ORIGINAL RESEARCH PAPER
VOLUME-6 | ISSUE-7 | JULY-2017 | ISSN No 2277 - 8179 | IF : 4.176 | IC Value : 78.46
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

ACCURACY OF MAGNETIC RESONANCE IMAGING IN PREOPERATIVE STAGING OF CARCINOMA RECTUM

Oncology

Shiva Kumar MBBS, MS, Mch Student, Department of surgical oncology, Kidwai memorial Institute of Oncology, Bangalore, Karnataka, India.

Swamyvelu Krishnamurthy Professor and Head, Department of surgical oncology, Kidwai memorial Institute of Oncology, Bangalore, Karnataka, India

Kapil Dev MBBS, MS, Mch Student, Department of surgical oncology, Kidwai memorial Institute of Oncology, Bangalore, Karnataka, India.

Arun Pandey MBBS, MS, Mch Student, Department of surgical oncology, Kidwai memorial Institute of Oncology, Bangalore, Karnataka, India.

ABSTRACT

Introduction: Rectal cancer staging provides critical information concerning the extent of the disease. The information gained from staging is used to determine prognosis, to guide management, and to assess response to therapy. Accurate staging is essential for directing the multidisciplinary approach to therapy. This study focuses on the evaluation of MRI in preoperative staging of rectal cancer.

Material and methods: A prospective cohort study of patients with diagnosis of rectal cancer admitted in the Department of Surgical Oncology for surgical treatment over the period from January 2015 to December 2016. The sensitivity, specificity, positive predictive accuracy, and negative predictive accuracy for magnetic resonance imaging in predicting a curative resection based on the histological yardstick of presence or absence of tumour at the margins of the specimen.

Results: A total of 72 patients with complete pathology and MRI data were available for comparison. The mean difference of EMD in both assessment was 0.06mm±3.82 (95% CI -0.42, 0.37). The mean difference was within predefined limit of 0.5mm which supported the equivalence of assessment. The accuracy for predicting the status of circumferential resection margin by initial imaging or imaging after treatment but before surgery in 72 patients was 90.3% (65/72, 86% to 94%) and negative predictive value was 70% (7/10).

Conclusion: MRI of rectal cancer is accurate, feasible, reproducible, and a robust standard for preoperative staging for multidisciplinary team protocol conjunct with clinical assessment to plan individualised treatment. This study enabled the accurate pre-operative prognostication and has a potential benefits to avoid unnecessary preoperative treatment in many patients, an objective staging system for future clinical trials.

KEYWORDS:

Rectal cancer; pre-operative staging; MRI; extramural depth; clear margin

Introduction

Rectal cancer staging provides critical information concerning the extent of the disease. The information gained from staging is used to determine prognosis, to guide management, and to assess response to therapy. Accurate staging is essential for directing the multidisciplinary approach to therapy. This study focuses on the evaluation of MRI in preoperative staging of rectal cancer.[1]The role of imaging in the management of rectal malignancy has progressively evolved and undergone several paradigm shifts. Recent advances in imaging techniques permit highly accurate locoregional and distant staging of the disease as well as prognostication on those who are likely to have a postoperative recurrence. In rectal malignancy, it is the local extent of the disease that often influences the surgical decision making and need for neoadjuvant therapy.[2]

Computerized Tomography (CT) is extensively used in the staging of the disease. Despite the better performance of positron emission tomography (PET)/CT as a tool for metastatic work-up, the lower cost and ease of availability makes contrast-enhanced CT still the modality of choice for this purpose. The limited soft tissue resolution of CT makes it a less preferred modality for the T-staging of rectal tumours. Notwithstanding its several innate limitations, traditionally Endorectal ultrasound (EUS) has been used as the gold standard for imaging the depth of rectal tumour invasion.[3] However, this status of EUS has been challenged by refinement of high-resolution magnetic resonance imaging (MRI) techniques that have made accurate T-staging possible MRI also enables the radiologist to identify the prognostic subgroups that may need neoadjuvant therapies according to the risk of local recurrence and treatment failure. This diagnostic and prognostic prowess of MRI has undoubtedly led to a paradigm shift in the preoperative investigation and treatment of rectal cancer.[4]

This study intended to address the status of MRI and its advantages and limitations in detection and pre-treatment staging, in rectal cancer.[1]With the easy availability of multi-slice CT and MRI, there is a need for prospective study to assess the accuracy of these imaging modalities when compared to postoperative histopathological staging.

Material and methods

Patients

It was a prospective cohort study of patients with diagnosis of rectal cancer admitted in the Department of Surgical Oncology for surgical treatment at Kidwai Memorial Institute of Oncology, Bangalore over the period from January 2015 to December 2016. We included patients with diagnosis of carcinoma rectum based on digital rectal examination, colonoscopy and histopathology of rectal biopsy. All eligible patients underwent preoperative surface coil MRI imaging with rectal and intravenous contrast of the abdomen and pelvis to assess the characteristics of tumour including level of lower edge of the tumour, maximal trans-mural depth (T stage), extramural depth of tumour, involvement of mesorectal lymph nodes, nodal involvement in upward direction including superior rectal artery region, inferior mesenteric artery region and para-aortic area. All patients underwent biopsy of rectal lesion to confirm the diagnosis and to grade of tumour. Required demographic parameters were considered into account for all the patients. All patients assessed for fitness for the anaesthesia under ASA II or less. All patients had haematological and biochemical work-up including liver function tests, renal function tests, cardiac assessment, chest radiogram and serum CEA.

Patients with significant locally advanced disease on digital rectal examination or CT scan (cT4b), history of neo-adjuvant treatment except short-course radiotherapy(25Gy in 5 fractions), history of previous surgical procedure for malignant or non-malignant cause, patients did not undergo curative resection or positive were excluded. The histopathological embedded tissue slices showing maximal tumour invasion in haematoxylin-eosin stain on whole or half-mount glass slides, and the maximal depth of extramural tumour spread were measured by using a 1-mm graticule overaid on the glass-mounted slide.

Statistical analysis

The differences between groups were considered statistically significant at $p<0.05$. We calculated the sensitivity, specificity, positive predictive accuracy, and negative predictive accuracy for magnetic resonance imaging in predicting a curative resection based on the

histological yardstick of presence or absence of tumour at the margins of the specimen. The equivalence between preoperative MRI measurement of the extramural depth of tumour invasion and histopathological measurement of the same parameter determined after primary surgery. The equivalency considered with 95% confidence interval of the difference between them within ±0.5mm. The categorical assessment of tumour stage between MRI and histopathology and corresponding weighted k score were calculated by using the Fleiss method.

Results

Patients' characteristics

Between January 2015 and December 2016, 82 potentially eligible patients consented to take part in this study. After exclusions, we had complete pathology and magnetic resonance imaging data available for comparison in 72 patients. Table 1 summarises patients' demographic and pathological characteristics. Median age of patients was 54 (32-71) years. Majority of the tumours (n=58, 80.5%) were located within 10cm from anal verge. Median duration from the MRI to surgery was 21 (3-44) days. Majority of the patients had clinical staging based MRI, T2 (n=24;33.3%) and T3 (n=35; 48.6%). On histopathological assessment, The cumulative proportion of T subcategories had same ratio of pT2 (n=17; 23.6%) and pT3 (n=37; 51.4%). The median number of nodes found per specimen was 15 (range 5-41).

Table I: Characteristics of 72 patients undergoing surgery for colorectal cancer. Figures are number (percentage) of patients unless stated otherwise

		No (%) of patients
median(range) age (years)		54(32-72)
Men		38
Women		34
height of primary tumour (from anal verge):		
	0-5cm	24(33.33)
	5.1-10cm	26(36.11)
	>10.1cm	18(25)
	Missing	4(5.55)
tumor differentiation		
	moderately/well	62(86.11)
	poorly	7(9.72)
	unknown	3(4.16)
Treatment given	Short course RT f/b Syrgery	21
	primary surgery	51
Median(range) days from MRI to primary surgery		(2-35)
surgery after chemoradiotheraoy/long course radiotherapy		17
median (range) days from MRI to surgery after chemoradiotheraoy/long course radiotherapy		30(5-40)
operation performed		
	Anterior resection	46(63.880
	Abdominoperinea l excixion	22(30.550
	Hartman's procedure	4(5.55)
	Extended resection	0
Tumor stage after primary surgery(n=72)		
	pT1	6(8.33)
	PT2	17(23.61)
	pT3	37(51.38)
	pT4	12(16.66)
Tumor stage on MRI(n=72)		
	cT1	4(5.55)
	cT2	24(33.33)
	cT3	35(48.61)
	cT4	9(12.5)
Median (range) nodes found per specimen		15(5-41)

Magnetic resonance imaging prediction of extramural depth of invasion

On MRI, mean extramural depth of invasion was 3.05±3.96 mm which was almost equal to EMD noted on histopathology as 3.09±4.02mm. The mean difference of EMD in both assessment was 0.06mm±3.82 (95% CI -0.42, 0.37). The mean difference was within predefined limit of 0.5mm which supported the equivalence of assessment. In 64 (88.9%) patients, the depth of tumor spread measured on MRI was within 5mm of histopathological depth. The overestimation of the extramural depth on MRI with more than 5mm observed in 6 patients (8.3%) and underestimation of the depth with the difference more than 5mm was seen in 2 patients (2.8%). The reason for this discrimination was assessed postoperatively with reviewing the MRI, interpretation error was the most common cause followed by movement artefact. Patients with misinterpretation, had median distance from anal verge was 10cm (2-14cm).

Magnetic resonance imaging prediction of circumferential resection margin status

Of the 62 patients in whom magnetic resonance imaging predicted clear margins and who underwent surgery, 58 had clear margins (93.5%, 95% CI 89% to 96%). The accuracy for predicting the status of circumferential resection margin by initial imaging or imaging after treatment but before surgery in 72 patients was 90.3% (65/72, 86% to 94%) and negative predictive value was 70% (7/10). (Table 2) In total, 61 (84.7%) patients had a clear margin on histopathology (table 2). In 61 of these patients, this was correctly predicted with magnetic resonance imaging, giving a sensitivity of 93% and specificity of 64%. In 7 (9%) of these patients, however, magnetic resonance imaging incorrectly predicted tumour in the margin.

Table II : Prediction of status of circumferential resection margin with magnetic resonance imaging in 408 patients including those undergoing surgery

By margin status predicted on pre-operative MRI		Margin status on histopathological assessment		
		clear	involved	total
Clear margin	short course radiotherapy/surgery	58	4	62
Involved margin	shirt course radiotherapy /surgery	3	7	10

Discussion

Accurate knowledge of extent of the tumour and pelvic anatomy has become the principal point in the current multidisciplinary team management of rectal cancer. Although, digital rectal examination has an important role in early diagnosis and is decisive in the hands of an experienced surgeon, but cumulative possibility of inaccurate staging is significant.[5–7] On the opposite, use of endo-luminal ultrasonography in staging for rectal cancer leads to generous over-staging and resultant over-treatment.[8] These contradictory results may indicate the introduction of a robust and accurate staging system. The advantages of thin-section MRI are to differentiate malignant tissue from muscularis propria and delineate mesorectal fascia, which define the circumferential resection margin at total mesorectal excision.[9-12] The measurement of extramural tumour invasion is an important end point to validate the staging accuracy of MRI with comparison to histopathological staging results.

Transmural extent of tumour (T stage) is the traditional method to prognostically stratify patients. Importance of extramural tumour invasion is significant in patients with stage T3 tumours, which is in majority of patients.[13,14] Extramural depth of disease more than 5mm have markedly poor prognosis than patients with less than 5mm spread. Patients with T3 tumour with less than 5mm extramural spread of disease are indistinguishable from T2 tumours; have variation in prognosis between two groups.[15-17] For the better assessment of prognosis in these borderline tumours, the accuracy of thin section MRI in rectal cancer is not studied well. We have confirmed, however, that magnetic resonance imaging is the best method available for predicting circumferential resection margin status and therefore clinical outcome.

The mean difference of less than 0.5mm between MRI and histopathology for the extramural depth of tumour invasion signify the accuracy of pre-operative MRI for staging in rectal cancer. In our

study, the mean difference 0.06mm±3.82 (95% CI -0.42, 0.37) ensuring quality control of the study. Apart from that, in our study all patients underwent total mesorectal excision, surgical quality was confirmed on histopathology with the proportion of patients with clear circumferential resection margin and lymph node yield.

The accuracy of MRI to predict clear margins in patients who underwent surgery was 93% and status of CRM by initial imaging before surgery was 90.3% and negative predictive value was 70%. Our results were comparable with multicentre trial done by MURCURY study group, which reported the accuracy of clear margin prediction was 94%, status of CRM was 88%.[18] Sensitivity of MRI for clear margin resection was 93% and specificity was 64%. The rate of incorrect prediction of MRI of the resection margin was less than 10% which was comparable with previous reports.[19,20]

There were few limitations in our study including, first only surface coil was used without endorectal coil; second, the rate of overestimation and underestimation of tumour depth is significantly more than 5%. The additional advantage of our study was to predict the lymph node metastasis according to extramural tumour invasion longitudinal, which is most important prognostic factor.

We concluded that MRI of rectal cancer is accurate, feasible, reproducible, and a robust standard for preoperative staging for multidisciplinary team protocol conjunct with clinical assessment to plan individualised treatment. This study enabled the accurate pre-operative prognostication and has a potential benefits to avoid unnecessary preoperative treatment in many patients, an objective staging system for future clinical trials, and targeted therapy.

References

1. James S. Wu, M.D. Rectal Cancer; Guest Editor, Harry L. Reynolds, Jr., M.D. Clin Colon Rectal Surg 2007;20:148–157.
2. Liang TY, Gopinathan A, Ang BWL. Imaging paradigms in assessment of rectal carcinoma: loco-regional and distant staging, Cancer Imaging (2012) 12, 290_303.
3. Harrison JC, Dean PJ, el-Zeky F, Vander Zwaag R. From Dukes through Jass: pathological prognostic indicators in rectal cancer. Hum Pathol 1994;25:498–505.
4. Willett CG, Badizadegan K, Ancukiewicz M, Shellito PC. Prognostic factors in stage T3N0 rectal cancer: do all patients require postoperative pelvic irradiation and chemotherapy? Dis Colon Rectum 1999;42:167–173.
5. Mason AY. Selective surgery for carcinoma of the rectum. Aust N Z J Surg 1976;46:322-9.
6. Nicholls RJ, Galloway DJ, Mason AY, Boyle P. Clinical local staging of rectal cancer. Br J Surg 1985;72(suppl):S51-2.
7. Nicholls RJ, Mason AY, Morson BC, Dixon AK, Fry IK. The clinical staging of rectal cancer.Br J Surg 1982;69:404-9.
8. Sauer R, Becker H, Hohenberger W, et al. Preoperative versus postoperative chemoradiotherapy for rectal cancer. N Engl J Med2004;351:1731–1740.
9. Brown G, Richards CJ, Newcombe RG, et al. Rectal carcinoma: thin-section MR imaging for staging in 28 patients. Radiology1999;211:215–222.
10. Brown G, Kirkham A, Williams GT, et al. High-resolution MRI of the anatomy important in total mesorectal excision of the rectum. AJR Am J Roentgenol 2004;182:431–439.
11. Blomqvist L, Holm T, Rubio C, Hindmarsh T. Rectal tumours: MR imaging with endorectal and/or phased-array coils, and histopathological staging on giant sections—a comparative study. Acta Radiol 1997;38:437–444.
12. Blomqvist L, Rubio C, Holm T, Machado M, Hindmarsh T. Rectal adenocarcinoma: assessment of tumour involvement of the lateral resection margin by MRI of resected specimen. Br J Radiol 1999;72:18–23.
13. Sobin L, Wittekind C, eds. TNM classification of malignant tumors. New York, NY: Wiley, 1997.
14. Hermanek P, Henson DE, Hutter RV, Sobin LH. UICC TNM supplement 1993: a commentary on uniform use. Berlin, Germany: Springer, 1993
15. Compton CC. Pathologic prognostic factors in the recurrence of rectal cancer. Clin Colorectal Cancer 2002;2:149–160.
16. Ueno H, Hase K, Mochizuki H. Criteria for extramural perineural invasion as a prognostic factor in rectal cancer. Br J Surg2001;88:994–1000.
17. ompton CC, Fielding LP, Burgart LJ, et al. Prognostic factors in colorectal cancer: College of American Pathologists consensus statement 1999. Arch Pathol Lab Med 2000;124:979–994.
18. MERCURY Study Group. Diagnostic accuracy of preoperative magnetic resonance imaging in predicting curative resection of rectal cancer: prospective observational study. Cite this article as: BMJ, doi:10.1136/bmj.38937.646400.55.
19. Brown G, Davies S, Williams GT, et al. Effectiveness preoperative staging in rectal cancer: digital rectal examination, endoluminal ultrasound or magnetic resonance imaging. Br J Cancer 2004;91(1):23–29.
20. Kwok H, Bissett IP, Hill GL. Preoperative staging of rectal cancer. Int J Colorectal Dis 2000;15:9–20.