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ORIGINAL ARTICLE

Can multidetector CT replace MRI for evaluating mesorectal fascia in rectal cancer?

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Abstract

Background: **Colorectal cancer is the fourth leading cause of cancer mortality. This study aims to compare the clinical outcomes of multidetector computed tomography (MDCT) with magnetic resonance imaging (MRI) for assessing mesorectal fascia (MRF) in patients with rectal cancer.**

Methods: **This research was a cross-sectional study of 60 patients with rectal cancer referred to two centers in Isfahan, Al-Zahra, and Seyed-al-Shohada hospitals. Considered parameters included sex, tumoral location, nodal involvement, as well as tumoral description. To assess the invasion of MRF in rectal cancer, researchers used MRI, axial MDCT, and multiplanar reconstruction CT scan (MPRCT). Sensitivity, specificity, and techniques' positive and negative predictive values were measured. Also, to assess the statistical associations, the Kappa coefficient was used.**

Results: **There was no significant association between axial MDCT and MRI reports regarding MRF involvement ($P > 0.05$). However, a statistical association was determined between the reports of multiplanar reconstruction CT (MPRCT) and MRI ($P < 0.01$, kappa $= 0.44$). In addition, the association between MPRCT and MRI reports was statistically significant in patients with wall thickening and negative nodal involvement (Kappa $= 0.699$, $P = 0.001$).On the other hand, there was more agreement between MPRCT and MRI reports in patients with tumors in the middle or upper rectum.**

Conclusion: **The association between MRI and MPRCT reports regarding MRF involvement was statistically significant in patients with wall thickening and negative nodal involvement in the upper and middle rectum. Consequently, it is possible to replace MRI with the MPRCT method for assessing MRF in some patients.**

Keywords: Fascia, Magnetic resonance imaging, Multidetector computed tomography, Rectal neoplasms

1. Introduction

Colorectal cancer is the fourth leading cause of cancer mortality rate and the second most common malignancy worldwide. Approximately one million patients with colorectal cancer are diagnosed annually [1–5], among which nearly 30% of them are detected in the rectal anatomical site [6].

The rectal cancer recurrence rate is higher than colon cancer due to the extensive lymphatic drainage of the pelvis [7]. In comparison to surgery and chemotherapy, which are the traditional treatment methods, neoadjuvant therapy has been recognized as an effective method to reduce the recurrence of the disease and improve the prognosis in recent years. Selection for neoadjuvant therapy is based on the stage of the disease. On the other hand, local staging is critical in managing these patients due to incorporating neoadjuvant chemo-radiation into treatment protocol [7]. Although conventional oncological surgery is the ideal treatment for advanced T2 rectal cancer [8], preoperative chemo-radiation improves the prognosis of T3 in patients with mesorectal fascia (MRF) involvement [9,10].

To stage rectal cancer, various methods such as multidetector computed tomography (MDCT) and magnetic resonance imaging (MRI) are common. MRI predicts the depth of tumor invasion by visualizing rectal wall layers and MRF [7,11]. Also, the MRI report has more practical details than the MDCT report for tumoral local staging [12,13].

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Nevertheless, modern MDCT methods seem advantageous to MRI for determining distant metastases [14–16].

Multiplanar reconstruction CT (MPRCT) can be potentially beneficial in local staging of rectal cancer and evaluating MRF because MPRCT images can be aligned perpendicular or parallel to the axis of the tumor, similar to MRI imaging [17,18]. Considering that a few studies investigated the diagnostic value of MPRCT and axial CT versus MRI in assessing MRF, this study aimed to understand whether the MDCT report is a replaceable method with the MRI report for evaluating MRF in rectal cancer.

2. Materials and methods

2.1. Sample selection

This cross-sectional study was conducted on patients with a confirmed diagnosis of rectal cancer referred to the radiology department of two sites, Al-Zahra, and Seyed-al- Shohada hospitals, between October 2017 and May 2020. Included patients were documented as having positive rectal malignancy, determined by the biopsy taken via colonoscopy. Patients were referred to the radiology department before receiving neoadjuvant chemoradiotherapy or surgery.

2.2. Procedure

A 128-slice MDCT scanner and MRI (1.5 T) with a phased-array coil were provided to assess the involvement of MRF. The MPRCT images were reconstructed as 2 mm sections. The MRI and MDCT data were evaluated at two-week intervals between two assessments. Also, the radiologist who performed each evaluation was blind to the objectives of the study. Meanwhile, techniques' sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were examined.

Based on MDCT results, tumors were classified into different groups based on the anatomical surface (anterior and posterior surface), nodal involvement (negative and positive), location of the tumor (upper, middle, and lower rectum), and lesion description (mass and wall thickening). Anterior and posterior tumors were categorized based on the tumor's location at 180° anterior and 180° posterior in axial images of MDCT.

Patients were divided into three groups according to their location at MDCT images. The tumors were classified into three groups the lower part, middle part, and upper part, which were 5 cm, 5–10 cm, and >10 cm above the anus. Considering their shape in MDCT, tumors were classified into mass or wall thickening. Moreover, tumors were divided into two subgroups based on the positive or negative report of nodal involvement.

2.3. Abdominopelvic MDCT was performed according to the following protocol

KV: 120.
MA: 50–500 (min–max).
Intravenous contrast: 100–150 cc.
Imaging was performed with a 70 s delay after contrast administration.
Oral contrast: neutral contrast (1000 cc water 20–30 min before scan).

2.4. Rectal MRI was performed according to the following protocol

T2 HASTE in sagittal, coronal, and axial planes with TR/TE = 2000/80.
T2 FSE in sagittal, coronal, and axial planes with TR/TE = 5000/70.
DWI in the axial plane with TR/TE = 6000/80.
Also, no intravenous contrast was used.
Rectal distention was done with 60 ml ultrasound gel before imaging to improve staging accuracy

2.5. Inclusion and exclusion criteria

Inclusion criteria were [1] confirmation of rectal cancer in patients by biopsy [2], no past medical history of performing surgery, chemotherapy, or radiotherapy, related to the current medical condition, rectal cancer, and [3] lack of claustrophobia or fear of closed spaces. Also, patients with incomplete medical records were excluded from the study.

2.6. Ethical considerations

Conducting this study is confirmed by the Ethical Committee of Isfahan University of Medical Sciences (ID: IR.MUI.MED.REC.1398.275).

2.7. Statistical analysis

SPSS version 22. Kappa coefficient was used for statistical analyses. $P < 0.05$ was considered statistically significant.

3. Results

This research study enrolled 60 patients. The mean participants' age was 61.2 ± 12.59 years old.

ORIGINAL ARTICLE

Table 1 indicates the frequency of patients with rectal concerning different variables. In addition, the correlation of axial CT and MPRCT with MRI findings is shown in Table 2.

The frequency of patients, with a positive diagnosis of MRF invasion determined by axial CT and MPRCT, was 35 (58.3%) and 45 (75%), respectively. Although there was no association between axial CT and MRI considering MRF invasion ($P > 0.05$), a weak correlation was determined between MPRCT and MRI about this parameter ($P < 0.01$) (Table 2).

Table 3 shows the sensitivity, specificity, PPV, and NPV, of MPRCT, which were categorized based on different parameters. Similarly, Table 4 includes the same data but for the axial CT. Table 5 presents the correlation of findings between axial CT and MRI categorized based on a set of parameters. According to these tables, no association was determined between axial CT and MRI findings concerning anatomical surface, description of the lesion, and location ($P > 0.05$). Likewise, Table 6 includes the results of the statistical analysis of the assumption about the association between the clinical findings of MPRCT and MRI. A moderate association was determined between the findings of MPRCT and

Table 1. The frequency of patients with rectal carcinoma regarding variables.

Variables	Frequency (Percent)
Sex	35 (58.3)
Male	25 (41.7)
Female	60 (100)
Total	
MRI	38 (63.3)
Not involved MRF	22 (36.7)
Involved MRF	60 (100)
Total	
Axial CT	37 (61.7)
Not involved MRF	23 (38.3)
Involved MRF	60 (100)
Total	
MPRCT	41 (68.3)
Not involved MRF	19 (31.7)
Involved MRF	60 (100)
Total	
Nodal involvement	28 (46.7)
Negative	23 (38.3)
Positive	60 (100
Total	
Anatomical surface	28 (46.7)
Anterior	20 (33.3)
Posterior	48 (80)
Total	12 (20)
Missing value	
Location	12 (20)
High	21(35)
Middle	15 (25)
Low	48 (80)
Total	12 (20)
Missing value	
Lesion	22 (36.7)
Wall thickening mass	27(45)
Total	49 (81.7)
Missing value	11 (18.3)

Table 2. Agreement between MRI with axial. CT and MPRCT.

CT Methods	MRI		Kappa	P-value
	MRF not involved	MRF involved		
Axial. CT	25 (67.5)	12 (32.4)	0.11	0.38
Not involved MRF	13 (56.5)	10 (43.4)		
Involved MRF	38 (63.3)	22 (36.7)		
Total				
MPRCT	32 (78.04)	9 (22)	0.44	0.001
Not involved MRF	6 (31.6)	13 (68.4)		
Involved MRF	38 (63.3)	22 (36.7)		
Total				

Table 3. The sensitivity, specificity, PPV and NPV of MPRCT method in terms of variables.

Variables	PPV	NPV	SEN	SP
Sex	71.4	72.2	50	86.6
Female	66.6	82.6	66.6	82.6
Male				
Nodal involvement	71.4	85.7	62.5	90
Negative	66.6	71.4	60	76.9
Positive				
Anatomical surface	60	77.7	60	77.7
Anterior	80	80	57.14	92.3
Posterior				
Description of Lesion	100	89.4	60	100
Wall thickening	58.3	66.6	58.3	66.6
Mass				
Location	100	80	50	100
High	62.5	92.3	83.3	80
Middle	60	60	42.8	75
Low				

PPV: positive predictive value; NPV: negative predictive value; MPRCT: Multiplanar reconstruction. CT.

Table 4. The sensitivity, specificity, PPV, and NPV of axial CT method in terms of variables.

Variables	PPV	NPV	SEN	SP
Sex	37.5	58.8	30.0	66.6
Female	46.6	75	58.3	65.2
Male				
Nodal involvement	40	77.7	50	70
Negative	45.4	58.3	50	53.4
Positive				
Anatomical surface	41.6	68.7	50	61.1
Anterior	50	71.4	42.8	76.9
Posterior				
Lesion	33.3	81.2	76.4	…
Wall thickening	46.1	57.1	50	53.3
Mass				
Location	50	75	50	75
High	45.4	90	83.3	60
Middle	33.3	50	14.2	75
Low				

PPV: positive predictive value; NPV: negative predictive value.

Table 5. Agreement between axial CT and MRI findings in terms of variables.

Axial CT in terms of variables		MRI		Kappa	p-value
		Not involved MRF	involved MRF		
Sex	**Female**			−0.34	0.86
	Not involved MRF	10 (58.8)	7 (41.2)		
	involved MRF				
		5 (62.5)	3 (37.5)		
	Male			0.22	0.18
	Not involved MRF	15 (75)	5 (25)		
	involved MRF				
		8 (53.3)	7 (46.6)		
Nodal involvement	**Negative**			0.186	0.318
	Not involved MRF	14 (77.7)	4 (22.22		
	involved MRF	6 (60)	4 (40)		
	Positive			0.038	0.855
	Not involved MRF	7 (58.3)	5 (41.7)		
	involved MRF	6 (54.5)	5 (45.4)		
Anatomical surface	**Anterior**			0.10	0.569
	Not involved MRF	11 (68.7)	5 (31.3)		
	involved MRF	7 (58.3)	5 (41.6)		
	Posterior			0.20	0.357
	Not involved MRF	10 (71.4)	4 (28.6)		
	involved MRF	3 (50)	3 (50)		
Description of Lesion	**Wall thickening**			0.15	0.46
	Not involved MRF	13 (81.2)	3 (18.8)		
	involved MRF	4 (66.7)	2 (33.3)		
	Mass			0.033	0.86
	Not involved MRF	8 (57.1)	6 (42.9)		
	involved MRF	7 (53.8)	6 (46.1)		
Location	**High**			0.25	0.386
	Not involved MRF	6 (75)	2 (25)		
	involved MRF	2 (25)	2 (25)		
	Middle			0.34	0.072
	Not involved MRF	9 (90)	1 (10)		
	involved MRF	6 (54.5)	5 (45.4)		
	Low			−0.1	0.60
	Not involved MRF	6 (50)	6 (50)		
	involved MRF	2 (66.7)	1(33.3)		

MRI regarding two parameters, negative nodal involvement as well as the location of the tumor in the upper and middle parts, in both male and female patients ($P < 0.05$).

Moreover, a significant agreement was determined between the MPRCT and MRI in tumors described as wall thickening ($P < 0.05$). Similarly, no association was identified between the findings of MPRCT and MRI in tumors located in the lower rectum and tumors with nodal involvement.

4. Discussion

MRI is the gold standard method in the prediction of tumor invasion to MRF before chemo-radiation [19–21]. The other method, CT scan, is part of the routine practice in staging patients with rectal cancer. However, the main limitation of staging with the CT scan technique is the inherent poor tissue contrast, in comparison to MRI [17].

For assessing MRF invasion, thin CT scan slices, with comparable accuracy to MRI, is replaceable with MRI, at least for some patients. To the best of our knowledge, a limited number of studies have been conducted on the same objective, assessing the diagnostic value of MDCT, in comparison to MRI, in the diagnosis of MRF invasion in patients with rectal cancer [14]. In addition, considering MRF invasion, a moderate association between the reports of MPRCT and MRI, ($k = 0.44$, $p <$ b 0.01) was identified. According to the statistical analysis of this study, applying MPRCT for assessing the MRF invasion had more benefits than axial CT did.

Furthermore, by classifying patients into multiple subgroups, we tried to identify whether a significant statistical association is identifiable between MDCT and MRI in any of our subgroups. The findings indicated a moderate association between MPRCT and MRI methods in patients without nodal involvement. However, no association was

Table 6. Agreement between the findings of MPRCT and MRI in terms of variables.

MPRCT in terms of variables		MRI		Kappa	P-value
Variables		No	Yes		
Sex	**Female**				
	Not involved MRF	13 (72.2)	5 (27.8)	0.38	0.045
	involved MRF	2 (28.6)	5 (71.4)		
	Male				
	Not involved MRF	19 (82.6)	4 (17.4)	0.49	0.004
	involved MRF	4 (33.3)	8 (66.6)		
Nodal involvement	**Negative**				
	Not involved MRF	18 (85.7)	3 (14.3)	0.54	0.004
	involved MRF	2 (28.6)	5 (71.4)		
	Positive				
	Not involved MRF	10 (71.4)	4 (28.6)	0.37	0.072
	involved MRF	3 (33.3)	6 (66.6)		
Anatomical surface	**Anterior**				
	Not involved MRF	14 (77.7)	4 (22.2)	0.37	0.046
	involved MRF	4 (40)	6 (60)		
	Posterior				
	Not involved MRF	12 (80)	3 (20)	0.52	0.015
	involved MRF	1 (20)	4 (80)		
Description of Lesion	**Wall thickening**				
	Not involved MRF	17 (89.4)	2 (10.5)	0.699	0.001
	involved MRF	0 (0)	3 (100)		
	Mass				
	Not involved MRF	10 (66.6)	5 (33.3)	0.25	0.194
	involved MRF	5 (41.7)	7 (58.3)		
Location	**High**				
	Not involved MRF	8 (80)	2 (20)	0.57	0.028
	involved MRF	0 (0)	2 (100)		
	Middle				
	Not involved MRF	12 (92.3)	1 (7.7)	0.57	0.007
	involved MRF	3 (37.5)	5 (62.5)		
	Low				
	Not involved MRF	6 (60)	4 (40)	0.24	0.464
	involved MRF	2 (40)	3 (60)		

identified between these methods in patients with nodal involvement.

Among all subgroups, a significant association was identified between the findings of MPRCT and MRI in the group of patients described as wall thickening of the rectum ($k = 0.699$). In addition, there was a moderate association between the findings of MPRCT and MRI in patients with tumors located at the middle and upper rectum. Vliegen et al. assessed the accuracy of MDCT and MRI in patients with rectal cancer. They reported that the performance of CT scan in the middle and upper rectum was significantly better than in the lower parts [19]. Similarly, according to the findings of this study, the accuracy of MDCT was poor in predicting MRF involvement in tumors that are identified the in lower and anterior parts.

Based on our findings in this study, MPRCT had a stronger association with MRI in patients with tumors described as wall thickening and negative nodal invasion. In detail, the MPRCT reports, which included information about tumors described as wall thickening, located in the upper and middle rectum, and negative nodal invasion, were more consistent with MRI reports for a similar clinical condition. This result may be due to the greater distance of these tumors from the MRF and the possibility of easier differentiation of invasion or non-invasion of this fascia. According to the results, replacing MRI with MPRCT in some patients can be considered in the future. It also benefits patients by a significant decrease in patients' diagnostic costs.

5. Conclusion

According to the results of this study, although axial MDCT is not replaceable with MRI for assessing MRF invasion in patients with rectal cancer, MPRCT showed applicability for this purpose. Moreover, an association was identified between the reports of MRI and MPRCT for assessing MRF invasion in patients with wall thickening of the upper

and middle rectum and negative nodal involvement. Hence, MPRCT, which is a common method in assessing distant metastasis, can replace MRI to assess MRF invasion in patients with wall thickening as tumoral description located in the upper and middle rectum and with negative nodal involvement.

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Conflict of interest

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