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A prospective study of diagnostic accuracy of multidisciplinary team and radiology reporting of preoperative colorectal cancer local staging

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Abstract

Introduction: The aim of this study was to correlate and assess diagnostic accuracy of preoperative staging at multidisciplinary team meeting (MDT) against the original radiology reports and pathological staging in colorectal cancer patients.

Methods: A prospective observational study was conducted at two institutions. Patients with histologically proven colorectal cancer and available preoperative imaging were included. Preoperative tumor and nodal staging (cT and cN) as determined by the MDT and the radiology report (computed tomography [CT] and/or magnetic resonance imaging [MRI]) were recorded. Kappa statistics were used to assess agreement between MDT and the radiology report for cN staging in colon cancer, cT and cN in rectal cancer, and tumor regression grade (TRG) in patients with rectal cancer who received neoadjuvant therapy. Pathological report after surgery served as the reference standard for local staging, and AUROC curves were constructed to compare diagnostic accuracy of the MDT and radiology report.

Results: A total of 481 patients were included. Agreement between MDT and radiology report for cN stage was good in colon cancer (k = .756, Confidence Interval (CI) 95% .686–.826). Agreement for cT and cN and in rectal cancer was very good (kw = .825, CI 95% .758–.892) and good (kw = .792, CI 95% .709–.875), respectively. In the rectal cancer group that received neoadjuvant therapy, agreement on TRG was very good (kw = .919, CI 95% .846–.993). AUROC curves using pathological staging indicated no difference in diagnostic accuracy between MDT and radiology reports for either colon or rectal cancer.

Conclusion: Preoperative colorectal cancer local staging was consistent between specialist MDT review and original radiology reports, with no significant differences in diagnostic accuracy identified.

KEYWORDS
colorectal cancer, multidisciplinary teams, preoperative N stage, preoperative T stage, radiology

1 | INTRODUCTION

Colorectal cancer is the third most frequently diagnosed cancer in the world, with 1.9 million new cases in 2020. It is also the second leading cause of cancer-related death, accounting for an estimated 935,000 deaths annually.[1] Modern preoperative radiologic staging modalities, such as computed tomography (CT) and magnetic resonance imaging (MRI), allow for fairly accurate preoperative staging, and inform selection of the most appropriate management strategy for each patient.

In rectal cancer, pelvic MRI preoperative staging provides essential information on tumor depth infiltration and perirectal nodal metastasis.[1] These factors determine the need for neoadjuvant therapy and extent of surgical treatment. The role of preoperative CT imaging in colon tumors is to identify adjacent organ infiltration (T4b stage) and distant metastasis. Locoregional staging (T and N stage) is of marginal clinical utility given neoadjuvant therapy is not standard of care.[2] However, there is growing interest in administering neoadjuvant chemotherapy to decrease the risk of disease recurrence in locally advanced colon cancers.[3] In view of this, accurate preoperative staging for both colon and rectal cancer assists patient selection for neoadjuvant therapy and surgical planning.[4]

Most colorectal cancer guidelines state that all patients should be discussed at a multidisciplinary team meeting (MDT)[5,6]; a collaborative forum for decision making attended ideally by surgeons, radiologists, pathologists, and medical and radiation oncologists.[7] At the MDT, accurately documented preoperative staging assists decision making.[8] In rectal cancer, for instance, discussion in the MDTs have shown to increase the proportion of patients receiving neoadjuvant treatment, resulting in better local disease control and higher curative surgery rates.[9,10]

Previous studies in this field have shown inconsistencies in staging documentation and demonstrated that preoperative staging accuracy with MDT recommendation to be significantly higher compared to the radiology report alone.[11,12] However, most reports come from small and single-center retrospective studies. Prospective data on the agreement and accuracy of MDT and radiology report in colorectal cancer are lacking, and in our context, with high quality specialized colorectal cancer staging reporting, it remains unclear whether the MDT discussion was upgrading or downgrading patient stage. Therefore, we aimed to prospectively investigate the level of agreement in preoperative staging between MDTs and radiology reports and to determine the accuracy of these modalities for diagnostic decision making in colorectal cancer.

2 | MATERIALS AND METHODS

This prospective cohort study is reported according to the STARD statement[13] and was approved by the Central Adelaide Local Health Network Human Research Ethics Committee (HREC/19/CALHN/73) and the Ethics Committee of a private tertiary care center (#116). This study was conducted in accordance with the Helsinki Declaration. The requirement for informed consent was waived given the low or negligible risk to patients.

2.1 | Patient selection

Consecutive patients with histologically proven colon or rectal adenocarcinoma at two tertiary care centers (both in Adelaide, Australia) who were discussed at the weekly colorectal MDTs between March 1, 2019, and March 04, 2022, were considered for the study. Patients without available reports from CT/MRI of preoperative stages from MDT and radiology or cases where the reporting radiologist was also a member of the colorectal MDT were excluded.

2.2 | Imaging and pathological evaluation

Preoperative imaging for colon and rectal cancer included abdominopelvic CT with oral and intravenous contrast or water as a negative contrast. Rectal cancers underwent high resolution multiparametric MRI. Rectal cancer patients receiving neoadjuvant therapy underwent restaging MRI 8–10 weeks following completion of their chemoradiotherapy (CRT).[14,15] All scans were reported by a specialist radiologist or junior radiologist supervised by a specialist radiologist at both institutions prior to MDT discussion. Reporting was performed in a standardized manner using the Cancer Council Australia recommended proforma.[16] Staging at MDT was determined by one of three specialist radiologists with specific experience in gastrointestinal and pelvic MRI and oncologic imaging, colorectal surgeons, medical and radiation oncologists, and pathologists. At the MDT meeting, CT or MRI scans were reviewed against the radiology report by specialist radiologists in combination with the treating team. Patients were recorded as node negative during data collection if there was no mention of abnormal nodes in the radiology report. Tumors above the peritoneal reflection were defined as colon cancers.

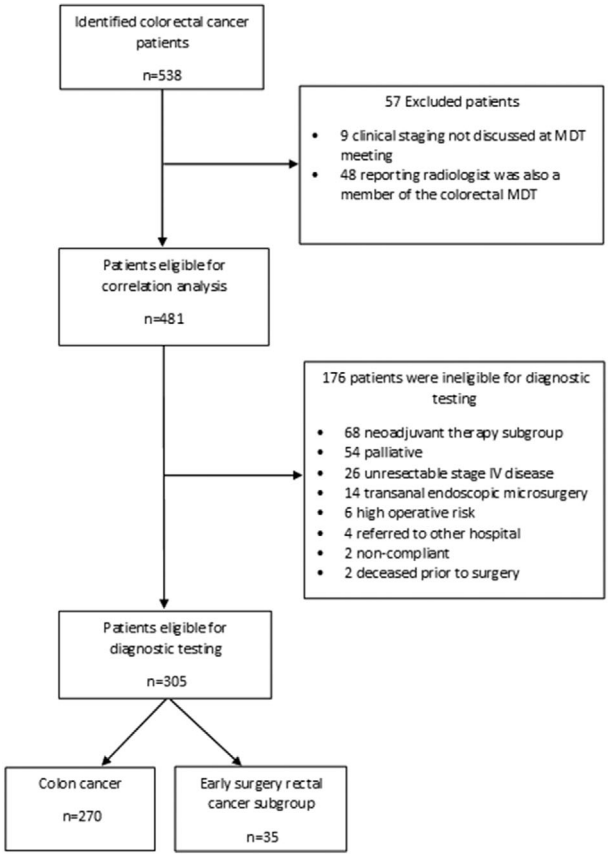

FIGURE 1 Patient selection

Agreement of preoperative staging and restaging tumor regression grade (TRG)[17] between MDT and radiology report for rectal cancer was also assessed. As previous studies have described[11,18], patients with rectal cancer were divided into "early surgery" or "neoadjuvant therapy" subgroups. The early surgery group underwent surgery after diagnosis or received short-course radiotherapy without a wait period (thus had pathological staging that could be used as the reference standard). The neoadjuvant therapy group received total neoadjuvant therapy (TNT), or standard long course chemoradiotherapy (CRT), or short course radiotherapy with a wait period (thus had significant tumor downstaging and the pathological staging could not be used to determine pre-operative clinical staging accuracy).

Tumors were grouped based on the presence or absence of tumor invasion through the muscularis propria into the surrounding mesorectum. Lymph node metastases were defined as any visible node ≥9 mm on the short axis, nodes with mucinous signal characteristics, nodes 5–9 mm with two additional morphologically suspicious features (round shape, irregular borders, or heterogenous contrast enhancement), and nodes >5 mm with all three features present were considered to be positive.[19] The presence of extramural vascular invasion (EMVI) was considered positive if tumor signal extends into an adjacent vascular structure from the primary tumor or involved lymph nodes, expanding and disrupting the vessel borders. A positive circumferential resection margin (CRM) for upper and mid rectal tumors was defined as involvement of the mesorectal fascia or within 1 mm of the mesorectal fascia. In low rectal tumors, tumor involving or within 1 mm of intersphincteric plane or levator ani muscle was considered as involved CRM.[16] For colon cancer, MDT and radiology reported cN-stage was compared with the pN-stage. In the rectal cancer: early surgery group, MDT and MRI reported cT and cN-stage were compared with the pT and pN-stages. For imaging and pathological staging, the 8th edition of the American Joint Committee on Cancer Tumour Node Metastasis (TNM) staging was used.[20]

TABLE 1 Baseline characteristics of colorectal cancer patients

Variable	Value
Age, median (range), y	70 (29–97)
Sex, *n* (%)	
Male	281 (58)
Female	200 (42)
Tumor location	
Caecum	49 (10)
Ascending colon	73 (15)
Transverse colon	88 (18)
Descending colon	19 (4)
Sigmoid colon	117 (24)
Rectum	135 (28)
Neoadjuvant therapy[†], *n* (%)	
TNT	55 (41)
Long course CRT	10 (7)
Short course RT	12 (9)
None	58 (43)
Operation	
Extended/Right hemicolectomy	153 (44)
Left hemicolectomy	8 (2)
Subtotal or total colectomy	19 (6)
High anterior resection	66 (19)
Low anterior resection	20 (6)
Ultra-low anterior resection	20 (6)
Hartmann's operation	32 (9)
Abdominoperineal resection	10 (3)
Proctocolectomy	3 (1)
Pelvic exenteration	12 (4)
Ileocolic resection	2 (1)
No. of harvested LNs	18 (1–124)
No. of positive LNs	0 (0–31)

Abbreviations: CRT, chemoradiotherapy; LNs, lymph nodes; RT, radiotherapy; TNT, total neoadjuvant therapy.
[†]Rectal cancer only.

2.3 | Statistical analysis

Descriptive statistics were used to describe baseline characteristics. Agreement between MDT and radiology report for clinical colon

TABLE 2 Diagnostic results of MDT and CT report compared with pathological N staging for colon cancer

N-stage	pN		
MDT cN	pN0	pN1-2	*p*-value
cN0	126	48	<.0001
cN1-2	36	60	
Report cN			
cN0	132	52	<.0001
cN1-2	30	56	
	MDT cN	Report cN	
AUROC	.667 (95% CI .607–.723)	.667 (95% CI .607–.723)	1.00
Accuracy (%)	69 (95% CI 63–74)	70 (95% CI 64–75)	
Sensitivity (%)	56 (95% CI 46–65)	52 (95% CI 42–62)	
Specificity (%)	78 (95% CI 71–84)	81 (95% CI 75–87)	
PPV (%)	63 (95% CI 54–70)	65 (95% CI 56–73)	
NPV (%)	72 (95% CI 68–77)	72 (95% CI 67–76)	

Abbreviations: AUROC, area under the receiver operating characteristic curve; CT, computed tomography; MDT, multidisciplinary team meeting; NPV, negative predictive value; PPV, positive predictive value.

cancer nodal (cN) staging was evaluated using Cohen's kappa (k). A weighted Cohen's Kappa (kw) was applied for matrices larger than 2 × 2 quadratic in the agreement evaluation for clinical tumor stage (cT), cN staging, CRM and EMVI for all rectal cancers, and radiological TRG (TRG 1–5) criteria proposed by Patel et al.[21] on restaging for the neoadjuvant therapy subgroup. A kappa and weighted-kappa values of <.20 was considered 'Poor', .21–.40 as 'Fair', .41–.60 as 'Moderate', .61–.80 as 'Good', and .81–1.00 as 'Very good'.[22] The Fisher's exact test was used for statistical analysis. Alpha was set at $p < .05$. Diagnostic measures using pathological were assessed using under the receiver characteristic curve (AUROC), accuracy, sensitivity, specificity, positive predicted value (PPV) and negative predicted value (NPV). SPSS Statistics for Windows, version 27 (SPSS Inc., Chicago, Ill., USA) and MedCalc for Windows, version 16.4.3 (MedCalc Software, Ostend, Belgium) were used for analysis.

3 | RESULTS

3.1 | Baseline characteristics

A total of 481 patients were included (Figure 1). Junior radiologists overseen by a specialist radiologist reviewed the scans of 151 (31%) patients, the remaining 330 (69%) patients had their scans reviewed by a specialist radiologist. The median age was 70 years (range 29–95) and 58% were male. Of these patients, 346 (72%) presented with colon cancer and 135 (28%) with rectal cancer. In rectal cancer, 55 (41%) received TNT, 10 (7%) received long-course CRT, 12 (9%) received short-course radiotherapy and 58 (43%) did not receive neoadjuvant treatment. The median number of resected lymph nodes for all resections was 18 (range, 1–124). Other demographics are summarized in Table 1.

3.2 | Agreement between MDT and radiology report

In 346 colon cancer patients, agreement between MDT and radiology report for cN stage was good ($k = .756$, CI 95% .686–.826, $p < .001$). In 135 rectal cancer patients (total cohort), agreement for cT and cN was very good (kw = .825, CI 95% .758–.892, $p < .0001$) and good (kw = .792, CI95 % .709–.875, $p < .0001$), respectively. In addition, the agreement for CRM and EMVI was very good ($k = .920$, CI 95% .851-.989, $p < .0001$) and very good ($k = .814$, CI 95% .740-.914, $p < .0001$), respectively. Of 68 patients in the neoadjuvant therapy subgroup, 64 patients underwent re-staging MRI. The correlation of TRG between MDT and radiology report was very good (kw = .919, CI 95% .846–.993, $p < .0001$).

3.3 | Diagnostic accuracy: cN stage in colon cancer

Diagnostic measures were calculated for 270 colon cancer patients with available histopathology (Table 2, Figure 2). The AUROC showed no significant difference between the MDT and radiology report (.667 vs. .667, $p = 1.00$). The MDT had similar accuracy (69% vs. 70%), sensitivity (56% vs. 52%), PPV (63% vs. 65%), and specificity (78% vs. 81%) compared with the radiology report. The NPV was 72% in both the MDT and radiology report.

3.4 | Diagnostic accuracy: cT and cN in early surgery rectal cancer subgroup

Diagnostic measures were calculated for 35 early surgery rectal patients (Table 3, Figure 2). MDT could differentiate low-risk

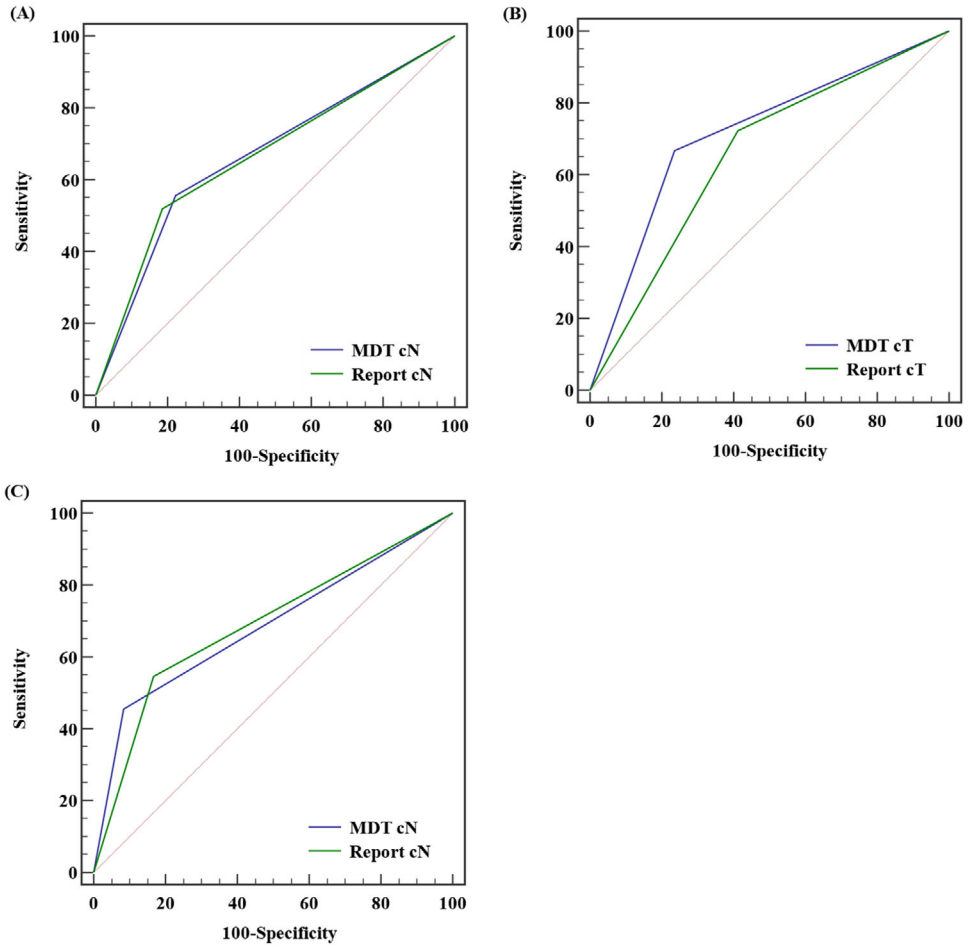

FIGURE 2 Receiver operating characteristic (ROC) curves comparing staging at multidisciplinary team meeting (MDT) versus radiology report for **(A)** N stage in the colon cancer, **(B)** T-stage in the rectal cancer early surgery subgroup, **(C)** N-stage in the rectal cancer early surgery subgroup

(cT0-T2) from high-risk tumors (cT3-T4) with an 71% versus 66% accuracy, 67% versus 72% sensitivity, 76% versus 59% specificity, 75% versus 65% PPV, 68% versus 67% NPV compared to the radiology report. The AUROC was not significantly different (AUROC .716 vs. .655, $p = .273$). The MDT differentiated between node positive (cN1-2) from node negative (cN0) tumors with an 77% versus 74% accuracy, 45% versus 55% sensitivity, 92% versus 83% specificity, 71% versus 60% PPV, 79% versus 80% NPV, compared to the radiology report. The AUROC was not significantly different (AUROC .686 vs. .689, $p = .944$).

4 | DISCUSSION

This is the first study to prospectively compare diagnostic agreement between a specialized colorectal cancer MDT and the radiology report for colorectal cancer patients. Our results demonstrate a good level of diagnostic agreement between MDT and radiology report in the setting of colorectal cancer, and no statistically significant difference in diagnostic accuracy.

In line with a meta-analysis and a Danish population-based study, we found that it remains challenging to correctly identify patients with nodal involvement. The meta-analyses of 13 studies found summary estimates for sensitivity and specificity concerning nodal involvement of 71% and 67%, respectively,[23] and the Danish study including 4834 patients found a sensitivity of 57%, specificity of 66%, and an accuracy of 63% in predicting nodal involvement by the MDT.[24] Similar results are observed in the current study, with a 56% sensitivity, 78% specificity, and 69% accuracy. A recent study by Koh et al., in which nodal staging was assessed by an expert radiologist issuing formal CT reports, found a sensitivity and specificity of 85% and 40%, respectively.[25] The differences in sensitivity and specificity between the current study and their findings can likely be attributed by their low sample size ($n = 23$). Moreover, Hong et al. reported the radiologist diagnostic AUROC for malignant nodal status of .663 using the largest measured short-axis diameter of lymph node and presence of internal heterogeneity when combined.[26] Our results demonstrate a similar AUROC of .667 for colon cancer nodal involvement staged on MDT and radiology report. This diagnostic difficulty likely arises from CT being unable to detect micrometastasis and distinguishing benign node enlargement

TABLE 3 Accuracy of clinical report and MDT tumor staging versus pathologic tumor stage in the early surgery subgroup for rectal cancer

T stage	pT		*p*-Value
MDT cT	T0-2	T3-4	
cT0-2	13	6	.018
cT3-4	4	12	
Report cT			
cT0-2	10	5	.068
cT3-4	7	13	
N Stage	pN		
MDT cN	N0	N1-2	
cN0	22	6	.021
cN1-2	2	5	
Report cN			
cN0	20	5	.041
cN1-2	4	6	
	MDT cT	Report cT	
AUROC	.716 (95% CI .538–.855)	.655 (95% CI .476–.807)	.273
Accuracy (%)	71 (95% CI 54–85)	66 (95% CI 48–81)	
Sensitivity (%)	67 (95% CI 41–87)	72 (95% CI 47–90)	
Specificity (%)	76 (95% CI 50–93)	59 (95% CI 33–82)	
PPV (%)	75 (95% CI 55–88)	65 (95% CI 50–78)	
NPV (%)	68 (95% CI 52–81)	67 (95% CI 46–82)	
	MDT cN	Report cN	
AUROC	.686 (95% CI .507–.831)	.689 (95% CI .511–.834)	.944
Accuracy (%)	77 (95% CI 60–90)	74 (95% CI 57–88)	
Sensitivity (%)	45 (95% CI 17–77)	55 (95% CI 23–83)	
Specificity (%)	92 (95% CI 73–99)	83 (95% CI 63–95)	
PPV (%)	71 (95% CI 36–92)	60 (95% CI 35–81)	
NPV (%)	79 (95% CI 68–86)	80 (95% CI 67–89)	

Abbreviations: AUROC, area under the receiver operating characteristic curve; MDT, multidisciplinary team meeting; NPV, negative predictive value; PPV, positive predictive value.

secondary to peritumoral inflammation from those with metastatic disease. Considering the limited clinical significance of preoperative nodal staging in colon cancer and the concordance between MDT review and the radiology report found in our study, preoperative nodal staging during MDT could be avoided. Nevertheless, it is clear that MDT is still to be recommended to make clinical management decisions in general, and perhaps less focus on repeat nodal staging would increase MDT efficiency and allow more cases to be discussed with that goal in mind.

Preoperative rectal cancer staging is important for the choice of treatment and prognosis of the patient, as the cT and cN stage are key factors to determine whether a patient is best treated by immediate surgery or could benefit from neoadjuvant therapy first. In our study, the sensitivity, specificity and AUROC assessment of advanced T stage (T0-2 vs. T3-4) in the MDT (67% sensitivity, 76% specificity and AUROC .716) and radiology report (72% sensitivity, 59% specificity and AUROC .655) were lower than in the meta-analysis by Zhang et al. (pooled sensitivity 87%, specificity 73% and AUROC .918).[27] This disparity in diagnostic AUROCs could be due to the different interpretation of perirectal tissue invasion, which, as pointed out by Zhang, could have an effect on diagnostic accuracy. In comparison with retrospective data from Australia and New Zealand, the accuracy of extramural tumor involvement on MDT staging was higher in our cohort (71% vs. 51% vs. 52%).[28,29]

The diagnosis of mesorectal nodal involvement (cN) by MDT and radiology report in the early surgery rectal cancer subgroup drew mixed results compared to the pooled results of radiologists' staging from Al-Sukhni et al. meta-analysis.[30] Our sensitivity on radiology reporting compares poorly to their pooled result (55% vs. 77%), while our specificity for the radiology report is much higher that reported in this meta-analysis (83% vs. 71%). Similarly, when comparing our MDT and radiology report results to those reported by Park et al., they reported a higher sensitivity (78%) and lower specificity (83%).[18] The sensitivity and specificity when adopting morphological and signal criteria to assess malignant nodes remains an area of controversy.[31–33] Nevertheless, our study and Park et al. both used size and nodal characteristics to identify suspicion of nodal metastasis. The poor sensitivity

in our cohort could be attributed to a small sample size, selection bias in the early surgery subgroup and by a higher size criterion (nodal short-axis diameter) being applied by the radiologist. Individual colorectal unit thresholds also matter for calibration. It maybe that due to the high adoption of TNT at the two hospitals in questions, identification of true negatives has taken on relatively more importance than identification of true positives.

There are several limitations to this study. Firstly, since rectal cancer patients with metastatic nodes undergo neoadjuvant treatment, selection bias is expected in the early surgery rectal cancer subgroup. Therefore, we are uncertain to what degree our findings can be generalized to patients with more advanced disease. Secondly, due to the small number of patients in the early surgery rectal cancer group, staging accuracy could not completely be assessed. Finally, given our small sample size, our findings need to be verified with a larger population study. MDT remains important for the discussion of management strategies and overall coordination of cancer care.

5 | CONCLUSION

Preoperative colorectal cancer local staging was consistent between specialised MDT and original radiology reports, with no significant differences in diagnostic accuracy identified between MDT and the radiology report in nodal staging in colon cancer and tumor and nodal staging in the early surgery rectal cancer.

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CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

ETHICS STATEMENT

Approval to conduct this study was granted by the Central Adelaide Local Health Network Human Research Ethics Committee (HREC/19/CALHN/73) and the St. Andrews Hospital Ethics Committee (#116). This study was conducted in accordance with the Helsinki Declaration.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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