction
- To document disease that is not potentially resectable with clear radial margins by total mesorectal excision plane surgery: namely tumour <1 mm or beyond the mesorectal fascia or tumour extending into or beyond the intersphincteric plane.
- Patients with radiologically staged tumours extending beyond the TME plane (potential CRM involvement) require exenterative surgery to achieve adequate radial clearance and should be referred to a specialist exenterative MDT.
- To document the length of tumour and location with respect to height above the anal verge and puborectalis sling to enable preoperative surgical management decisions regarding plane of surgery and potential sphincter preservation.
- To describe the area/quadrant of maximal infiltration by tumour to enable surgical and radiotherapy planning.
- To document the depth of extramural tumour spread within the rectal wall – for tumours that have spread beyond the muscularis propria, to measure the extramural tumour spread in mm (for prognostic T substage) into the mesorectum and the presence of adverse features such as nodal spread, extramural venous invasion and peritoneal infiltration.
- To identify the presence of complications such as obstruction or perforation.
- To identify loco-regional nodes outside the mesorectum: external and common iliac regions and internal iliac nodes.
- To use CT to assess lungs, liver, peritoneal cavity and retroperitoneum for presence of metastatic disease.
- To document segmental distribution of spread to lungs and liver to enable assessment disease is resectable.

Staging

MRI is the investigation of choice for preoperative local staging of rectal cancer. It will show the relationship of tumour to the muscularis propria extension through the rectal wall and to the mesorectal fascia and also involvement of local nodes and vessels and thus fulfil all the local staging objectives.

Protocol for imaging of rectal cancer

Sequence	Plane	Slice thickness	Field of view	Principle observations
T2W	Sagittal	5 mm	Large	Localise tumour Height of tumour above anal verge Length of tumour
T2W	Axial	5 mm	Large	Pelvic disease outside mesorectum
T2W	Oblique axial/coronals and sagittal for low anterior tumours	3 mm	Small 16 cm field of view (FOV) 256 x 256 matrix, a minimum of 4 signal averages to obtain adequate high-resolution images (0.6 x 0.6 mm in plane resolution)	Assess primary tumour and tumour spread within mesorectum to the L5/S1 level Scans perpendicular to the long axis of the rectal wall and coronal imaging to assess the intersphincteric and levator planes

MRI

MRI of the pelvis at 1.5 Tesla; an abdomino-pelvic surface coil should be used. Anti-peristaltics may be helpful in a minority of cases (such as female patients post-hysterectomy). When reporting MRI scans, the following key findings should be stated:

- Site of tumour – upper/mid/lower third
- Height from puborectalis sling and anal verge and craniocaudal length
- For tumours arising at or within 2 cm above the level of the puborectalis sling – assessment of the safety of the total mesorectal excision surgical (TME) plane
- Relationship to important landmarks, such as peritoneal reflection/seminal vesicles
- Infiltrating border – smooth or nodular infiltration
- Presence or absence of extramural venous invasion
- Maximum depth of extramural spread in mm with T substage given
- Presence or absence of malignant lymph nodes
- Minimum distance to mesorectal fascia
- In the final assessment, the TNM stage and an assessment of potential resection margin involvement/safety of the TME plane (classified as potentially involved if tumour <1 mm to the mesorectal fascia) should be made.

Endoscopic ultrasound

Intraluminal endoscopic ultrasound (EUS) can be undertaken with a flexible or rigid probe. The technique makes use of the interfaces between the tissue layers and at boundaries between layers of different acoustic impedance. This gives a typical pattern of five layers when using a 7.0 MHz probe. With very high 20-MHz probes, it may be possible to subdivide the mucosa, lamina propria and muscularis mucosae and to subdivide T1 tumours into minimal (SM1), slight (SM2) or deep (SM3). Endorectal ultrasound may be used to assess whether potentially early-stage

tumours (T1 or T2) are suitable for local resection using techniques such as transanal microscopic microsurgery (TEMS). However, it should also be borne in mind that non-sessile tumours such as villous tumours and larger polyps cannot always be accurately staged by EUS and in these circumstances, high-resolution MRI will also enable detection of early-stage tumours suitable for initial assessment by local excision or TEMS by describing the degree of submucosal and muscularis wall preservation at the invading edge of the tumour.

CT

The protocol employed is the same as for CT staging of colon cancers and, as for colon cancer patients, CT of the thorax, abdomen and pelvis with intravenous contrast medium should be performed for all patients to detect distant spread of disease. CT is only recommended for local staging of the primary rectal cancer if MRI/EUS staging is contraindicated.

Assessment of distant metastatic disease in colon and rectal cancers

In recent years, the benefits of surgical resection and systemic chemotherapy in prolonging survival in patients with pulmonary and/or hepatic metastases have become established.[5] Results of surgery in patients with resectable lung or liver disease show a 40% five-year survival rate.[6] Current strategies now aim to increase the number of patients who are suitable for curative resection. Such strategies include the use of preoperative systemic chemotherapy so that patients initially thought to have non-resectable disease may undergo surgery with curative intent. Improving outcomes is dependent on patient selection, which requires careful assessment of the precise location of metastases and exclusion of patients with irresectable metastatic disease.

- Magnetic resonance is the technique of choice in staging patients with colorectal liver metastases, since it shows superior sensitivity in identifying lesions compared with CT and PET-CT. The technique requires the use of liver-specific contrast agents which results in the higher sensitivities in the detection of metastatic disease.
- Careful review of CT thorax/abdomen and pelvis enables detection of other sites of metastatic disease which may not be amenable to curative resection; for example, retroperitoneal lymphadenopathy, disseminated pulmonary metastatic disease or peritoneal/omental spread.
- ^{18}FDG PET-CT has been shown to be a cost-effective tool in the evaluation of extrahepatic/extrapulmonary disease in patients being considered for pulmonary/hepatic resection (however, lesions <1 cm may not be detected, and mucinous metastases may not be shown), therefore CT and MRI scans should also be carefully reviewed.

Follow-up

- Intensive follow-up that incorporates carcinoembryonic antigen (CEA) monitoring and six-monthly CT scanning of chest, abdomen and pelvis in the first two years contributes to the earlier detection of asymptomatic disease recurrence in patients with colorectal cancer who are then more likely to proceed to potentially curative resection of metastatic disease.
- For patients diagnosed with local recurrence, MRI is the modality of choice to assess local extent within the pelvis prior to planning exenterative surgery with intent to cure or for determining radical non-surgical therapy.
- Outside the liver and pelvis, ^{18}FDG PET-CT detects occult distant metastases in patients, leading to changes in management. It is particularly efficient in detecting small volume disease in areas which may be difficult to visualise with CT, such as mesentery or peritoneum.
- Follow-up is undertaken when there is the suspicion of recurrent disease, such as elevation of serum CEA levels, which should also be performed as a baseline prior to chemotherapy.
- Careful review of surveillance CT scans when compared with baseline imaging will identify a recurrence in the vast majority of cases.

In patients with a rising CEA level in whom recurrent disease has not been detected by CT or pelvic/liver MRI, ^{18}FDG PET-CT may be helpful in locating the recurrence.

- A proportion of patients will present with potentially resectable metastatic disease to lungs and/or liver and, in these patients, careful assessment of metastatic disease will help to plan for subsequent metastatectomy.

Anal canal cancer

Clinical background

Carcinoma of the anal canal is a relatively uncommon cancer, accounting for less than 2% of large bowel malignancies and 1–6% of all anorectal tumours. Its incidence has been reported to be approximately 0.4 per 100,000 in males and 0.6 per 100,000 in females.[7] There has been a slight increase in the incidence of the disease over the past few years in Denmark, Sweden and the USA.

Cancer arising from the anal canal can originate anywhere between the anorectal junction above and the anal verge below. The anal verge represents the junction between modified squamous epithelium of the anal canal and the anal skin. The majority of cancers arising from the anal canal are squamous cell carcinoma. Treatment with a combination of chemotherapy and radiotherapy is curative in the majority of patients with squamous cell carcinoma of the anus, without the need for radical surgery. However, radical surgery, such as abdomino-perineal resection, may still be necessary to treat local failure or recurrence following chemoradiation.

Anal cancer spreads via the lymphatic system and to a lesser extent by the blood stream. Tumours of the distal anal canal (below the dentate line and anal verge) drain to the inguinal nodes, femoral nodes and thus to the external iliac system. The lymphatics of the proximal anal canal drain to the mesorectal nodes, along relevant branches of the inferior mesenteric artery and thus to para-aortic nodes. They also drain to the internal iliac and obturator nodes.

Who should be imaged?

All patients with biopsy-proven anal cancer. Patients with anal neoplasia in situ (AIN) probably do not require staging.

Staging objectives

- To assess tumour length.
- To determine circumferential extent.
- To assess involvement of adjacent structures.
- To determine presence or absence of locoregional lymphadenopathy.
- To assess for distant metastases.

Staging

As a minimum, patients should undergo CT of chest, abdomen and pelvis as staging for metastatic disease. MRI is the modality of choice to assess extent of local invasion to sphincter pelvic floor and adjacent structures. CT is used for detection of hepatic nodal and pulmonary metastases. PET-CT may characterise local, regional nodes and detect distant metastases, especially when CT/MRI is equivocal. Imaging is increasingly employed to define disease extent to aid treatment planning, for the follow-up of patients undergoing chemoradiation, and in the surveillance of patients to detect relapse.

Clear pretreatment delineation of pelvic disease by MRI enables optimal planning of radiotherapy to the target volume.

Distant metastases can be detected by using CT scanning.

Enlarged groin lymph nodes can be assessed by fine needle aspiration (or biopsy), if necessary under ultrasound guidance. A high proportion of enlarged groin nodes in patients with anal cancer will show reactive changes only.

Protocol for imaging of anal canal cancer

Sequence	Plane	Slice thickness	Field of view	Principle observations
T2W	Sagittal	5 mm	Large	Localise tumour Height of tumour above anal verge. Length of tumour
T2W	Axial	5 mm	Large	Pelvic disease
T2W	Oblique axial/coronal and sagittal for low anterior tumours	3 mm	Small 16 cm field of view (FOV) 256 x 256 matrix, a minimum of 4 signal averages to obtain adequate high-resolution images (0.6 x 0.6 mm in plane resolution)	Assess primary tumour and tumour spread within mesorectum to the L5/S1 level Scans perpendicular to the long axis of the rectal wall and coronal imaging to assess the intersphincteric and levator planes Ensure high spatial resolution coverage of inguinal and pelvic sidewall nodal territory

CT

- CT of the abdomen and pelvis (to cover groin areas) with intravenous contrast medium should be performed to detect distant spread of disease.
- Oral administration of 1 litre of water or iodinated contrast medium to delineate small and large bowel.
- 100–150 ml of intravenous iodinated contrast medium injected at 3–4 ml/sec.
- MDCT is commenced at 20–25 seconds (chest) and 70–80 seconds (abdomen and pelvis) post-injection.
- Using MDCT, slice thickness will depend on scanner capability. In general, sections are acquired at 1.25–2.5 mm and reformatted at 5 mm for viewing.

Values of $CTDI_{vol}$ should normally be below the relevant national reference dose for the region of scan and patient group (see Appendix and Radiation protection for the patient in CT in Section 2).

MRI

MRI of the pelvis at 1.5 Tesla; an abdomino-pelvic surface coil should be used.

Follow-up

Clinical response should be assessed at six to eight weeks after completion of treatment.

- By this time 60–85% achieve complete clinical response.[8] Good partial regression can be managed by close follow-up to confirm that complete regression takes place, which may take 3–6 months.
- The advantages of biopsy should be considered against the substantial risks of radionecrosis.
- Suspicion of major residual tumour or progression on MRI should be considered for biopsy.
- MRI can complement clinical assessment, and act as a useful baseline: the high-resolution T2W technique also has the advantage of showing fibrosis as low signal intensity which enables assessment of post-treatment-related changes on subsequent follow-up imaging. Following chemoradiotherapy, MRI is able to demonstrate tumour regression and document sustained response. However, since the relationship of tumour to the anal sphincter complex can be defined more clearly by imaging than by clinical examination, it is proposed by Association of Coloproctology of Great Britain and Ireland

that patients with anal cancers should be imaged using high-resolution MRI at baseline and following chemoradiotherapy.[9] For patients with a good partial regression this may require assessment by MRI at three to six-monthly intervals.

Approximately 10% of patients who undergo chemoradiotherapy do not respond fully[8] and most local treatment failures are apparent within 18 months of starting combined therapy. Post-treatment assessment can be useful to document tumour regression. In patients that fail to show a response or have recurrent disease, imaging enables delineation of disease for possible salvage surgery. Patients being considered for salvage surgery should be restaged with:

- Pelvic MRI for the extent of local disease
- CT chest/abdomen for distant metastases
- PET scanning may be of value for detecting distant metastases or local spread after chemoradiotherapy and is indicated if radical salvage surgery is planned.

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