Rectal cancer: MRI assessment and staging

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Learning objectives

To illustrate the normal anatomy of the rectum and surrounding fascial planes.

Discuss rectal cancer staging with particular reference to MRI as an imaging tool for local and nodal disease.

Background

Rectal cancer is a common disease with high mortality and recurrence rates. Total mesorectal excision and pre-operative radiation is significantly reducing recurrence rates.

Imaging in rectal cancer is used to stratify cases based on the risk of recurrence into the right treatment arms. To these ends accurate local staging (T and N) is essential and high resolution MRI is emerging as a very useful tool.

Imaging findings OR Procedure details

Anatomy

The rectum extends from the anal canal to the recto-sigmoid junction measuring approximately 15 cm. Beginning at the anal verge, it is divided into 3 segments measuring 7 - 10 cm (lower third), 4 - 5 cm (middle third) and 4 -5 cm (upper third) respectively.

The anal verge (figure 1) is best identified on coronal images where the levator ani muscles insert onto the rectal muscular layer. Identifying tumour invasion into the levator ani (implying T4 disease) is important for surgical planning.

The mesorectum consists of fatty tissue surrounding the rectum. It contains lymph nodes, vessels and fibrous septa. It is surrounded by a thin layer of mesorectal fascia (figure 3), best seen on thin-section axial T2 images as a thin hypointense layer surrounding the
high signal mesorectal fat. The mesorectal fascia represents the circumferential resection margin (CRM) representing the fascial plane used for total mesorectal excision (TME).

Denovilliers' fascia (figure 4) is slightly thicker and forms the anterior surface of the mesorectum and extends superiorly to fuse with the peritoneal reflection.

The peritoneal reflection (figure 5) extends from the superior surface of the bladder to the anterior surface of the rectum at junction of the middle and lower third in men (slightly more variable in females). The rectovesical pouch is the peritoneum lined recess formed by this reflection between the rectum and bladder. On thin section T2 sagittal images the reflection is seen as a thin low signal layer and can be traced to its attachment on the rectum.

The presacral fascia (figure 6) is seen on sagittal thin section T2 images as low signal layer. The posterior surface of the mesorectum (figure 6) is seen as a low signal layer immediately anterior to the presacral fascia. The potential space inbetween these two fascial layers is the rectosacral space. Collections can be seen in this space if tumours on the posterior wall of the rectum perforate into this space, becoming T4 tumours.

Rectal wall anatomy (figure 7) can be delineated on T2 images into 3 layers. The hyperintense inner layer consists the mucosa and submucosa (these 2 layers cannot be differentiated). An intermediate hypointense layer represents the muscularis propria. A hyperintense outer layer represents the peri-rectal fat tissue.

**Tumour Staging**

Tumour on T2 weighted images is seen as intermediate signal in comparison to high signal mesorectal fat and low signal muscularis. It is also higher signal than the mucosal / submucosal layer.

In T1 disease (figure 8), tumour signal infiltrates the mucosal / submucosal layer. The muscularis is unaffected.

In T2 disease (figure 9) the muscularis layer is involved. The interface between the submucosa and muscularis is disrupted with thinning of the muscularis layer. The outer layer of the muscularis however should be crisp.

In T3 disease (figure 10), the perirectal fat is involved. The muscularis layer is completely involved and cannot be clearly differentiated from perirectal fat. Tumour infiltration is characterised by nodular or rounded border. Desmoplastic reaction around the tumour
can result in overstaging from T2 to T3. This appears as a hypo-intense speculated area in the perirectal fat and represents fibrosis alone without any tumour cells. Involvement of the CRM is related to early recurrence and needs to be carefully evaluated in T3 disease. Where tumour touches the CRM it is said to be 'involved' (figure 11). Where it is <5mm from the CRM, the CRM is said to be 'threatened'. In both cases, pre-operative chemo-radiotherapy is used to shrink the tumour before total mesorectal excision. Evaluation of the CRM is difficult in thin patients where there is little mesorectal fat and in tumours of the anterior wall of the rectum where there is little mesorectal fat separating the muscularis layer and the CRM.

In T4 disease (Figure 11), tumour signal is seen involving adjacent structures (organs, pelvic wall muscles).

<table>
<thead>
<tr>
<th>Tumour Stage</th>
<th>Histological Staging</th>
<th>MRI Staging</th>
<th>Treatment</th>
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<tr>
<td>T1</td>
<td>Tumour invades submucosa</td>
<td>Tumour signal is low in comparison to adjacent high signal submucosa</td>
<td>Local therapy eg. Transanal excision</td>
</tr>
<tr>
<td>T2</td>
<td>Tumour invades muscularis propria</td>
<td>Tumour signal extends into the muscle layer with loss of interface between the submucosa and circular muscle layer</td>
<td>Total mesorectal excision</td>
</tr>
<tr>
<td>T3</td>
<td>Tumour penetrates muscularis propria and invades the submucosa or non-peritonealised perirectal tissue</td>
<td>Tumour signal extends through muscle layer into the perirectal fat obliterating interface between muscle and perirectal fat.</td>
<td>Total mesorectal excision +/- short or long course pre-operative radiotherapy</td>
</tr>
</tbody>
</table>

T3a: Extramural tumour spread <5mm

T3b Extramural tumour spread >5mm
Table 1: Tumour staging and treatment

| T4 | Tumour directly invades other organs or structures | Tumour signal extends into adjacent structure or viscus | Long course radiotherapy with a view to downstaging |

**Nodal staging (figures 12 and 13)**

Rectal cancer has 2 main routes of lymphatic spread. From the upper rectum, it travels along the superior rectal vessels to the inferior mesenteric vessels. From the lower rectum, it travels along the middle rectal vessels to the internal iliac vessels. Downward spread along the inferior rectal vessels to the groin is unusual except in very advanced cases and when the anal canal is involved.

An important paper assessing predictors of lymph node involvement found that size is not a good predictor. 58% of malignant nodes were < 5mm and there was significant overlap in size between benign and malignant nodes. Signal status and border were better. 91% of mixed signal nodes containing foci of different signal were malignant and 92% of nodes with irregular borders were malignant. Combing mixed signal and irregular borders gives a sensitivity of 85% and specificity of 98%.

**Conclusion**

The survival rates for resectable rectal cancer has improved in the last decade. MRI is essential to identify patients suitable for resection based on accurate local staging.

**Personal Information**

**References**

