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DIAGNOSTIC ACCURACY OF CT SCAN IN LOCAL STAGING OF COLON CANCER

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ABSTRACT

Background and Objectives: Accurate preoperative staging is paramount in colon cancer management. While abdominal CT is the primary imaging modality for local staging, its diagnostic accuracy for identifying high-risk disease (T3/T4 tumors, nodal involvement) remains variable. The aim of this study is to find out the diagnostic accuracy of abdominal CT in local staging of colon cancer patients, by comparing CT findings with histopathological analysis as the gold standard method at the Dow Institute of Radiology (DIR).

Methods: This cross-sectional study included 151 patients aged 18-50 years with newly diagnosed colon cancer scheduled for surgery. All participants underwent contrast-enhanced abdominal CT. CT findings were interpreted independently by two radiologists blinded to histopathological results. A tumor was classified as high-risk on CT and histopathology based on predefined criteria for T-stage, N-stage, and extramural venous invasion.

Results: The study demonstrated that CT scan had a sensitivity of 76.7%, a specificity of 84.6%, and an overall diagnostic accuracy of 80.1% for identifying high-risk colon cancer. Stratified analysis revealed higher accuracy in females (86.5%), younger patients (18-34 years, 82.7%), and tumors located in the sigmoid colon (88.4%) and rectosigmoid junction (88.0%).

Conclusion: Preoperative abdominal CT shows substantial diagnostic accuracy for local staging of colon cancer, proving to be a reliable tool for identifying high-risk disease. Its high specificity makes it particularly valuable for ruling out advanced stages, thereby playing a critical role in initial therapeutic decision-making.

INTRODUCTION

Colon cancer represents a major global health challenge, ranking as the third most common cancer and the second leading cause of cancer-related mortality worldwide (1). Its pathogenesis involves a complex interplay of genetic, environmental, and lifestyle factors, often evolving from premalignant adenomatous polyps, which underscores the critical need for early detection and intervention (2,3). With a rising incidence that now accounts for approximately 11% of all cancer diagnoses, the disease imposes a significant burden across diverse populations (4,5).

Accurate staging is fundamental to guiding management, with the American Joint Committee on Cancer (AJCC) TNM system serving as the gold standard for evaluating tumor depth (T-stage) and nodal involvement (N-stage). Precise staging informs prognosis and therapeutic strategy, particularly in locally advanced cases, which comprise 20–30% of patients, often presenting as T3/T4 tumors with nodal or peritoneal metastases (6,7). While abdominal CT is a widely accessible, non-invasive tool for local and metastatic staging, its diagnostic performance remains variable, with reported sensitivities and specificities ranging from 54% to 75.6% and 58% to 89%, respectively (11-21).

Treatment paradigms are evolving, with adjuvant chemotherapy recommended for stage III and high-risk stage II disease, and neoadjuvant approaches gaining traction through trials. In this context, reliable preoperative staging with CT is indispensable, enabling tailored treatment, optimizing resource use, and enhancing patient counseling. This study therefore aims to evaluate the diagnostic accuracy of preoperative abdominal CT against histopathology, the reference standard, to strengthen clinical decision-making in colon cancer care.

MATERIAL AND METHODS

This cross-sectional study was carried out at the Dow Institute of Radiology (DUHS) over a period of six months following approval from the Institutional Review Board. A total of 151 patients were enrolled, the sample size being calculated using the method described by Malmström et al., assuming a specificity of 89% ± 5% at 95% confidence. Patients were selected through consecutive sampling. Those aged between 18 and 50 years with newly diagnosed colon cancer on clinical and imaging evaluation and scheduled for surgery were included after providing informed consent. Patients with contraindications to contrast-enhanced CT such as impaired renal function or allergy, previous history of colon cancer, prior neoadjuvant therapy, second primary malignancies, pregnancy, or unwillingness to consent were excluded.

All eligible participants underwent abdominal CT scan with intravenous contrast using a standardized imaging protocol. The images were independently interpreted by two radiologists blinded to surgical and histopathological outcomes. Tumor characteristics including tumor site, tumor size and lymph node features were documented. Histopathology findings served as the gold standard for local staging. Demographic and clinical details, along with CT and histopathological findings, were

recorded in a structured proforma, anonymized, and stored securely to ensure confidentiality.

For operational purposes, a tumor was classified as high-risk stage on CT if it showed features of locally advanced disease. These included cT3 tumors extending beyond the muscularis propria with pericolic fat stranding or nodularity, cT4a lesions with loss of the fat plane or direct peritoneal abutment, cT4b tumors invading adjacent organs, cN1 or cN2 nodal involvement defined by enlarged or morphologically suspicious lymph nodes (evidence of EMVI). On histopathology, high-risk tumors included pT3 or pT4 lesions with extension beyond the muscularis propria or direct invasion of adjacent structures, pN1 or pN2 lymph node metastases, microscopic evidence of EMVI, or the presence of tumor deposits in pericolic fat.

Diagnostic accuracy was determined by classifying cases as true positives when CT correctly identified high-risk disease confirmed on histopathology, true negatives when CT correctly identified low-risk disease, false positives when CT overestimated risk, and false negatives when CT failed to identify high-risk disease. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were calculated using standard formulas derived from contingency tables.

Data analysis was performed using IBM SPSS version 26. Continuous variables such as age, tumor size, and lymph node size were summarized as mean ± standard deviation, while categorical variables including gender, tumor site, and risk classification were expressed as frequencies and percentages. Associations between CT features and histopathological risk classification were assessed using the chi-square test, and logistic regression was employed to adjust for confounding factors such as age, gender, and comorbidities.

RESULTS

A total of 151 patients with colon cancer were included in the study. The mean age of participants was 34.3±9.4 years. Slightly more than half of the patients (53.6%) were in the 18–34 years age group, while there was a nearly equal gender distribution, with 77 males (51.0%). The mean tumor size was 5.09±1.82 cm, while the mean lymph node size was 1.82 ± 0.68 cm. Regarding tumor location, the most frequent site was the sigmoid colon (28.5%), followed by the descending colon, ascending colon, rectosigmoid junction and transverse colon. On CT scan, 68 patients (45.0%) were classified as high-risk, whereas histopathology identified 73 patients (48.3%) as high-risk. Detailed analysis of descriptive statistics is presented in table 1.

When CT findings were compared with histopathology, the overall sensitivity was 76.7%, specificity 84.6% and overall accuracy 80.1% (table 2). Stratification analysis showed that diagnostic accuracy varied across subgroups. Sensitivity was higher in females (87.9%) compared to males (67.5%), while overall accuracy was also higher in females (86.5% vs. 75.3%). By age, younger patients (18–34 years) showed slightly better accuracy (82.7%) compared to those aged 35–50 years (78.6%). Tumor site-wise analysis revealed the highest accuracy for sigmoid colon (88.4%) and rectosigmoid junction (88.0%), while the lowest was seen for descending (71.9%) and transverse colon (71.4%). Detailed stratification analysis is reflected in table 3.

Table 1: Descriptive statistics for the categorical variables of the study (n=151)

Variable	Category	Frequency	Percent
Age group	18–34 yrs	81	53.6
	35–50 yrs	70	46.4
Gender	Female	74	49.0
	Male	77	51.0
Tumor Site	Ascending colon	30	19.9
	Descending colon	32	21.2
	Rectosigmoid junction	25	16.6
	Sigmoid colon	43	28.5
	Transverse colon	21	13.9
CT Findings	High-Risk	68	45.0
	Low-Risk	83	55.0
Histopathology Findings	High-Risk	73	48.3
	Low-Risk	78	51.7

Table 2: Diagnostic Accuracy of CT for risk staging of colon cancer (taking histopathology findings as Gold Standard)

Staging on CT	Staging on Histopathology		Total
	High Risk	Low Risk	
High Risk	56	12	68
Low Risk	17	66	83
Total	73	78	151

Sensitivity: 76.7%
Specificity: 84.6%
Overall Accuracy: 80.1%
PPV: 82.4%
NPV: 79.5%

Table 3: Diagnostic Accuracy of CT for risk staging of colon cancer (Stratified by Variables)

	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)	NPV (%)
Age Group					
18–34	78.4	86.4	82.7	82.9	82.6
35–50	75.0	82.4	78.6	81.8	75.7
Gender					
Female	87.9	85.4	86.5	82.9	89.7
Male	67.5	83.8	75.3	81.8	70.5
Tumor Site					
Ascending colon	81.2	78.6	80.0	81.2	78.6
Descending colon	57.1	83.3	71.9	72.7	71.4
Rectosigmoid junction	81.8	92.9	88.0	90.0	86.7
Sigmoid colon	95.0	82.6	88.4	82.6	95.0
Transverse colon	58.3	88.9	71.4	87.5	61.5

DISCUSSION

The present study evaluated the diagnostic accuracy of abdominal CT in identifying high-risk colon cancer, using histopathology as the gold standard, in a sample of 151 patients. The findings demonstrate that CT imaging achieved a sensitivity of 76.7%, specificity of 84.6%, and overall accuracy of 80.1%, reflecting a reliable, though not flawless, modality for preoperative risk stratification. The sensitivity in the current study, while respectable, highlights that nearly one in four high-risk tumors may be missed by CT, underscoring the limitations of imaging in detecting microscopic or subtle peritoneal and nodal disease. Specificity, however, was higher, reflecting that false positives were relatively uncommon and that CT remains reliable for ruling out high-risk disease when absent. These results have significant implications for clinical decision-making, particularly in guiding surgical planning and the consideration of adjuvant or neoadjuvant therapies. The mean age of 34.3 years of the study population reflecting the relatively young demographic included under the study criteria. Although colon cancer is generally more prevalent in older populations, the inclusion of patients aged 18 to 50 underscores a rising concern for early-onset

colorectal cancer, which has been increasingly reported in contemporary literature (8). The nearly equal gender distribution is not consistent with global epidemiological patterns which shows male dominance (9), however there is a subtle differences in diagnostic accuracy between males and females, as observed in this study, may reflect both biological and technical factors. Tumor site distribution, with the sigmoid colon being the most frequent location, also parallels prior epidemiological studies that identify the distal colon as the most common site of involvement (10).

The diagnostic performance of CT observed in this study is in line with previously published reports. Malmström et al. reported 65% sensitivity and specificity close to 89%, figures that are remarkably similar to the present findings (11). Likewise, Choi et al (12). as well as van den Berg et al (13). documented comparable diagnostic yields for nodal staging and high-risk tumor characterization. van den Berg et al., who demonstrated that CT-detected T3–T4 disease corresponded to histopathological T3–T4 in 85% of patients, with diagnostic accuracy further improving to 96.4% when both EMVI and tumor deposits were present. This parallels our observation that CT performs best when overt high-risk features are evident, but still misses a subset of advanced tumors, explaining the false negatives seen in 23.3% of high-risk histopathology cases. Similarly, Choi et al. reported that CT has only moderate sensitivity but good specificity for nodal staging in colon cancer, consistent with our results where specificity (84.6%) exceeded sensitivity (76.7%), reflecting CT's strength in ruling out nodal metastasis but its limitation in detecting microscopic disease. Dai (2019) and Fletcher (2000) reported higher sensitivities (84% and 88%) and comparable specificities (83% and 72%), showing that CT is particularly reliable when protocols are optimized (14,15). Similarly, Hoppe (2004) and Kim (2008) documented sensitivities of 76% and 69% and specificities of 88% and 89%, respectively, which align closely with our results (16,17).

On the other hand, our sensitivity exceeded that of Cao (2016) (65%) and Wong (2002) (59%), suggesting that improved imaging protocols and experience at our center may have contributed to better detection rates (18,19). Specificity in our series (84.6%) was also higher than Fletcher (2000) (72%) but slightly lower than Wong (2002) (93%) and Johnson (2008) (89%) (15,19,20). Importantly, our findings mirror the overall conclusion of Pickhardt (2003), who reported high diagnostic performance (sensitivity 89%, specificity 80%), highlighting that CT colonography and enhanced CT play a crucial role in identifying advanced disease (21). Collectively, this comparison indicates that our results fall well within the spectrum of previously published sensitivities and specificities. The consistency reinforces the reliability of CT in preoperative staging of colorectal tumors while emphasizing, as in prior studies, the persistent limitation of moderate sensitivity due to missed microscopic disease or subtle tumor deposits.

The stratified analysis revealed additional nuances. Females exhibited higher sensitivity and overall diagnostic accuracy compared to males. One possible explanation is that body habitus differences may allow better delineation of pericolic structures in female patients, thereby enhancing radiological interpretation. Similarly, younger patients demonstrated marginally better accuracy compared to those aged 35–50, perhaps reflecting fewer comorbidities, less distorted anatomy, and better image quality in this subgroup. Upon tumor site analysis, sigmoid and rectosigmoid junction tumors exhibited the highest diagnostic accuracy, exceeding 88%. This may be attributed to the relative anatomical accessibility of these regions, reduced motion artifacts, and better

visualization during CT imaging. This underscores the importance of correlating CT findings with intraoperative and pathological data, particularly for tumors located in less accessible sites.

Our study reinforced that accurate preoperative identification of high-risk tumors is crucial, as it influences surgical planning, extent of resection, and consideration of adjuvant chemotherapy. Patients with T3 or T4 tumors, nodal involvement, or EMVI have a significantly worse prognosis, and timely recognition ensures that optimal therapeutic strategies, including multidisciplinary input, are initiated.

Nevertheless, limitations must be acknowledged. First, the study was conducted in a single institution with a relatively modest sample size, which may limit generalizability. The exclusion of patients over 50 years of age, though necessary for methodological homogeneity, restricts applicability to the broader population, where colon cancer is more common. Furthermore, CT has inherent limitations in differentiating inflammatory stranding from tumor infiltration and in detecting small nodal metastases, which may explain the observed false negatives and false positives. Histopathology, though considered the gold standard, also has sampling limitations, particularly in borderline cases of EMVI or microscopic deposits. Finally, advanced imaging techniques such as dual-energy CT or radiomics-based assessment, which may improve diagnostic accuracy, were not employed in this study.

CONCLUSION

Fndings of our study affirm the critical role of preoperative abdominal CT in accurately identifying high-risk colon cancer, with a sensitivity of 76.7%, specificity of 84.6%, and overall accuracy of 80.1%. These results emphasize importance of CT in guiding surgical planning and therapeutic decisions. This accuracy provides a solid foundation for surgeons and oncologists to make confident, early management decisions, directly impacting patient care pathways. Higher accuracy in specific subgroups, such as females and sigmoid colon tumors, underscores the need for tailored imaging approaches. The reliable detection of high-risk features enhances clinical decision-making, optimizing patient outcomes in colon cancer care.

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