

Diagnosis

CT and MR Imaging in Colorectal Carcinoma: A Tool for Diagnosis, Staging, Response Evaluation, and Follow-Up

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Abstract



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Keywords

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- radiology
- contrast

The present review highlights the role of computed tomography (CT), CT colonography (CTC), and magnetic resonance imaging (MRI) in the diagnosis, staging, response evaluation, and follow-up of colorectal cancer. For a CT scan, prior bowel preparation is required. This is done to enhance imaging of the colon with the use of oral or rectal contrast agents. Negative contrast like air or carbon dioxide are helpful in detecting polyps and masses by distending the colon. Virtual colonoscopy offers a lower-radiation alternative for polyp and cancer detection. Intravenous contrast administration with arterial and venous phase CT images is also important in complete staging of a known case of colon cancer and for evaluation of residual/recurrent disease. With respect to MRI, high-resolution T2-weighted images in multiple planes are important, with diffusion-weighted imaging (DWI) sequences being important for restaging. Intravenous contrast is not generally recommended. Contrast-enhanced CT and MRI are used for nodal and distant metastasis staging, with special attention to the pelvic side wall nodes. Positron emission tomography (PET) CT is to be considered for further evaluation if the findings are unclear and recurrence is suspected.

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Introduction

Colorectal carcinoma (CRC) remains one of the leading causes of cancer-related deaths in developed countries. Dietary habits and hereditary and environmental factors remain risk factors for development of CRC. Most colon cancers are thought to directly develop from adenomatous polyps. The malignant potential of polyps are determined by their size. Polyps greater than 2 cm are at greater than 40% risk of being cancerous, while polyps less than 0.5 cm have essentially no malignant potential.¹

Depending upon the stage of disease, patients may present with a range of symptoms starting from rectal bleeding, abdominal pain, and change in bowel habits to fatigue, weight loss, and anemia in advanced stages.²

As anatomy, lymphatic drainage and treatment options of colon cancer and rectal cancer differ significantly. The present review will summarize the application of computed tomography (CT), CT colonography (CTC), and magnetic resonance imaging (MRI), which play an important role in the diagnosis, staging, response evaluation, and follow-up of CRC.

Initial Diagnosis

Colon cancer: As most of the cancers are thought to directly develop from adenomatous polyps, early detection of polyps play an important role in the prevention or early diagnosis of colon cancer. This will also lead to more patients being potentially eligible for curative treatment. Any patient suspected of having a colon cancer should undergo detailed clinical evaluation with proper history taking and measurement of carcinoembryonic antigen (CEA).³ The sensitivity to detect CRC range around 95% for both colonoscopy and CTC.⁴ However, colonoscopy remains the first line of examination for localization of tumor with an added advantage of taking subsequent biopsy from the lesion. CTC remains the second-line option in patients in whom the lesion could not be reached by colonoscopy due to a non-negotiable stricture or in patients in whom colonoscopy is contraindicated.⁵ Other techniques like MRI and abdominal CT have inferior performance in early detection of polyps or colon cancers and, therefore, should not be considered primary diagnostic tools.⁶

Rectal cancer: Primary diagnosis of rectal cancer is more straightforward as compared with colon cancer by using digital rectal examination or proctoscopy. Locoregional staging plays a very important role in the management of rectal cancers. MRI and endoscopic ultrasound (EUS) remain the modalities of choice for locoregional staging.³

Techniques of Computed Tomography

Bowel preparation is done for all planned cases a day prior to the scan. For imaging of colon cancers, oral contrast opacification of colon is of utmost importance when abdominal CT is performed. Water soluble oral contrast agents can be administered 60 to 90 minutes prior to the study to ensure the contrast has reached the colon at the time of scan, which can be confirmed by taking a CT topogram image.

Alternatively, positive rectal contrast can also be administered through a rectal tube. Neutral contrast in the form of water⁷ or negative contrast material in the form of air⁸ could also be administered via rectal tube for colonic imaging.

Negative contrast in the form of air or carbon dioxide used to distend the colon for CTC can particularly be used for detection of polyps and small masses. While using negative contrast, both prone and supine images should be taken to differentiate residual fecal matter from polyps and help displace fluid in dependent segments that may obscure an underlying lesion. It also helps in distension of the segment of the colon that may remain collapsed in the supine position. Recent advances with virtual colonoscopy with fly-through images can also be performed after 3D reconstruction of dataset for detection of polyps and early colon cancers. Due to high contrast between air and bowel wall/lesion, CTC can be performed with a lower radiation dose than CT scan.

The abdomen is routinely imaged from the diaphragm to the pubic symphysis. Intravenous contrast administration with arterial and venous phase CT images is important in complete staging of a known case of colon cancer and for evaluation of residual/recurrent disease. Routinely, 100 to 120 mL of iohexol contrast is administered intravenously at a rate of 2 to 3 mL/s.

Techniques of MRI

MRI should be performed with at least 1.5-T field strength with an external phased-array coil. The use of endorectal coil is no longer recommended. No dedicated consensus is available on whether spasmolytics or bowel preparation should be used prior to examination.⁹ In most centers, bowel preparation is not used and spasmolytics are recommended. High-resolution T2-weighted images in axial, coronal, and sagittal planes should be obtained with a slice thickness of 1 to 3 mm. Diffusion-weighted sequences are increasingly used mainly in restaging of rectal cancers after chemoradiotherapy (CRT). Use of intravenous contrast in MRI does not give any additional prognostic information and is not recommended.

Staging

Once the diagnosis is made, staging should be performed using the latest version (8th edition) of the American joint Committee on Cancer (AJCC) tumor, node, and metastasis (TNM) classification¹⁰ (→Table 1).

T staging of colon cancer: Contrast-enhanced CT scan of the abdomen with arterial and venous phase images are most widely used and are the recommended modality for local staging of colon cancer, and MR is the modality of choice for rectosigmoid cancer staging.³ CT scan helps differentiate tumors localized to the bowel wall from those exceeding the bowel wall with or without infiltration of adjacent structures (→Fig. 1 and →Fig. 2). However, differentiating T2 and T3 lesions on CT scan can prove challenging in some cases. Apart from T4 tumors, subclassification of T stage does

Table 1 TNM Staging for CRC

T stage	
T0	No evidence of primary tumor
Tis	Carcinoma in situ
T1	Tumor invades the submucosa
T2	Tumor invades the muscularis propria
T3	Tumor invades into pericolicorectal tissue
T3a	Invasion ≤ 1 mm
T3b	Invasion 1–5 mm
T3c	Invasion ≥ 6 –15 mm
T3d	Invasion ≥ 15 mm
T4a	Tumor penetrates the visceral peritoneum
T4b	Tumor invades into adjacent organs
N stage	
N0	No evidence of lymph node metastasis
N1a	Metastasis in one regional lymph node
N1b	Metastasis in 2–3 regional lymph nodes
N1c	Tumor deposits in the subserosa or pericolic/perirectal tissue (not to be differentiated by imaging)
N2a	Metastasis in 4–6 regional lymph nodes
N2b	Metastasis in ≥ 7 regional lymph node
M stage	
M0	No distant metastasis
M1a	Metastasis confined to one organ
M1b	Metastasis in more than one organ
M1c	Metastasis to the peritoneum with or without other organ involvement

not change the surgical management.¹¹ Application of CT scan in the detection of T1 tumor is limited due its low soft tissue contrast.

T staging of rectal cancer: MRI is the modality of choice for locoregional staging of rectal cancers; however, MRI does not differentiate T1 lesions from T2 lesions.^{12,13} Therefore, for patients suspected with T1 lesion, EUS would be the modality of choice. MRI is very useful for evaluating the tumor extension into the mesorectal fat and involvement of the mesorectal fascia (MRF; **→Fig. 3**). The distance of the tumor from the MRF (or circumferential resection margin) plays an important role in therapeutic decision-making, surgical planning, and subclassification of T3 tumors. The distance of the tumor from the MRF also exhibits an important prognostic value. Tumors (or involved nodes) lying ≤ 1 mm from the MRF or the infiltrating MRF are associated with a high risk of local recurrence.¹⁴ MRI also plays an important role in measuring the distance between the anorectal junction and the distal part of the tumor, determining the length of the tumor, sphincteric involvement, and extramural invasion of the tumor.

N staging of CRC: All routinely available radiological modalities exhibit low sensitivity and specificity for identifying nodal metastasis. Unlike other gastrointestinal malignancies, the size criteria are unreliable as up to 50% of metastatic nodes are ≤ 5 mm in short axis diameter.¹⁴ More reliable methods for identifying nodal metastasis are based on morphological factors like irregularity of lymph node borders, presence of round shape, and signal heterogeneity within the nodes.³ Risk assessment based on nodal metastasis should be done with caution with $\leq T3b$ tumors, which have a favorable prognosis irrespective of the presence or absence of nodal metastasis.¹⁵ Special attention should be given to the pelvic side wall nodes and nodes in the obturator fossa, as these nodes fall out of standard

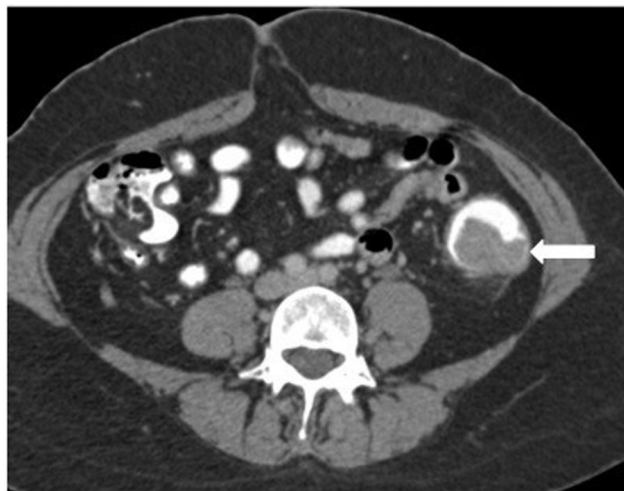


Fig. 1 Oral and intravenous (IV) contrast-enhanced axial computed tomography images showing a well-defined polypoidal mass lesion (arrow) arising from the posterior wall of the descending colon with a mass lesion involving the muscularis propria and no evidence of involvement of pericolic tissue, suggestive of a T2 lesion.



Fig. 2 Contrast-enhanced axial computed tomography images showing a large circumferential well-defined heterogeneously enhancing centrally necrotic infiltrating mass lesion causing involvement of pericolic tissue and infiltration into adjacent small bowel loops (arrow), suggestive of a T4 lesion.

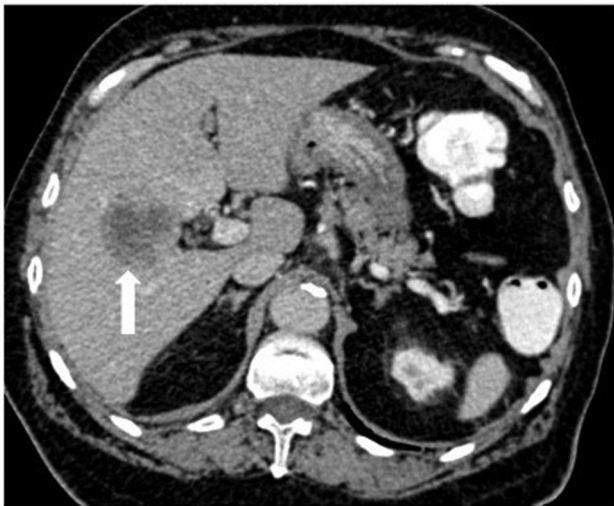


Fig. 3 Portal phase axial contrast-enhanced computed tomography scan image through the liver demonstrates an ill-defined poorly enhancing hypodense lesion in the right lobe of the liver (arrow) in a known case of carcinoma of the sigmoid colon, suggesting liver metastasis.

resection plane and radiation field. If these nodes are not mentioned in the report, there are high chances of these nodes being left untreated and a high local recurrence rate. Recently, a novel MRI technique, diffusion-weighted imaging with background body signal suppression (DWIBS), that gives functional data about tumor cellularity and helps in the detection of suspicious lymph nodes has been introduced.¹⁶

M staging: Preoperative M staging is important as, at the time of diagnosis, distant metastases are present in approximately 25% of colon cancers (19% liver and 3% lung metastasis) and 18% of rectal cancers (15% liver and 4% lung metastasis).¹⁶ According to the European Registration of Cancer Care (EURECCA) consensus, contrast-enhanced abdominal CT and chest CT should be performed for primary M staging of CRC (→ Fig. 4).³ Ultrasonography and MRI remain the second-line tools in cases of doubtful liver lesions on CT scan. For detection of liver metastasis ≥ 1 cm, contrast-enhanced CT scan is considered equal to MRI; however, the sensitivity drops for small lesions, which become important if liver resection is planned.¹⁷ To detect smaller lesions, MRI should be done using hepatocyte-specific contrast agents and diffusion-weighted images.¹⁸

Response Evaluation After Neoadjuvant Treatment

Restaging after neoadjuvant CRT is usually performed using MRI after 6 to 8 weeks of treatment or before surgery as the surgical approach may differ if the cancer is downstaged following CRT. Restaging following CRT is also important as the likelihood for complete pathological response following CRT is around 25%, and these patients might be candidates for a wait-and-watch strategy, which is currently investigated.¹⁹ As compared with conventional imaging techniques, use of DWI has increased in sensitivity in detecting residual tumor from 50% to nearly 80%.²⁰ In 2000, the Response Evaluation Criteria in Solid Tumors (RECIST 1.0) were proposed for

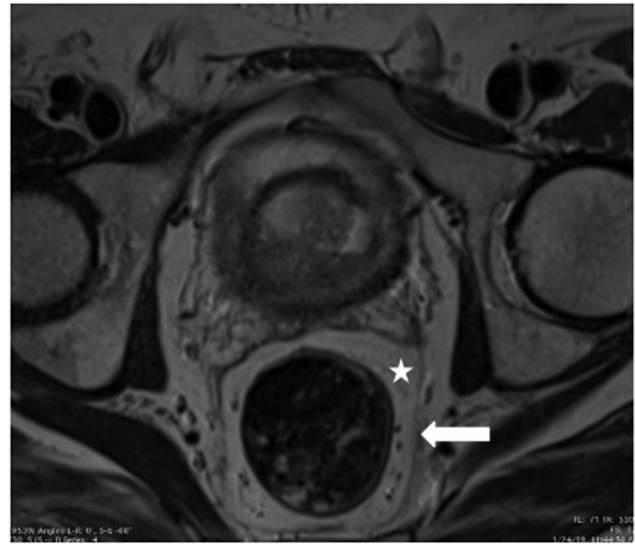


Fig. 4 Axial T2-weighted magnetic resonance image showing a normal anatomy of the rectum, mesorectal fat (*), and mesorectal fascia (arrow).

evaluating treatment response, followed by a revision in 2009 (RECIST 1.1).²¹ More recently, the MR tumor regression grade (mrTRG) is commonly used for grading tumors.^{22,23}

Magnetic Resonance Tumor Regression Grade (mrTRG)

The following MR tumor regression grade (mrTRG) categories are used to assess tumor regression (→ Fig. 5):

- TRG 1: Complete radiological response (linear scar only); no evidence of treated tumor.
- TRG 2: Good response (dense hypointense fibrosis, no obvious tumor signal); no tumor or minimal residual disease.
- TRG 3: Moderate response (~50% fibrosis/mucin and visible intermediate signal) signifying residual tumor.
- TRG 4: Slight response (mostly tumor, minimal fibrosis/mucinous degeneration).
- TRG 5: No response/regrowth of tumor (same as baseline or progression).

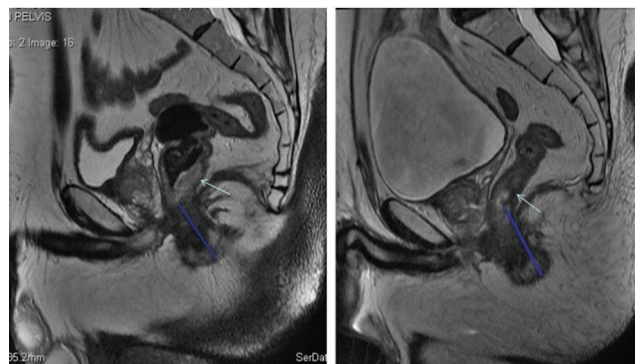


Fig. 5 Sagittal T2-weighted (T2W) magnetic resonance imaging showing low rectal cancer with intermediate signal before treatment. Following radiation therapy treatment, there is now dense low T2W signal in keeping with fibrosis and a tumor regression grade 2 response.

Follow-up: There is poor evidence for a routine use of radiological imaging for follow-up in CRC patients. Chest X-ray is recommended for annual follow-up of patients with rectal cancers in stages II and III within the first 5 years after treatment; however, there is no evidence for routine use of chest X-ray in patients with colon cancer for detecting lung metastasis.¹⁴ For detecting liver metastasis, several guidelines recommend an annual abdominal CT for the first 3 years after treatment.²⁴ In case of suspected recurrence or unclear findings on CT/MRI, further evaluation with positron emission tomography (PET) CT might be helpful.¹⁴

Conclusion

Radiological imaging plays a very important role in the initial diagnosis, staging, response evaluation, and follow-up of patients with CRC.

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Conflict of Interest

None declared.

References

- Roland CL, Barnett CC. Colorectal polyps. In: Harken AH, Moore EE, eds. *Abernathy's Surgical Secrets*. 6th ed. St. Louis, MO: Mosby; 2009:258–261
- Parikh PM, Sahoo TP, Biswas G, et al. Practical consensus guidelines for the use of S-1 in GI malignancies. *South Asian J Cancer* 2024;13(01):77–82
- Hari A, Jinto EG, Dennis D, et al. Choice of baseline hazards in joint modeling of longitudinal and time-to-event cancer survival data. *Stat Appl Genet Mol Biol* 2024;23(01):20230038
- Pickhardt PJ, Hassan C, Halligan S, Marmo R. Colorectal cancer: CT colonography and colonoscopy for detection: systematic review and meta-analysis. *Radiology* 2011;259(02):393–405
- Theis J, Kim DH, Lubner MG, Muñoz del Rio A, Pickhardt PJ. CT colonography after incomplete optical colonoscopy: bowel preparation quality at same-day vs. deferred examination. *Abdom Radiol (NY)* 2016;41(01):10–18
- Sha J, Chen J, Lv X, Liu S, Chen R, Zhang Z. Computed tomography colonography versus colonoscopy for detection of colorectal cancer: a diagnostic performance study. *BMC Med Imaging* 2020;20(01):51
- Pickhardt PJ. Positive oral contrast material for abdominal CT: current clinical indications and areas of controversy. *AJR Am J Roentgenol* 2020;215(01):69–78
- Hamlin DJ, Burgener FA. Positive and negative contrast agents in CT evaluation of the abdomen and pelvis. *J Comput Tomogr* 1981; 5(02):82–90
- Arya S, Das D, Engineer R, Saklani A. Imaging in rectal cancer with emphasis on local staging with MRI. *Indian J Radiol Imaging* 2015; 25(02):148–161
- Amin MB, Greene FL, Edge SB, et al. *The Eighth Edition AJCC Cancer Staging Manual: continuing to build a bridge from a population-based to a more “personalized” approach to cancer staging*. *CA Cancer J Clin* 2017;67(02):93–99
- Singla SC, Kaushal D, Sagoo HS, Calton N. Comparative analysis of colorectal carcinoma staging using operative, histopathology and computed tomography findings. *Int J Appl Basic Med Res* 2017;7 (01):10–14
- Hennig J. An evolution of low-field strength MRI. *Magn Reson Mater Biol Phys Med* 2023;36(03):335–346
- van de Velde CJ, Boelens PG, Tanis PJ, et al. Experts reviews of the multidisciplinary consensus conference colon and rectal cancer 2012: science, opinions and experiences from the experts of surgery. *Eur J Surg Oncol* 2014;40(04):454–468
- Yang X, Chen Y, Wen Z, et al. Role of quantitative dynamic contrast-enhanced MRI in evaluating regional lymph nodes with a short-axis diameter of less than 5 mm in rectal cancer. *AJR Am J Roentgenol* 2019;212(01):77–83
- Hsu WC, Huang PC, Pan KT, et al. Predictors of invasive adenocarcinomas among pure ground-glass nodules less than 2 cm in diameter. *Cancers (Basel)* 2021;13(16):3945
- Stewart CL, Warner S, Ito K, et al. Cytoreduction for colorectal metastases: liver, lung, peritoneum, lymph nodes, bone, brain. When does it palliate, prolong survival, and potentially cure? *Curr Probl Surg* 2018;55(09):330–379
- Acciuffi S, Meyer F, Bauschke A, Croner R, Settmacher U, Alten-dorf-Hofmann A. Solitary colorectal liver metastasis: overview of treatment strategies and role of prognostic factors. *J Cancer Res Clin Oncol* 2022;148(03):657–665
- Uribe PM, Hudson AM, Lockard G, et al. Hepatocyte growth factor mimetic confers protection from aminoglycoside-induced hair cell death in vitro. *Hear Res* 2023;434:108786
- Renehan AG, Malcomson L, Emsley R, et al. Watch-and-wait approach versus surgical resection after chemoradiotherapy for patients with rectal cancer (the OnCoRe project): a propensity-score matched cohort analysis. *Lancet Oncol* 2016;17(02): 174–183
- Erber BM, Reidler P, Goller SS, et al. Impact of dynamic contrast enhanced and diffusion-weighted MR imaging on detection of early local recurrence of soft tissue sarcoma. *J Magn Reson Imaging* 2023;57(02):622–630
- Unterrainer M, Deroose CM, Herrmann K, et al; European Organisation for Research and Treatment of Cancer (EORTC) Imaging Group. Electronic address: <https://twitter.com/EORTC> European Organisation for Research and Treatment of Cancer (EORTC) Gastrointestinal Tract Cancer Group European Society of Oncologic Imaging (ESOI) and the European Society of Gastrointestinal and Abdominal Radiology (ESGAR) Imaging standardisation in metastatic colorectal cancer: a joint EORTC-ESOI-ESGAR expert consensus recommendation. *Eur J Cancer* 2022;176:193–206
- Achilli P, Magistro C, Abd El Aziz MA, et al. Modest agreement between magnetic resonance and pathological tumor regression after neoadjuvant therapy for rectal cancer in the real world. *Int J Cancer* 2022;151(01):120–127
- Kershaw L, Forker L, Roberts D, et al. Feasibility of a multiparametric MRI protocol for imaging biomarkers associated with neoadjuvant radiotherapy for soft tissue sarcoma. *BJR Open* 2021;3(01):20200061
- Dawood ZS, Hamad A, Moazzam Z, et al. Colonoscopy, imaging, and carcinoembryonic antigen: comparison of guideline adherence to surveillance strategies in patients who underwent resection of colorectal cancer. A systematic review and meta-analysis. *Surg Oncol* 2023;47:101910