# Developments in the Radiological Management of Rectal Cancer

**Andrew Riddell,**
MB ChB MRCS, SpR
Colorectal Surgery,
The Royal Free Hospital,
London.

**Richard Novell,**
MChir FRCS,
Consultant Coloproctologist
The Royal Free Hospital,
London.

**Correspondence:**
Richard Novell,
University Dept. of Surgery,
The Royal Free Hospital,
Pond St,
London NW3 2QG, UK.

Colorectal cancer (CRC) is one of the commonest malignancies throughout the world, affecting two thirds of a million people every year and resulting in 400,000 deaths worldwide [1]. In the UK colorectal cancer has a mortality rate second only to lung cancer, with rectal cancers comprising approximately 40% of the total.

The management of rectal cancer has steadily advanced over the last two decades since Quirke et al demonstrated the importance of local recurrence following surgical resection [2], leading to the widespread adoption of total mesorectal excision (TME) [3] as a gold standard. TME has led to a reduction in local recurrence rate from over 20% to less than 10% [4]. There has also been a steady increase in the rate of anterior resection (which restores bowel continuity) and a decrease in the rate of abdomino-perineal resection and permanent colostomy for low rectal tumours. This has been due in part to patient choice and the evolution of better stapling devices to facilitate low colo-anal anastomosis but principally as a result of increasing specialisation of surgeons. A 1cm distal resection margin is now considered safe, allowing ultra-low rectal resection with preservation of the anal sphincter. The successful application of TME requires an adequate, tumour-free radial resection margin to demonstrate the benefits of enhanced disease-free survival, and accurate preoperative imaging is essential for both selection of the correct operation and of appropriate pre- and post-operative oncological management.

### Imaging techniques

Endorectal ultrasound is the oldest tool for evaluation of rectal cancer and in experienced hands can be very accurate at assessing the tumour (T) stage. However it can be difficult or impossible to perform in very low or stenosing tumours, poorly tolerated by patients and limited by both depth of scan and examiner experience.

Computerised tomography (CT) is superior to other modalities in scanning the entire abdomen, thorax and pelvis for metastatic disease but is of limited accuracy in staging rectal cancers. Older studies report low accuracy in assessment of T stage with rates of 52-70%. This has improved with newer scanners and scanning techniques but even recent studies have shown that CT does not correlate well enough with the superior results of magnetic resonance imaging to replace it in rectal cancer staging [5].

Over the last decade advances in the resolution of magnetic resonance imaging (MRI), particularly the development of phased array surface coils, coupled with increasing availability have led to MRI of the pelvis becoming a standard part of pre-operative staging in rectal cancer. This evolution in imaging and pre-operative staging has mirrored that of TME in colorectal surgery. The UK National Institute for Clinical Effectiveness (NICE) guidelines now state that all patients with invasive rectal cancers for whom surgery is being considered should undergo MRI scanning.

### Surgical circumferential resection margin (CRM)

The mesorectal fascia is a thin layer enveloping the fatty mesorectum, which in turn surrounds the smooth muscle of the rectal wall. High resolution MRI consistently demonstrates this mesorectal plane which marks the circumferential resection margin following optimal surgery [6]. Images recorded in a plane perpendicular to the rectum and mesorectum correspond precisely to equivalent radial slices through the histological specimen [7].

Because MRI is unique amongst scanning modalities in identifying the mesorectal fascia and because a competent TME will proceed along this plane, the CRM may be accurately predicted pre-operatively [8]. In 2001 Beets-Tan demonstrated that although MRI staging of rectal tumours had a moderate accuracy (67-83%) in predicting histological stage [9], the more important CRM was predictable with a high degree of accuracy and consistency, a tumour-free margin of only 2mm being predicted with an accuracy of 97%.

### Preoperative staging

The purpose of preoperative staging is to predict the histological extent of the tumour and thus the likelihood of local recurrence and disease free survival. The presence or absence of residual tumour following surgical resection strongly determines future outcome. The American Joint Committee on Cancer Prognostic Factors Consensus Conference defines R0 as the absence of residual disease, R1 as residual microscopic disease and R2 as residual macroscopic disease. MRI allows the surgeon to differentiate between favourable and unfavourable rectal tumours by accurately predicting R0 and R1 resections and therefore disease-free survival (Figure 1).

The MERCURY trial demonstrated that MRI

MRI allows the surgeon to differentiate between favourable and unfavourable rectal tumours by accurately predicting R0 and R1 resections and therefore disease-free survival


*Figure 1: Tumour of middle third of rectum extending through the rectal wall but not invading the mesorectal fat which appears white on MRI: predicted R0 resection (negative CRM involvement).*

predicts extension beyond the rectal wall to within 0.5mm tolerance[6]. With increasing confidence in the ability of MRI to predict radial clearance between tumour and CRM some groups are now limiting the indications for pre-operative radiotherapy (designed to downstage the tumour and improve resectability) to tumours extending to within 1mm of the mesorectal fascia[10] as a minimum distance of 1 mm appears to discriminate between those patients with a high (85%) or low (3%) risk of local recurrence[2]. However, a recent review of the worldwide literature reveals variation in the precise definition of a positive CRM[11].

## Additional Advantages of MRI

As an investigation MRI is fast (taking 20-30mins including planning), generally well tolerated by patients and involves no exposure to ionising radiation. In addition to defining the CRM, MRI also provides information regarding depth of invasion, involvement of other organs such as prostate and anal sphincters, extramural venous invasion and involvement of the peritoneal reflection for tumours of the middle third of the rectum.

Abdomino-perineal excision (APE) is now undertaken infrequently for very low rectal tumours involving the levator plate (pelvic floor) or anal sphincter muscles and the resection margins are thus different to those in anterior resection. The mesorectum becomes increasingly attenuated distally, disappearing completely just above the anus at the level of the pelvic floor: it therefore presents less of a barrier to radial spread of tumours at this level, particularly anteriorly. Technical difficulties relating to surgical access to the lower rectum, particularly in the narrow male pelvis, may increase the risks of incomplete tumour clearance. The structures of the lower rectum are well identified at MRI which can demonstrate possible lines of surgical excision by defining sphincter and levator plate involvement[6]. Through careful selection of candidates for radical APE it is to be hoped that MRI can facilitate a reduction in positive CRM rates comparable to that seen in anterior resection with TME.

## Limitations

Although MRI is currently the best option for preoperative staging of rectal cancers, some limitations remain. Due to the enclosed design of present scanners MRI is not well tolerated by claustrophobic patients. It cannot at present detect small-volume peritoneal invasion, nor demonstrate microscopic tumour invasion within peri-tumoral fibrosis. In patients with disease encroaching on the mesorectum and little fibrotic stranding this may lead to incorrect tumour staging, but is usually of little consequence in predicting resection margin [9]. Although accurate pre-op staging of lymph node spread with MRI is currently a significant limitation of the procedure, the use of ultra-small super-paramagnetic iron oxide particles (USPIO) as a contrast medium for MR lymphography has shown some promising initial results. The particles are taken up by nodal macrophages and give a decreased signal in normal or relatively unchanged lymph nodes [12].

## Conclusion

Over the last decade MRI has proved itself superior to all other modalities for pre operative imaging of rectal cancer. Rectal MRI has been demonstrated to be an accurate predictor of a positive surgical CRM, thus allowing the correct choice of both operation and adjuvant therapy (usually pre-operative radiotherapy in Europe or post operative therapy in the USA). This ability to predict the likelihood of complete tumour resection and therefore disease-free survival is vital in ensuring both adequate treatment where necessary and the avoidance of overtreatment and its attendant morbidity. ■

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