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Review Article

THE ROLE OF HIGH RESOLUTION MAGNETIC RESONANCE IMAGING (MRI) IN DETECTING CIRCUMFERENTIAL RESECTION MARGIN (CRM) FOR THE PROGNOSIS OF RECTAL CANCER

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ABSTRACT

Rectal cancer carries poor prognosis because of metastasis and local recurrence. Local recurrence has a profound effect on morbidity and quality of life. Therefore, preoperative staging of rectal cancer has an important impact on treatment plan. The main factor in predicting the local recurrence is the circumferential resection margin (CRM). Surgical resection with stage-appropriate neoadjuvant combined-modality therapy is the mainstay in the treatment of rectal cancer. Recently, high-resolution magnetic resonance imaging (MRI) is regarded as a superior modality in the preoperative assessment of CRM with high accuracy and reproducibility and for T staging of tumor. However MRI is less accurate in diagnosis of nodal involvement.

Keywords: Rectal cancer, Circumferential resection margin (CRM), High Resolution Magnetic Resonance Imaging (MRI)

INTRODUCTION

Colorectal cancer is a malignant disease on the rise. Colorectal cancer is the second most common cancer in women and the third most common cancer in men with 570,100 and 663,600 estimated new cases per year worldwide, respectively(1). Colorectal cancer is the second most common cancer in general and the most common of the gastrointestinal tract cancers. One-third of all colorectal cancers occur in the recto-sigmoid or rectal region. Rectal cancer is a major problem precisely because of its high incidence. Prognosis of rectal cancer is determined by depth of invasion, number of involved lymph nodes, and involvement of circumferential resection margin. Current approach in the management of rectal cancer includes preoperative staging with different imaging modalities followed by neo-adjuvant chemo-radiotherapy (for stage II/III cancers). This approach has lowered the local recurrence rate (11%) and improved survival (58% 5-year survival)(2).Surgical resection with stage-appropriate neoadjuvant combined-modality therapy is the mainstay in the treatment of rectal cancer. A multidisciplinary approach defining the optimal timing and a combination of surgery, chemotherapy and radiation therapy, is necessary to develop an effective individual strategy for therapy (3). Therefore the accurate pre-operative staging of rectal cancer is mandatory and the challenge for imaging is to distinguish tumors with different risks for recurrence: early stage localized lesions, locally advanced cancers, advanced or metastatic disease (4).

Circumferential resection margin (CRM):

Tumor to mesorectal fascia distance, which is called as circumferential resection margin (CRM), is another prognostic indicator and an independent predictor of local recurrence. Pathologists consider any specimen showing tumor ≤ 1 mm from the mesorectal fascia as having a positive margin (5, 6), although the criteria of ≤ 2 mm (7) has been proposed as more reliable. More recently, the circumferential resection margin (CRM) has been identified as an indicator of the quality of surgery within a unit, and there is now good evidence to relate the CRM status to improved outcomes (7, 8). CRM involvement is the single most powerful predictor of local recurrence in rectal cancer, and consequently, assessment of the CRM, or mesorectal fascia, has become important in the assessment of patients (9, 10, 11).

Evaluation of the CRM could therefore be considered as an early alternative end point for future randomized trials comparing different treatment regiments for patients with locally advanced rectal cancer (12). The most advantageous treatment strategy for this specific subset of patients requires a multidisciplinary approach. This implies not only high-quality surgery and neoadjuvant therapy but also optimal imaging to identify patients who will benefit from this strategy and accurate pathologic assessment of CRM involvement (5, 13) for evaluating successfulness of the strategy.

DISCUSSION AND RESULT

High Resolution magnetic resonance imaging (MRI):

Rectal cancer carries poor prognosis because of metastasis and local recurrence. Local recurrence has a profound effect on morbidity and quality of life. Randomized trials have proven that neoadjuvant treatment can significantly reduce local recurrence rate in some selected cases of advanced rectal cancer. Therefore, preoperative staging of rectal cancer has an important impact on treatment plan. High-resolution T2-weighted imaging is the key sequence in the magnetic resonance (MR) imaging evaluation of primary rectal cancer. In experienced hands, this technique allows differentiation between rectal tumors confined within the rectal wall (stage T2 tumors) and those that extend beyond the muscularis propria (stage T3 tumors) (14).In the past decade, the increasingly widespread adoption of total mesorectal excision (TME) has resulted in a dramatic decline in the prevalence of local recurrence from 38% to less than 10% (15). TME is a surgical technique that entails en bloc resection of the primary tumor and the mesorectum by means of dissection along the mesorectal fascial plane or the circumferential resection margin (CRM) (15). Even with TME, however, the presence of a tumor or malignant node within 1 mm of the CRM remains an important predisposing factor for local recurrence (5). Consequently, reliable preoperative imaging evaluation is vital to surgical planning.

High-resolution magnetic resonance imaging (MRI) is regarded as a superior modality in the preoperative assessment of CRM with high accuracy and reproducibility. For low rectal cancers, mesorectum is thin at the level of levator ani especially in relation to prostate; so predicting circumferential resection margin involvement is not easy. However high spatial resolution coronal imaging shows levator muscles,sphincter complex and intersphincteric plane accurately. This is used to stage low rectal tumors and plan plane of surgery (standard surgery, intersphincteric resection, Extralevator abdominoperineal resection). MR imaging of the rectum may be performed with either an endorectal coil or a phased-array surface coil. Transrectal MRI using an endorectal coil can generate images with good spatial resolution due to its high signal-to-noise ratio. This provides more accurate information about wall penetration than conventional MRI. However, as in the case of transrectal ultrasound, its use is limited by the necessity for specialised, dedicated equipment, poor patient acceptability and limited access to the tumour in patients with high or stenosing lesions. The assessment of the mesorectal fascia is also hampered by its limited field of view (11,16-19). Hence standard MRI includes images with phased-array body coil only.

High resolution magnetic resonance imaging (MRI) has achieved good accuracy in the preoperative prediction of positive CRM, depth of extramural spread and other poor prognostic features suggestive of locally advanced disease. MRI can accurately predict CRM status and direct risk-stratified management strategies so as to select patients appropriate for preoperative neoadjuvant therapy. MRI prediction of CRM mesorectal fascia (MRF) with final histology was performed by Beets-Tan *et al*[20]. They concluded that tumour-free margin of at least 1.0 mm could be predicted when the measured distance on MRI was at least

5.0 mm, and a margin of at least 2.0 mm when the MRI distance was at least 6.0 mm. Inter observer agreement was better for CRM than for T stage. However nodes threatening CRM were difficult to evaluate. While the original study by Beets-tan concluded that MRI prediction of CRM involvement is reliable but suggested the use of a wider threshold on MRI compared to pathology[20]. The MERCURY group based their predicted CRM involvement on MRI to be less than 1 mm. A prospective study by Taylor *et al*[21] also showed that a cutoff of 1 mm on MRI could be used to predict clear margins with a low positive histologic CRM rate (3.3%)[21].

High resolution MRI has a sensitivity of 60-88% and a specificity of 73-100% for determining CRM status (22). A meta-analysis including nine studies and 529 patients reported that the sensitivity and specificity of MRI for detecting CRM involvement were 94% and 85% respectively (23). Karatag et al. (24) showed that phased-array coil MRI had 95.8% accuracy for determining CRM involvement and negative predictive value was 100%. Al-Sukhni et al. (25) recently reported a meta-analysis of 21 studies where MRI with phased-array coil was found to have 94% specificity (range, 88%–97%) for predicting CRM involvement. Accuracy of MRI for predicting CRM involvement might differ according to the tumor location. According to Peschaud et al. (26), MRI was in agreement with pathological CRM involvement in 22% of patients with low anterior rectal tumors, 83% of patients with low posterior rectal tumors, and 100% of patients with mid-rectal tumors. When patients with low anterior rectal cancer were excluded, the overall agreement was 90%, with 100% sensitivity and 86% specificity. The authors postulated that the presence of rather thin perirectal fat anterior to the rectum might limit the ability of MRI to detect anterior mesorectal fascia. Also the proximity of low anterior rectal wall to seminal vesicle in men and posterior vaginal wall in women might contribute to the poor performance of MRI in detection of CRM involvement in low anterior tumors (24). In the MERCURY group study, the accuracy for predicting the status of CRM by initial imaging or imaging after treatment but before surgery in 408 patients was 88%. Of the 408 patients, 311 underwent primary surgery. The accuracy for prediction of a clear margin was 91% with a negative predictive value of 93%. This compared with an accuracy of 77% and negative predictive value of 98% in patients who had received preoperative chemoradiotherapy or long course radiotherapy[27].

It appears that, although MR imaging is accurate in advanced stage T3 tumors, considerable experience and good-quality images are required to assess the subtle findings that help distinguish early stage T3 tumors from stage T2 tumors. The accuracy of MR imaging in this context depends on the experience of the radiologist and is subject to significant inter- and intra observer variability (16, 28, 29). Limitations include difficulty in differentiating fibrosis from tumor infiltration, which compromises the ability to distinguish early stage T3 tumors from stage T2 tumors (30). In a meta-analysis of imaging studies used for the staging of rectal cancer, it was found that there were no significant differences among endorectal sonography, CT, and MRI in nodal staging. The sensitivity and specificity of endorectal sonography, CT, and MRI for detecting lymph node metastasis were 67% and 78%, 55% and 74%, and 66% and 76% respectively (31)

Endorectal ultrasonography (ERUS):

Its accuracy in numerous trials and meta-analyses ranges from 80 to 95% for T-staging and 70 to 75% for N-staging, levels that are slightly higher than the respective 75 to 85% and 60 to 70% observed for magnetic resonance imaging (MRI) (32). Additionally, ERUS is capable of evaluating a wide range of pertinent features, providing information in each case that may help direct therapy. However the accuracy rates had declined significantly over time, with the lowest rates being reported in the most recent articles. The idea that the accuracy of ERUS is operator-dependent has been supported in the literature (33,34). ERUS, although accurate in the staging of rectal tumors (particularly superficial tumors), is limited in the assessment of the relationship of a tumor to the mesorectal fascia because of its limited field of view (35). This represents a substantial limitation with respect to presurgical planning .

Computed Tomoghaphy Scan:

CT scan is used for staging rectal carcinomas before treatment, for staging of recurrent disease, and for detecting the presence of distant metastases after surgery. However Magnetic resonance imaging (MRI) is slightly more accurate than CT in staging primary rectal tumors. MRI imaging is more likely to determine smaller lesions, more accurately determining the volume of the tumor compared to CT scanning. The volume of the tumor detected on an MRI scan is smaller and shorter at the distal of the anal sphincter than the volume based on the CT scan. One meta-analysis showed 52% sensitivity and 78% specificity of CT when it came to detecting nodal metastasis, and 65% sensitivity and 80% specificity for MRI scans. In another meta-analysis, the corresponding sensitivity and specificity were 55% and 74% for CT and 66% and 76% for MRI scans (31). Today, in the pre-operative stages, rectal MRI becomes mandatory.

CONCLUSIONS

In summary, the preoperative evaluation of primary rectal cancer is still a topic of great interest among surgeons, oncologists, radiologists and pathologists, because there are many points to consider in order to achieve the correct management of the patient. An accurate preoperative staging is therefore essential. MRI with phased array surface coil has proved to be an effective technique both for rectal cancer staging and for predicting an involved CRM. CRM involvement is crutial for the predicting the local recurrence.MRI represents an accurate diagnostic tool to help the clinician in order to select patients who may benefit from neoadjuvant therapy.

Disclosure:

No author has any potential conflict of interest.

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