Minimally invasive surgery for early rectal cancer - what the radiologist needs to know

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Learning objectives

1. To better understand current conservative surgical techniques used for resection of malignant rectal lesions with curative intent.
2. Learn the anatomy of both rectal MRI and endoscopic ultrasound (EUS) which is required for appropriate patient selection prior to minimally invasive surgery.
3. Understand what the surgeon wants to know, with reference to the specific surgical techniques and suggestions for structured reporting.
Background

Colorectal cancer is currently the third most common cancer and the fourth most common cause of cancer-related deaths (1). There are approximately 41,000 new cases of colorectal cancer in the United Kingdom every year (2013-2015). The National Cancer Institute’s database quotes the five-year relative survival rate for stage I rectal cancer to be 88%, dropping to 81% for stage IIa disease and 58% for stage IIIc disease.

Trends toward earlier diagnosis due to screening

Bowel screening programmes for colorectal cancer are in place throughout the world. In England, bowel screening is currently offered to adults from 60 to 74 years of age using the faecal occult blood test (FOBt) (2), soon to be replaced by the introduction of the faecal immunochemical test (FIT). High-risk groups excluded from the screening programme include those with a history of colorectal cancer, adenomas, inflammatory bowel disease, a strong family history or pre-disposing hereditary conditions. Patients with an abnormal FOBt result are offered either an optical colonoscopy or CT colonography. Any suspicious lesion is biopsied, and then referred urgently for management if the biopsy confirms colorectal cancer. Those with a normal screening test are then offered another faecal occult blood test every two years until they reach the maximum age for the screening cohort. Beyond this age, patients may be screened every 2 years upon their own request.

It is therefore perhaps unsurprising that although the incidence of colorectal cancer is increasing in the UK, the mortality is declining (3). This is almost certainly due to a combination of factors, including the national bowel screening programme, the increasing sensitivity of pre-operative imaging, the development of neoadjuvant chemotherapy, and improving surgical techniques.

Current T-Staging of Colorectal Cancers: TNM 8 (4)

<table>
<thead>
<tr>
<th>T Stage</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX</td>
<td>Primary tumour cannot be assessed</td>
</tr>
<tr>
<td>T0</td>
<td>No evidence of primary tumour</td>
</tr>
<tr>
<td>Tis</td>
<td>Carcinoma in situ</td>
</tr>
<tr>
<td>T1</td>
<td>Tumour invades submucosa</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>T2</td>
<td>Tumour invades the muscularis propria</td>
</tr>
<tr>
<td>T3</td>
<td>Tumour invades through muscularis propria into the pericoloretal tissues</td>
</tr>
<tr>
<td>T4 - T4a</td>
<td>Invades through visceral peritoneum</td>
</tr>
<tr>
<td>- T4b</td>
<td>Invades or directly adheres to other adjacent organs or structures</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>N Stage</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>NX</td>
<td>Lymph nodes cannot be assessed</td>
</tr>
<tr>
<td>N0</td>
<td>No regional lymph node metastases</td>
</tr>
<tr>
<td>N1</td>
<td>Metastases in 1 - 3 regional lymph nodes</td>
</tr>
<tr>
<td>N1a</td>
<td>1 lymph node</td>
</tr>
<tr>
<td>N1b</td>
<td>2 - 3 lymph nodes</td>
</tr>
<tr>
<td>N2</td>
<td>Metastases in 4 or more regional lymph nodes</td>
</tr>
<tr>
<td>N2a</td>
<td>4 - 6 lymph nodes</td>
</tr>
<tr>
<td>N2b</td>
<td>7+ lymph nodes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>M Stage</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>M0</td>
<td>No evidence of metastasis in other sites or organs</td>
</tr>
<tr>
<td></td>
<td>- defined by imaging</td>
</tr>
<tr>
<td>M1</td>
<td>Distant metastasis</td>
</tr>
<tr>
<td>M1a</td>
<td>Confined to 1 organ/site without peritoneal metastasis</td>
</tr>
<tr>
<td></td>
<td>Confined to 1 organ/site without peritoneal metastasis</td>
</tr>
<tr>
<td>M1b</td>
<td>Metastasis to 2 or more sites/organs, without peritoneal metastasis</td>
</tr>
</tbody>
</table>
Surgical Management

Abdominoperineal (AP) or anterior resection has traditionally been the mainstay of surgical management with curative intent for patients with rectal cancer. However, due to earlier diagnosis with the advent of bowel screening, rectal EUS and improved rectal MRI sensitivity, there is increasing utilisation of minimally invasive and sphincter preserving surgical techniques including transanal endoscopic operations (TEOs) and transanal total mesenteric excision (taTME) in curative-intent resection of rectal cancer.

Traditional Radical Resection of Rectal Cancer

Abdominoperineal (AP) resection (including ExtraLevator AP Resection - ELAPE) and anterior resection are forms of radical resection that have traditionally been the mainstay of surgical management with curative intent for patients with rectal cancer. All radical resections with curative intent also include total mesenteric excision, involving precise dissection and removal of the entire mesorectum as an intact unit. A brief summary of the indications, procedure overview and complications are included below:

Abdominoperineal (AP) resection and ELAPE

Indication:
- Low rectal tumours (lower third of rectum)
- Anal carcinoma

Procedure overview:
- Removal of the anus, rectum, regional lymph nodes and part of the sigmoid colon
- Formation of an end colostomy.

Complications (5):
- Intra-abdominal or pelvic sepsis: affects up to 32% of patients with early complications (5)
- Perineal wound
- Nerve injury
- Urologic injury (e.g. if the dissection of Denonvilliers’ fascia is too close to the prostate)
• Sexual dysfunction

Low Anterior Resection

Indication:
• Tumours of the upper two thirds of the rectum

Procedure Overview:
• Anastomosis between the remaining rectum and sigmoid colon
• Preservation of the internal sphincter.

Complications:
• Anastomotic leak
• Abdominal wound infection
• Pelvic abscess
• Haematoma
Findings and procedure details

**Definition of early rectal cancer**

Early rectal cancer is defined as a "rectal cancer with good prognostic features that might be safely removed preserving the rectum, and that will have a very limited risk of relapse after local excision." (6). This generally indicates T1 tumours with no local nodes (N0) and a low risk of lymph node metastases. The risk of lymph node involvement increases with the presence of lymphovascular invasion and poor tumour differentiation.

**Imaging of early rectal cancer:**

MRI and endorectal ultrasound (ERUS) are complementary imaging modalities in the staging and pre-operative surgical planning of T1 tumours. When used in conjunction, they increase the accuracy of T-staging of early rectal cancers (7). For staging T2 tumours or larger, MRI is the modality of choice (6). Unlike ERUS, MRI is also is able to identify lymph nodes within the mesorectum and within the pelvic side-wall (8).

**Case 1.** Correlation of imaging in the same patient with a large rectal polyp on both ERUS (Fig. 1 on page 20) and on MRI (Fig. 2 on page 20), suitable for TEO resection. The he muscularis propria remins intact around the tumour, which extends from approximately the 4 o'clock to 6 o'clock position.
Fig. 1: Case 1. EUS images in a patient with a large rectal polyp. T = tumour. White arrow = Muscularis mucosa, hypoechoic - breached by the tumour. Yellow arrow = Submucosa, hyperechoic. Red arrow = Muscularis propria, hypoechoic - intact around the tumour

References: Truro/UK
Fig. 2: Case 1. T2 axial images in the same patient with a large rectal polyp. T = Tumour. Red arrow = hypoechoic muscularis propria, which is not breached by tumour. Yellow arrows = mesorectal fascia or circumferential resection margin. White arrow = mesorectal fat.

References: Truro/UK

Case 2. Second patient with a large rectal polyp, biopsy positive for adenocarcinoma: On both ERUS (Fig. 3 on page 21) and MRI (Fig. 4 on page 22) the muscularis propria is intact throughout with no evidence of invasion, in keeping with a T1 lesion. The patient underwent TEO resection and the final histopathology confirmed T1 tumour.
Fig. 3: Case 2. The low rectal polyp is seen on EUS. The hypoechoic muscularis propria (red arrow) is intact throughout with no evidence of tumour within it. If malignancy proven T1 at worst. T = tumour.  

References: Truro/UK
**Fig. 4**: Case 2. The invading edge of the tumour extends from 2 o'clock to 3 o'clock, but does not breach the hypoechoic muscularis propria (red arrow), making this a T1 cancer (at worst).

**References**: Truro/UK

**Case 3**. Third patient with a large rectal polyp and biopsy-proven adenocarcinoma: On ERUS (Fig. 5 on page 23) the muscularis propria is intact throughout with no involvement. There is some irregularity of the submucosa in places. On MRI, the invading edge of the tumour extends from 4 o'clock to 6 o'clock (Fig. 6 on page 24). The tumour is confined to the muscularis propria. The stage is therefore either T1 or benign, the final histopathology confirmed a T1 tumour.
Fig. 5: Case 3. EUS demonstrates the polypoidal lesion in the rectum. The muscularis propria (red arrow) is intact. There is some irregularity of the submucosa (white arrow). Appearances are in keeping with a T1 lesion.

References: Truro/UK
**Fig. 6**: Case 3. Axial T2 MRI images demonstrating that the invading edge of the tumour (T) extends from 4 o'clock to 6 o'clock. The tumour is confined to the muscularis propria (red arrow). The T stage is therefore either T1 or benign. Final histopathology following TEO confirmed a T1 lesion.

**References**: Truro/UK

**Case 4.** Unfortunately this patient was unable to have an MRI. However, ERUS (Fig. 7 on page 25) demonstrates T3 disease. There is loss of the hypoechoic muscularis propria from the 9 o'clock to 11 o'clock position (red arrow) adjacent to the tumour (T). This is in contrast to the presence of the normal hypoechoic muscularis propria seen elsewhere (green arrow). This patient is not suitable for minimally invasive surgery.
Fig. 7: Case 4. EUS demonstrates T3 disease. There is loss of the hypoechoic muscularis propria from the 9 o’clock to 11 o’clock position (red arrow) at the point of invasion of this semi-annular tumour (T). This is in contrast to the presence of the normal hypoechoic muscularis propria seen elsewhere (green arrow).

References: Truro/UK

Treatment Strategies

All patients deemed suitable for curative-intent resection of rectal cancer should receive a complete colonoscopy and digital rectal examination (6), as the risk of synchronous colorectal cancers and colorectal polyps is approximately 3% and 30% respectively (9, 10). There should be a multidisciplinary team meeting (MDT) discussion that involves the surgeon, radiologist, pathologist and oncologist when deciding what treatment method to proceed with. This may involve a minimally invasive operation or a radical resection. Discussion of the critical role of neoadjuvant chemotherapy is beyond the scope of this poster.
Evolving Surgical techniques

There is increasing utilisation of minimally invasive and sphincter preserving surgical techniques in early rectal cancer. These minimally invasive techniques may be considered intraluminal or extra-luminal: Intra-luminal techniques include transanal endoscopic microsurgery (TEMS) or transanal endoscopic operations (TEO). Extra-luminal minimally invasive techniques include the sphincter-preserving method of transanal total mesenteric excision (taTME) in curative-intent resection of rectal cancer.

Transanal endoscopic microsurgery (TEMS) or Transanal endoscopic operation (TEO)

Procedure Overview:

The patient is positioned in a lateral decubitus or supine position. The scope is inserted via the anus with a three-dimensional viewing endoscopic system attached, allowing passage of instruments and removal the polyp or T1 cancer via the anus (Fig. 9 on page 27 and Fig. 8 on page 26). TEO only differ from TEMS in that it involves the incorporation of high-definition vision. The two procedures are similar, and have no technical or clinical difference in outcome (11).

The resection margin is then marked and a full thickness incision is made, which should include a sufficient border of normal mucosa. This technique does not allow wide excision of the tumour or excision of the mesorectum with all lymph nodes. The rectum is then washed out and the defect is closed with sutures via the TEM scope.
Fig. 9: Insertion of the TEMS scope through the anus, allowing passage of instruments for dissection and removal of the polyp or T1 cancer via the anus.

References: Oxford Colorectal Surgery 2011-2017
Fig. 8: Insertion of the TEMS scope through the anus, allowing passage of instruments for dissection and removal of the polyp or T1 cancer via the anus. 


Complications (12):

- Conversion to radical surgery in up to 4.3% (12)
- Haemorrhage (27%)
- Urinary tract infection (21%)
- Suture line dehiscence (14%)
- Faecal incontinence - often temporary (1%)

Benefits in comparison to radical resection:

- Shorter operation time
- Shorter hospital stay: Same day or next day discharge (13)
- Avoid pelvic floor disruption, perineal wound complications and stoma formation
• Improved post-operative quality of life (14)
• Comparable survival, disease-free survival and distant metastases (14)

Drawbacks in comparison to radical resection:

• Limited data comparing oncologic outcomes of TEMS and radical resection
• Unable to excise local nodes
• Tumours that are less than 5 cm from the anal verge may not be visualized adequately with TEMS (15)

What the surgeon wants to know

Is this patient suitable for a TEMS/TEO procedure?

Careful patient selection is essential prior to local excision of early rectal cancer, and should involve a multidisciplinary team meeting discussion between the surgeon, radiologist and histopathologist. To avoid the need for a radical salvage resection the following selection criteria are recommended (15):

Suggested criteria for local excision by TEMS:

<table>
<thead>
<tr>
<th>Physical examination</th>
<th>Tumour &lt; 3 cm</th>
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<tbody>
<tr>
<td></td>
<td>Tumour &lt;30% bowel circumference</td>
</tr>
<tr>
<td></td>
<td>Tumour within 15 cm of dentate line</td>
</tr>
<tr>
<td></td>
<td>Tumour freely mobile</td>
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</table>

<table>
<thead>
<tr>
<th>Imaging (ERUS and MRI)</th>
<th>Tumour limited to submucosa (T1)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>No lymph node involvement (N0)</td>
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</tbody>
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<thead>
<tr>
<th>Histology</th>
<th>Well to moderately differentiated</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>No lymphovascular invasion</td>
</tr>
<tr>
<td></td>
<td>No perineural invasion</td>
</tr>
<tr>
<td></td>
<td>No mucinous or signet cell component</td>
</tr>
</tbody>
</table>
Following a TEMS procedure, has the resection been adequate?

The definitive histopathology must be reviewed following TEMS. Ideally TEMS would be the endpoint of operative management, however it may turn out to be part of the diagnostic work-up. If there are inadequate resection margins or if the histology is high grade, then a radical salvage resection should be offered to the patient (16).

How should patients be followed up after TEMS?

In the context of favourable histology and clear resection margins, an appropriate follow-up strategy is required to ensure early detection of local recurrence or distant metastasis. MRI is a feasible follow-up strategy (17). However, nodal recurrence remains challenging and postoperative changes can also make interpretation of MRI difficult, leading to underestimation of recurrence (17). Therefore surveillance varies centre to centre, and may involve both colonoscopy and MRI.
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**Fig. 4:** Case 2. The invading edge of the tumour extends from 2 o'clock to 3 o'clock, but does not breach the hypoechoic muscularis propria (red arrow), making this a T1 cancer (at worst).

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**Fig. 8:** Insertion of the TEMS scope through the anus, allowing passage of instruments for dissection and removal of the polyp or T1 cancer via the anus.

**Fig. 9:** Insertion of the TEMS scope through the anus, allowing passage of instruments for dissection and removal of the polyp or T1 cancer via the anus.

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Conclusion

This poster is a brief overview of the topical and complex discussion surrounding the appropriate management and follow-up of early rectal cancer. A fundamental understanding of evolving conservative surgical techniques for early rectal cancer underpins the role of the radiologist in management pathway planning, both in the multidisciplinary team and in accurate reporting. The management of early rectal cancer should always be based on a multidisciplinary approach, aiming to increase the rate of organ-preserving procedures without jeopardising survival (6).
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References


