ACCURACY OF MRI IN PREDICTION OF TRANSMURAL INVASION AND TUMOUR-FREE RESECTION MARGIN IN RECTAL CANCER

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Introduction:
Colorectal carcinoma is the second most common malignancy in Australia. A third of these involve the rectum. If no metastases are present, treatment is surgery with the aim of cure. Local recurrence is a major obstacle due to microscopically positive radial resection margins. Total mesorectal excision (TME) is en-bloc removal of rectum + mesorectum by sharp dissection along the mesorectal fascia and significantly reduces local recurrence rates to under 10%. With TME, the main factor affecting local recurrence is tumour involvement of the circumferential resection margin (CRM) ie mesorectal fascia resulting in 22-55% local recurrence rates versus under 10%. If CRM is involved a long-course of chemoradiotherapy is given to downsize the tumour, facilitating margin-free resection reducing local recurrence rates. If CRM is not involved, the main factor guiding treatment is the depth of tumour penetration. A short-course neoadjuvant radiotherapy decreases local recurrence in patients with transmural invasion of tumour. If tumour is confined to the rectal wall, the decrease in local recurrence is too small to justify the toxicity of radiotherapy
For these reasons, accurate pre-operative identification of transmural invasion and CRM involvement is needed to select patients for neoadjuvant therapy to minimise local recurrence and avoid the toxicity of chemoradiotherapy in patients who have early stage disease.MRI provides good spatial and contrast resolution and has been shown to be accurate for local staging of rectal cancer and is superior to both CT and endoanal US.

Methods:
Rectal MRIs were performed on 101 consecutive patients with histologically proven rectal adenocarcinoma between 8/4/2004 and 26/7/2010. All included patients (50, 33 male and 17 female) underwent rectal MRI, followed by surgery, without neoadjuvant therapy. Mean age of 67.5 years (22-84). Mean time from MRI to surgery was 19.2 days (0-42 days). Patients were excluded if they had undergone neoadjuvant therapy (46 patients) or histopathology was unavailable (5 patients).
High resolution MRI scans were performed on either a 1.5 tesla (45 patients) Siemens Avanto , Picker Edge or a 3 tesla (5 patients) Siemens Tim Trio with phased array surface coils.
The axial FSE T2 weighted sequence is the single most important sequence for identifying tranmural invasion. The imaging plane should be perpendicular to the rectal wall at the level of the tumour, so that true axial images of the tumour-involved rectal wall are obtained, avoiding partial voluming, and obtain crisp interface between rectal wall and mesorectal fat.
Images read by 2 radiologists, blinded to the surgical findings and histopathology.
Images were assessed for the T stage of the tumour (depth of invasion) and involvement of CRM (<1mm from mesorectal fascia).
T1: invasion of submucosa
T2: invasion of muscularis propria
T3:extension beyond muscularis propria into mesorectum= transmural invasion
T4: transmural extension with invasion of adjacent organs/structures
MRI findings were compared to the histology of the surgical resection specimen and the accuracy, sensitivity, specificity, positive predictive value and negative predictive value determined for both the presence of transmural invasion (T3/4 versus T1/2) and CRM involvement.

Results
49 patients had a single tumour and 1 patient had 2 tumours. 10 tumours were well differentiated, 33 were moderately differentiated and 4 were poorly differentiated, 2 were mucinous and 1 was signet cell. 18 tumours were low rectal (<5 cm), 17 were middle (5-10 cm) and 16 were upper (10-15 cm).
Transmural invasion
Histopathologically, transmural invasion (T3 or T4) was present in 29 of 51 (T1 or T2) tumours and absent in 22 of 51.
25 of the 29 tumours with transmural invasion were correctly identified with 4 false negatives. 19 of the 22 tumours without transmural invasion were correctly identified with 3 false positives (Accuracy: 86%, Sens: 86%, Spec: 86 %, PPV: 89%, NPV: 83 %).
Of the 3 false positives, all 3 studies were compromised by poor image quality due to partial voluming from tortuous bowel causing blurring of the interface between tumour-involved rectal wall and mesorectal fat, misinterpreted as transmural invasion.
Of the 4 false negatives 2 were compromised by marked motion degradation, 1 was obscured by tumour intussuception and 1 was interpreted as desmoplastic reaction instead of tumour penetration through the rectal wall.
CRM involvement
Histopathologically CRM was involved in 7 of 48 tumours and not involved in 41 of 48 tumours.
Histology of CRM involvement was unavailable in 3 (had mucosal excision, not TME).
With MRI, CRM involvement was correctly identified in 7 of 7 cases and correctly identified as absent in 37 with 4 false positives (Sens 100%, Spec 90%, PPV 64%, NPV 100%).
Of the 4 false positives, 1 suffered poor image quality due to motion degradation, 2 were due to reader error, both being high tumours at rectosigmoid junction and 1 was desmoplasia at peritoneal reflection, interpreted as tumour.

Discussion
High resolution MRI is accurate for identifying transmural invasion and CRM involvement in rectal cancer and should be performed in all patients with a new diagnosis of rectal cancer in whom surgery is being contemplated. The radiologist must report the relationship of the tumour to the CRM, in addition to T and N stage.
Accurate pre-operative local staging of rectal cancer is imperative for appropriate selection of treatment. It is aided by high quality imaging. This is best achieved by radiologist input in choosing imaging planes perpendicular to the tumour wall and the use of buscopan for high rectal tumours.