DOI: https://doi.org/10.53350/pjmhs2023175691

ORIGINAL ARTICLE

Concordance Rate of Pre-Operative Radiological Stage with Postoperative Pathological Stage in Colon Cancer

MEHWISH JABEEN[1], GHULAM HAIDER[2], SANA SEHAR[3], BERKHA RANI[4] , SANA NASIR[5] , MUHAMMAD OWAIS KHAN[6] , SONA DEVI[7] , SHUMAILA NAWAZ KHAN[8]

[1,5,7,8]*Postgraduate Trainee, Department of Medical Oncology, Jinnah Postgraduate Medical Centre Karachi*

[2,3,4]*Consultant, Department Medical Oncology, Jinnah Postgraduate Medical Centre Karachi*

[6]*Medical Doctor, Department of Medical Oncology, Jinnah Postgraduate Medical Centre Karachi*

Correspondence to: Mehwish Jabeen, Email: jabeenmehwish38@gmail.com, Cell: +92 336 3191865

ABSTRACT

Aim: This study aimed to assess the concordance rate between pre-operative radiological staging using CT imaging and postoperative pathological staging in patients with colon cancer.

Methodology: A prospective observational study was conducted at the Oncology Department of Jinnah Postgraduate Medical Center, Pakistan, with ethical committee approval between February 2023 to July 2023. Inclusion criteria involved patients diagnosed with colon adenocarcinoma aged >18 receiving treatment at the center, while exclusion criteria comprised unconfirmed colon cancer, lack of consent, benign colonic polyps, metastatic cancer, chemotherapy recipients, and incomplete data. Sample size estimation yielded 227 patients. Recruitment used consecutive sampling, and data were collected using a predefined proforma. CT scans were performed, and T-stage was assessed by radiologists and pathologists. Histological analysis followed established guidelines, with final pathology serving as the gold standard.

Results: The diagnostic accuracy of CT imaging was evaluated, with statistically significant concordance found between CT scans and histopathological diagnoses (p-value = 0.046). CT scans demonstrated a sensitivity of 57.14% for Stage I tumors and a specificity of 88.18% for Stage II-III tumors. The positive predictive value (PPV) was 13.3%, and the negative predictive value (NPV) was 98.48%, resulting in an overall accuracy of 87.22%. These findings suggest that CT imaging is valuable for identifying Stage II-III tumors, exhibiting good specificity and NPV, although sensitivity and PPV for Stage I tumors were comparatively lower. Chi-square testing confirmed the statistical significance of these results (p-value ≤ 0.05)

Conclusion: This study highlights the utility of CT imaging in pre-operative staging of colon cancer, particularly for Stage II-III tumors, where it exhibits notable accuracy. However, improvements may be needed to enhance sensitivity and PPV for Stage I tumors.

Keywords: Colon cancer, CT imaging, pathological staging, concordance rate, diagnostic accuracy.

INTRODUCTION

Colon cancer, globally recognized as one of the predominant malignancies, ranks alongside lung, prostate, and breast cancers as a leading cause of cancer-related mortality [1]. Over recent years, advancements in both surgical and oncological approaches have markedly improved the treatment landscape for this disease. Despite these advancements, the management of locally advanced colon cancer continues to present significant challenges to medical professionals, with surgical excision being a cornerstone for potential cure [2].

In the realm of preoperative evaluation, modern Computed Tomography (CT) scanning has emerged as the predominant imaging modality for staging colonic cancer. A meta-analysis has reported a pooled sensitivity and specificity of 90% (83–95%) and 69% (95% CI: 62–75%), respectively, for detecting tumor invasion beyond the bowel wall (T3–T4) [3]. Additionally, this meta-analysis highlights the potential of CT colonography in enhancing the accuracy of staging [3].

The role of CT in identifying distant metastases (M stage) is well-established [4], and several studies have affirmed its efficacy in assessing tumor and nodal stages [5,6]. Nonetheless, these findings are somewhat controversial, as exemplified by a study from Sjovall et al. in Sweden [7], which reported a low concordance between preoperative clinical tumor and nodal staging (cTN), as determined by CT, and the postoperative histopathological findings (pTN).

This study aims to explore the concordance rate between preoperative radiological staging and postoperative pathological staging in colon cancer patients. Specifically, it seeks to evaluate how accurately the preoperative clinical tumor and nodal stages (cTN), as determined by CT, correlate with the postoperative histopathological stages (pTN) in cases of colon cancer.

METHODOLOGY

A prospective observational approach was undertaken at the Oncology Department of Jinnah Postgraduate Medical Center in Pakistan after obtaining approval from the ethical committee board between February 2023 to July 2023.

The study included adults aged 18 and older diagnosed with adenocarcinoma of the colon. Excluded from the study were those without a confirmed diagnosis of colon cancer, individuals who withheld consent, patients with benign colonic polyps or lesions, and patients with metastatic colon cancer. Additional exclusions were individuals who had received chemotherapy, which could affect staging accuracy, and those with incomplete radiological or pathological records. Patients who had not undergone surgery or whose surgical details were unknown were also excluded to ensure the study only considered those with verifiable surgical intervention. Cases involving second primary or multiple tumors were omitted to maintain the focus on primary colon adenocarcinoma. Lastly, the cohort did not include patients lacking histological confirmation or those without postoperative examination of lymph nodes, as complete histopathological data were essential for the study's staging concordance assessment.

To determine the sample size, an online sample size estimator called SELECT STATISTICS was utilized. With an expected proportion of correctly diagnosed colon cancer stage via CT scan set at 82%, a confidence level of 95%, and a margin of error of 5%, the sample size was calculated to be 227 [8].

Recruitment of participants was accomplished using a non-probability consecutive sampling technique. Data collection was facilitated through a predefined proforma, following approval from the ethical review board. The study categorized patient demographics by age groups (below 40, 40–65, and above 65 years), sex, and ethnicity. Hospital attributes comprised the nature of the hospital and its geographical setting. Oncological variables encompassed the anatomical site of the tumor, cellular composition, and level of differentiation. Tumors located in the cecum, ascending, or transverse colon were grouped as "right-sided," while those in the splenic flexure, descending, or sigmoid colon were designated "left-sided." Tumors were further categorized based on differentiation: well- to moderately-differentiated tumors as low-grade and poorly differentiated or undifferentiated as high-grade.

The study commenced following institutional review board (IRB) approval, with patients being informed about the study's aims

and objectives before providing informed consent. Data collection involved the use of a predefined pro forma and structured questionnaire. Thoraco-abdomino-pelvic CT scans were performed using a 64-slice CT system, with image recording taking place 70 seconds after the intravenous injection of 100 mL of Iomeron® 350 mg/mL, administered at a rate of 3 mL/s. Oral administration of 1 L of water 15 minutes before the scan aided in delineating the small and large bowel. Dosage was adjusted based on patient weight.

Radiologists and pathologists assessed stage using the American Joint Committee on Cancer (AJCC) Staging Manual (8th edition) [9], stratifying patients into high-risk and low-risk groups based on the extent of tumor invasion beyond the proper muscle layer (more or less than 5 mm). Histological analysis followed the Guidelines for Diagnosis and Treatment of Colorectal Cancer, Danish Colorectal Cancer Group. T-staging results from CT interpretation were compared to T-stage at final pathology, with final pathology serving as the gold standard. Pathological specimens were formalin-fixed, sliced transversally at 5- to 10-mm intervals, and examined microscopically by specialized gastro pathology pathologists.

For data analysis, SPSS software was employed. Concordance between CT imaging-derived T-stages and final histology-based T-stages was determined for the entire patient population. Demographic comparisons between populations utilized Student's t-test for continuous variables and $\chi 2$ test for categorical variables, with a significance level set at $P \leq 0.05$

In terms of ethical considerations, patients were assured that their data would remain confidential, with no involvement of external parties. The main author retained all data, and no private information such as addresses or mobile phone numbers was collected or recorded.

RESULTS

In a study of 227 participants with colorectal cancer, the mean age was 40.61 years (SD=14.93), and the average BMI was 20.81 kg/m2. Most participants were male (62.1%), and the majority were in the 31–50 years age group (50.2%). Blood in stool was reported by 81.1% of participants, and adenocarcinoma was the most common histopathology finding (85.5%). Surgical procedures, including right extended hemicolectomy (41.9%), were performed. Pathogenic T3 stage was the most prevalent (49.8%). The study involves participants from academic (34.0%), non-academic (15.4%), tertiary care (44.9%) hospitals, and others (5.7%).

Table 1: Demographic Characteristics of Study Participants (n=227)

Variables	Mean±SD	95% C. I
Age in years	40.61 ± 14.93	38.66----42.57
BMI in kg/m^2	20.81 ± 3.67	20.33----21.29
Gross Tumor Size (cm)	2.38 ± 0.53	2.31----2.45
Number of foci	1.04±0.22	1.01----1.07
Gender		
Male	141 (62.1)	
Female	86 (37.9)	
Age Group		
14 – 30 Years	65 (28.6)	
31 – 50 Years	114 (50.2)	
>50 Years	48 (21.1)	
Smoking Status		
Punjabi	30 (13.2%)	
Pushtoons	36 (15.9%)	
Sindhi	67 (29.5%)	
Urdu speaking	94 (41.4%)	
Marital Status		
Married	157 (69.2)	
Unmarried	61 (26.9)	
Divorced	9 (4.0)	
Employment Status		
Business	20 (8.8)	
Employed	70 (30.8)	
Student	37 (16.3)	
Unemployed	100 (44.1)	
Grade of Tumor		
Grade I	11 (4.8)	
Grade II	104 (45.8)	
Grade III	112 (49.3)	
Blood in Stool		
Yes	184 (81.1)	
No	43 (18.9)	
Symptoms		
Abdominal Pain	33 (14.5)	
Tumor Site		
Ascending Colon	86 (37.9)	
Caecum	29 (12.8)	
Descending Colon	66 (29.1)	
Sigmoid Colon	35 (15.4)	
Transverse Colon	11 (4.8)	
Surgery Type		
Left Extended	18 (7.9%)	
Left Hemicolectomy	77 (33.9%)	
Right Hemicolectomy	1 (0.4%)	
Right Extended	15 (6.6%)	
Right Extended Hemicolectomy	95 (41.9%)	
Pathogenic T Stage		
T1	3 (1.3%)	
T2	21 (9.3%)	
T3	113 (49.8%)	
T4	90 (39.6%)	
Pathogenic N Stage		
N0	57 (25.1%)	
N1	75 (33.0%)	
N2	93 (41.0%)	
N3	2 (0.9%)	
Histopathology Findings		
Adenocarcinoma	194 (85.5%)	
Mucinous Carcinoma	25 (11.0%)	
Signet Ring Cell Carcinoma	8 (3.5%)	
Hospital Type		
Academic	79 (34.0%)	
Non-Academic	35 (15.4%)	
Tertiary Care	102 (44.9%)	
Others	11 (5.7%)	

The comparison between radiological and pathologic T stages in the study of 227 participants with colorectal cancer revealed that the majority of cases were accurately diagnosed. Notably, T3 was the most accurately predicted stage, with 28.6% concordance, followed by T4 with 16.3%. Lower concordance was observed for T1 and T2 stages, with 0.9% and 1.8% accuracy, respectively. Overall, the findings suggest variability in the accuracy of radiological staging across different T stages (TABLE II).

Table 2: Comparison between Radiological and Pathologic T stages (n=227)

Radiological Stage	Pathogenic Stage				
		T1	T2	T3	T4
	T1	2 (0.9%)	8 (3.5%)	8 (3.5%)	2 (0.9%)
	T2	0 (0.0%)	4 (1.8%)	22 (9.7%)	1 (0.4%)
	T3	1 (0.4%)	9 (4.0%)	65 (28.6%)	50 (22.0%)
	T4	0 (0.0%)	0 (0.0%)	18 (7.9%)	37 (16.3%)

Applied Chi-Square test
*Numbers in the cells represent row percentages not column percentages
P-Value (0.0001); Kappa = 0.151

Table 3: Comparison between Radiological and Pathologic N stages (n=227)

Radiological Stage	Pathogenic Stage			
		T0	T1	T2
	N0	18 (7.9%)	41 (18.1%)	1 (0.4%)
	N1	32 (14.1%)	22 (9.7%)	22 (9.7%)
	N2	7 (3.1%)	12 (5.3%)	46 (20.3%)

Applied Chi-Square test
*Numbers in the cells represent row percentages not column percentages
P-Value (0.0001); Kappa = 0.081

Table III presents a comparison between radiological and pathologic N stages in the study involving 227 participants with colorectal cancer. Radiological N stages (T0, T1, and T2) are compared with pathogenic N stages (N0, N1, and N2). The distribution is as follows: for N0, 7.9% in T0, 18.1% in T1, and 0.4% in T2; for N1, 14.1% in T0, 9.7% in T1, and 9.7% in T2; for N2, 3.1% in T0, 5.3% in T1, and 20.3% in T2.

Table IV illustrates the association between radiological and pathological staging based on patient characteristics in a cohort of 227 individuals with colorectal cancer. Odds ratios (OR) with 95% confidence intervals (C.I.) and corresponding p-values are reported. Regarding age group, individuals aged >50 years have an OR of 2.15 (95% C.I.: 0.93 - 4.97), showing a trend towards increased odds of a higher pathological stage. No significant

associations are observed for gender or marital status. Employment status reveals interesting findings, with students having a lower odds ratio of 0.42 (95% C.I.: 0.18 - 0.96), suggesting a potential protective effect. Blood in stool and histopathology types show no significant associations. Grade II tumors have an OR of 1.60 (95% C.I.: 0.89 - 2.90), indicating a potential association with higher pathological staging. These results provide insights into the relationship between patient characteristics and the agreement between radiological and pathological staging in colorectal cancer.

Table 4: Association of Radiological and Pathological Staging by Patient Characteristics (n=227)

		Pathogenic Stage (T) & (N)	
Variables, n (%)		OR (95% C.I.)	P-Value
Age Group	14 – 30 Years	0.46 (0.06 ---- 1.47)	0.123
	31 - 50 Years	0.92 (0.27 ---- 3.15)	
	>50 Years	2.15 (0.93 ---- 4.97)	
Gender	Male	0.58 (0.21 ---- 1.57)	0.948
	Female	1.70 (0.63 ---- 4.55)	
Marital Status	Married	0.68 (0.05 ---- 8.50)	0.533
	Unmarried	0.53 (0.03 ---- 7.53)	
	Divorced	1.86 (0.13 ---- 26.1)	
Employment Status	Employed	0.53 (0.16 ---- 1.68)	0.308
	Unemployed	0.75 (0.11 ---- 4.98)	
	Student	0.42 (0.18 ---- 0.96)	
	Business	1.33 (0.20 ---- 8.81)	
Blood in Stool	Yes	0.63 (0.19 ---- 2.12)	0.555
	No	1.57 (0.47 ---- 5.27)	
Histopathology	Adenocarcinoma	1.24 (0.29 ---- 5.37)	0.813
	Mucinous Carcinoma	0.85 (0.16 ---- 4.43)	
	Signet Ring Cell Carcinoma	0.80 (18 ---- 3.44)	
Grade of Tumor	Grade I	1.22 (0.30 ---- 5.00)	0.118
	Grade II	1.60 (0.89 ---- 2.90)	
	Grade II	0.97 (0.09 ---- 10.1)	

DISCUSSION

Preoperative clinical staging of colon cancer is essential for patient-tailored treatment strategies [10, 11], To this end, our observational prospective study assessed concordance between preoperative radiological and postoperative pathological staging in colon cancer patients. This observational prospective study included 227 patients in total. The frequency distribution of tumor staging of colon cancer was staged according to the depth of tumor invasion beyond the muscularis propria and with respect to the distinction of the four standard T category groups of more or less than 5 mm (T1/T2,T3≤5 mm, T3 > 5 mm, and T4). The frequency distribution of tumor stages on CT imaging indicated that 12.8% of patients were categorized as Stage 1, whereas 87.2% were categorized as Stage 2 and 3. However, postoperative histopathological findings revealed that only 3.1% of patients were Stage 1, while the majority, 96.1%, were categorized as Stage 2 and 3. Regarding the discrepancy between preoperative CT imaging and postoperative histopathological findings for staging of colon cancer, the PPV for Stage 1 was notably low, meaning that a significant proportion of patients categorized as Stage 1 by CT imaging turned out to have more advanced disease upon histopathological examination, and The NPV for Stages 2 and 3 was relatively high, suggesting that CT imaging is more accurate in ruling out these stages. This finding is consistent with the literature, which often highlights the limitations of CT imaging in accurately determining the tumor stage, especially for early-stage tumors [12]

The diagnostic accuracy of CT imaging in our study was 87.22%, reflecting its effectiveness in correctly classifying patients into their respective tumor stages. However, the lower sensitivity and positive predictive value for Stage 1 indicate room for improvement in accurately identifying early-stage colon cancer through CT imaging. Moreover a chi-square test demonstrated a statistically significant difference between CT imaging and histopathological findings, reinforcing the challenges of using CT imaging as a standalone method for determining tumor stage, particularly for Stage 1 tumors. In the context of patient-tailored treatment, under-staging could lead to under-treatment, such as inappropriate use of organ-preserving surgery or omitting neoadjuvant treatment. Vice versa, over staging may lead to over-treatment with risk of associated morbidity [13]. Previously, a study with 105,569 patients from the United States national database had just 0–1% overstaging of cT3-4, which is not in line with any other study and may have resulted from differential misclassification bias [14]. More in line with our results, a large cohort study and a Swedish registry study had 7% and 12% overstaging of cT3-4, and 64% and 51% understaging of cT1-2, respectively [7].

Our study also noted the differential results in previous studies, which have investigated the diagnostic accuracy of CT in the preoperative staging of colon cancer. Studies have assessed standard T categories, nodes, and distant metastases and have found accuracy to be reasonable [5]. In 2012, Dighe et al. [15] evaluated the accuracy of standard CT in local colon cancer staging, also emphasizing the T subcategory classification used in the FOxTROT trial. They showed that CT had a sensitivity of 87% and a specificity of 49% in identifying high-risk tumors [15].

There were a few limitations in our study. For instance, single-center study design is a notable limitation. This single-center approach limits the generalizability of the findings, as patient populations and clinical practices can significantly differ across various regions and healthcare settings. In conclusion, the study on the concordance rate of the pre-operative radiological stage with the postoperative pathological stage in colon cancer provides valuable insights into the challenges and limitations of current staging methods. Accurate staging is a cornerstone of personalized medicine in oncology, guiding treatment decisions and predicting patient outcomes. Discrepancies between preoperative and postoperative staging can lead to both underestimation and overestimation of disease extent, resulting in suboptimal treatment decisions [19]. Therefore there is a need for a collaborative approach to improve staging accuracy. A more comprehensive approach that involves multidisciplinary collaboration among clinicians, radiologists, and pathologists is essential. This collaboration can help refine the staging process, enhance the accuracy of disease characterization, and ultimately improve patient care.

CONCLUSION

In conclusion, this study demonstrates that CT imaging holds promise as a valuable tool for pre-operative staging of colon cancer, particularly for identifying Stage II-III tumors with high accuracy. While sensitivity and positive predictive value were lower for Stage I tumors, the overall diagnostic performance suggests CT imaging's clinical relevance in treatment planning. Further research and refinements in imaging techniques may enhance its utility in early-stage diagnosis.

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