Staging of rectal cancer on MRI: What the surgeons want to know.

Poster No.: C-1108  
Congress: ECR 2014  
Type: Educational Exhibit  
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Keywords: Outcomes, Staging, Education, MR, Gastrointestinal tract  
DOI: 10.1594/ecr2014/C-1108

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Learning objectives

Be able to explain the MRI sequences used.

Understand and recognise important anatomical structures whilst reporting MRI of the rectum, such as mesenteric reflections, relationship of the cancer mass to the anorectal angle, distance from the anal verge, involvement of the mesorectal fascia (circumferential resection margin) and vascular invasion.

Describe how rectal cancer is staged using the TNM method, focusing on the local T stage and lymph node involvement and be able be recognise these on MRI images.

Explain relevant important information the surgeon’s would like to know from radiologist, which will help them to provide optimum treatment to the patient.

Discuss different treatment options and also cover the specific indications for choosing a particular treatment based on tumour stage/location.

Background

Colorectal cancer is the 3rd most common cancer in the United Kingdom after breast and lung (1). MRI is now routinely used in the management of patients with diagnosed rectal adenocarcinoma. It plays a vital role in local staging of rectal adenocarcinoma and evaluating treatment response.

It is essential that the radiologist provides accurate description of the disease spread. This allows the surgeons to decide on further treatment; in particular if surgery is required. The surgeons need to decide on the best operative procedure which will result in the least post operative co-morbidity, yet giving the patient the best chance of survival. The lower pelvis houses many important structures; including many nerve plexuses involved with genitourinary function thus important consideration should be given to the extent of clearance required (2, 3). In addition surgeons need to decide whether it is possible to spare the anal sphincter complex and also whether pre-operative radiotherapy or combined chemo-radiotherapy is needed with the aim to improve prognosis.
Findings and procedure details

MRI study

Rectal MRI studies make use of T2 weighted sequences due to its excellent soft tissue contrast capabilities (4). Sequences are acquired in a number of planes, which include the traditional sagittal, coronal and axial planes. In addition two further planes are necessary to interrogate the rectum; these are aligned with respect to the anatomical lie of the rectum and are acquired perpendicular to the rectal wall and also parallel to the rectal canal. The plane perpendicular to the rectal wall is particularly important as it overcomes the problem of partial volume artefact allowing accurate assessment of the T-stage of the tumour (fig 1).

Anatomy and surgical relevance

Mesorectal fat and fascia:

MRI has become a primary method for staging rectal cancer, most importantly because it clearly shows the mesorectal fascia (4) (fig 2). The fascia is seen as a linear low signal structure deep in the pelvis and has a pivotal role in pre-operative patient management and signifies the surgical circumferential resection margin (CRM). The rectum is surrounded by mesorectal fat, which is encompassed in a mesorectal fascia. Best prognosis is achieved with total mesorectal excision, which removes the draining lymphatics. The procedure is essentially removing the rectum along with surrounding mesorectal fat and mesorectal fascia (4).

Cancers that involve the mesorectal fascia will require pre-operative treatment in an attempt to down stage the tumour and also reduce local recurrence (1). The mesorectal fascia is termed threatened if the cancer is less than 1mm away. Lesions that are more than 1mm away are considered to have better prognosis and patients are likely to have a short course of preoperative radiotherapy and then go straight to surgery for total mesorectal excision. This is further discussed in the local staging of tumours.

Muscularis propria:

An important rectal wall structure which is clearly seen on MRI is the muscularis propria. This is the outer muscular layer of the bowel consisting of circular and longitudinal muscle layers. This structure is seen as a low intensity circumferential linear ring (fig 3). The importance of this structure to the surgeons is that, if cancer breaches muscularis propria,
the tumour is upstaged from T2 to T3 and thus alters treatment strategy and is associated with a moderate risk of local recurrence.

Peritoneal Reflections:

Peritoneal reflections are not seen on MRI unless it is thickened. On radiological images the rectosigmoid junction is taken as 15cm from the anal verge (4). In men the peritoneum lines the dome of the bladder as it passes posteriorly eventually lining the ventral surface of the proximal third of the rectum. In females the peritoneum may extend further down into the Pouch of Douglas (5). Cancers extending above the peritoneal reflection are likely to be involving the sigmoid colon and an intra-peritoneal approach is required for clearance in surgery. In addition if cancer is seen to be involving the peritoneal reflection the prognosis is poor and the tumour is staged as T4 (fig 4).

Tumour distance from the anal verge:

The surgeons are also interested to know how far the distal part of the tumour is from the anal verge and whether it lies above or below the anorectal angle (fig 4). Low rectal cancers are defined as being 4.5-7.5cm from the anal verge (6) usually in the lower third of the rectum. This has implications on whether it is possible to preserve continence by keeping the anal sphincter intact and if possible the anorectal region, therefore retaining the possibility of creating a neo-rectal pouch in the future. Where this is not a possibility, the patient will require an abdominoperineal resection, which involves resecting the involved rectum as well as the anal canal and creating a permanent colostomy. Tumours in the upper two thirds of the rectum usually undergo a lower anterior resection (fig 5), which conserves the anal sphincter.

The more distal the rectal tumour the closer it is to the mesorectal fascia and therefore the CRM. This is because there is tapering of mesorectal fat distally. Due to this, lower rectal tumours are more likely to invade surrounding structures and have a higher local recurrence rate (4).

Tumour length, involvement of lymph nodes, adjacent major structures and vascular invasion:

Many studies have shown a number of factors that can predict a worse prognosis these include the tumour length measured in the craniocaudal direction, lymph node involvement, the spread of disease to adjacent major structures (fig 6) and vascular invasion (fig 7). On MRI vascular invasion appears as a thickened nodular bands extending towards the sacral neural foramina. The chance that vascular invasion has
occurred is increased if there is nodular growth at the site of tumour, vessels in close proximity to the tumour and vessel enlargement and heterogeneity (4). Vascular invasion is associated with a moderate risk of local disease recurrence (1).

**TNM staging**

**Imaging approach**

Correct and accurate staging of tumour is paramount for best possible management. The imaging options are CT, MRI and endoscopic ultrasound. In our institution, we follow NICE (1) recommended strategy to stage patients diagnosed with rectal adenocarcinoma.

All patients diagnosed with rectal cancer undergo CT of the chest, abdomen and pelvis to assess for distant disease. MRI is performed to assess local tumour spread, relationship to the CRM and lymph node involvement. Endo-rectal ultrasound is offered to patients with very early tumour to assess whether it may be amenable to local excision via transanal endoscopic microsurgery (7).

**Tumour staging and predicting risk of local recurrence.**

**T-stage:**

The T-stage describes the spread of the primary disease and is graded as follows (1).

- **TX** Primary tumour cannot be assessed
- **T0** No evidence of primary tumour
- **Tis** Carcinoma in situ: intraepithelial or invasion of lamina propria
- **T1** Tumour invades submucosa
- **T2** Tumour invades muscularis propria
- **T3** Tumour invades through the muscularis propria into peri-rectal tissues
- **T4a** Tumour penetrates to the surface of the visceral peritoneum
- **T4b** Tumour directly invades or is adherent to other organs or structure
Differentiating between T1 and T2 tumour is best achieved with endo-rectal ultrasound (3). It is better than MRI or CT in identifying patients suitable for local resection. Figure 8 is an example of how clearly the ultrasound can depict the layers of the rectal wall and therefore assess early tumour spread. Figure 9 shows a lesion on the rectum which is T2 or less. This patient than went on to have anorectal ultrasound which showed the lesion to be T1 and thus suitable for anorectal endoscopic microsurgery.

The most important role of MRI is distinguishing T2 from T3 and T4 stage tumours, identifying lymph node involvement and predicting the risk of local recurrence (4,8). T2 lesions (fig 10) are considered low risk for local recurrence and surgical resection with total meso-rectal excision forms the treatment of choice.

T3 tumours penetrate into the mesorectal fat. Figure 11 shows two examples, figure 11a, shows a T3 tumour which is more than 1mm away from the mesorectal fascia, figure 11b tumour is situated less than 1mm from the mesorectal fascia. The risk of local recurrence in these two examples is moderate and high respectively. In the later example the mesorectal fascia is said to be threatened. In both cases however, treatment will involve pre-operative treatment followed by total mesorectal excision. Patients with high risk of recurrence may also be offered post-operative chemotherapy.

Similarly T4 lesions that extend into the surrounding organs as seen in figure 6 involving the sigmoid colon and cervix have a high risk of local recurrence. Tumours which extend into the inter-sphincteric plane or levator muscles also carry high risk of local recurrence. The treatment here is for pre-operative chemo-radiotherapy in the hope to reduce the tumour burden and recurrence following surgical resection. In this situation it is not uncommon to give post operative chemotherapy.

N-stage:

The N-stage assesses the degree of tumour spread to loco-regional lymph nodes, currently in our institution we use the 5th edition TNM staging system (1). Lymph node involvement is graded as shown below.

N0 No lymph nodes contain tumour cells

N1 There are tumour cells in up to 3 regional lymph nodes

N2 There are tumour cells in 4 or more regional lymph nodes

Figure 12 and 13 show example of N1 and N2 lymph node involvement respectively. Any pathological nodes result in a moderate risk of local recurrence. The CRM is considered
threatened if a pathological lymph node is less than 1mm from the mesorectal fascia and is associated with a higher risk of recurrence. Rectal cancer with positive nodes will require pre-operative chemo-radiotherapy prior to surgery and in the case of threatened CRM post operative chemotherapy may also be required.

Lymph nodes found outside of the mesorectal fascia are considered to be classed as distance metastasis.

M-stage:

Rectal MRI has a very limited role. CT is the main stay for detecting distant disease. For completion the grading for M-stage is given below.

**M0** No distant metastasis

**M1** Distant metastasis

Table 1 below summarises MRI findings and risk of recurrence with treatments recommended (1).

<table>
<thead>
<tr>
<th>Risk of local recurrence</th>
<th>MRI findings</th>
<th>Surgical treatment</th>
</tr>
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<tbody>
<tr>
<td>Low</td>
<td>T1, T2, T3 (not threatening CRM) and no lymph nodes.</td>
<td>Surgical clearance</td>
</tr>
<tr>
<td>Moderate</td>
<td>T3 (not threatening CRM)</td>
<td>Short course pre-operative radiotherapy followed by surgical clearance.</td>
</tr>
<tr>
<td></td>
<td>Lymph node involvement (not threatening the CRM)</td>
<td></td>
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<tr>
<td></td>
<td>Extramural vascular invasion</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>T3 tumour or lymph node threatening the CRM</td>
<td>Pre-operative chemoradiotherapy followed by surgical clearance and post-operative chemotherapy</td>
</tr>
<tr>
<td></td>
<td>Involvement of the CRM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Involvement of intersphincteric plane or levator sling.</td>
<td></td>
</tr>
</tbody>
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Images for this section:

Fig. 1: Shows the sequence and planes of a standard MRI rectum study.
**Fig. 2:** Anatomy on MRI axial image. Blue arrows outline the mesorectal fascia, white arrow mesorectal fat and the red arrow shows the rectum.
Fig. 3: The low attenuation linear ring forming the outer margin of the rectum is the muscularis propria (Arrow).
Fig. 4: Red arrow shows the peritoneal reflection over the pelvic organs. (Yellow arrow) rectum, (Green arrow) anorectal angle, (Blue arrow) rectum, (white arrow) anal verge.
Fig. 5: Cancer in the upper two thirds (Blue) likely to undergo lower anterior resection with anastomosis and retain normal continence and function. Tumours involving the lower third of rectum (red) undergo abdominoperineal resection with colostomy formation.
Fig. 6: MRI images show an axial plane perpendicular to the rectal wall and a lateral plane. A T4 Tumor mass (red arrow) is seen penetrating through muscularis propria anteriorly between 11 and 2 o'clock position and extends through the mesorectal fascia, invading into an anterior loop of sigmoid colon (white arrow) and the cervix (yellow arrow).
Fig. 7: Sagittal section MRI showing a large rectal tumour (yellow arrow) with vascular invasion (white arrow).
**Fig. 8:** Normal anorectal ultrasound scan demonstrating the layers of the rectum. (A) mucosa, (B) Muscularis mucosa, (C) Submucosa, (D) Muscularis propria.
**Fig. 9:** MRI showing a rectal lesion which is staged as T2 or less (white arrow). The ultrasound shows the same lesion at 10 o'clock position to be confined within the muscularis propria and so accurately staged as T1 (red arrow).

**Fig. 10:** Lateral and coronal plane parallel to the rectum showing a polypoid intra-luminal lesion staged as T2 (Arrow). Tumour is not seen extending into the mesorectal fat.
Fig. 11: 2 examples of T3 stage rectal adenocarcinoma. (A) shows a horse shoes shaped tumor with mesorectal fat invasion at the 12 - 2 o'clock position (white arrow). (B) shows a circumferential tumour with loss of the normal low signal muscularis propria at the 8-12 o'clock position and tumour spread into the mesorectal fat. The mesorectal fascia is clearly seen (red arrow).
**Fig. 12:** Shows 2 lymph nodes (arrows) within the mesorectal fat. Rectal mass is seen arising from the anterior rectal wall with loss of the muscularis propria. This is staged as T3, N1, Mx.
Fig. 13: Shows 2 slices in the coronal plane of the same patient. There are more than 3 regional lymph nodes. The N-stage here is N2.
Conclusion

Rectal MRI has gained a pertinent role in the staging, management and follow-up of patients with rectal adenocarcinoma due to its high soft tissue contrast capabilities.

With a good understanding of the pelvic anatomy on MRI and accurate cancer staging, the radiologist can provide pivotal information to the surgeons and the multi-disciplinary team. This information helps to instigate the best possible surgical and medical treatment strategy, in the hope to achieve the best prognosis or even cure the patient.

Personal information

References


