Diagnostic Accuracy of Computed Tomography for Local Staging of Colon Cancer

Original Article

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ABSTRACT

Background: Recent studies have demonstrated the significance of precise presurgical local staging of colon cancer for identifying patients who are ineligible for laparoscopic surgery or who will benefit from neoadjuvant chemotherapy. Although computed tomography (CT) has been widely recognized as the accepted standard for imaging, the majority of published data have focused on how well CT performs in staging liver and extrahepatic metastases and the evidence supporting the accuracy of locoregional staging is poorer. Therefore, this study was conducted to determine the diagnostic accuracy of abdominal CT with contrast in the detection of local staging of colon cancer in comparison to post-operative histopathology.

Patients and Methods: This Diagnostic accuracy testing study included 50 colon cancer patients conducted at Kobri El-Qoba military complex and Maadi military complex in the period between October 2021 and September 2022. A CT scan was performed on each patient receiving either an emergency or elective colon cancer resection. CT findings were then compared with the eventual histopathology findings regarding T stage as the gold standard.

Results: The radiological accuracy of CT showed a 70.58% sensitivity and 78.8% specificity in the diagnosis of T1/T2 tumors whereas T4 staging had a sensitivity of 90% and a specificity of 100%. For local colon cancer staging, CT had an overall sensitivity and specificity of 76.73% and 85.53%, respectively.

Conclusion: The results of the current study suggested that CT would be a reasonable imaging technique for the local staging of colon cancer prior to surgery.

Key Words: Colon cancer, computed tomography, diagnostic accuracy, local staging.

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INTRODUCTION

Colon cancer is recognized as the cancer with the third-highest rate of diagnoses and the second-highest cancer-related fatality rates globally After breast cancer[1] (**Malki *et al*. 2020**). Worldwide, it is one of the cancers with rising incidence and encompassing 11% of all cancer diagnoses[2] (**Sawicki *et al*. 2021**). Colon cancer patient staging typically requires a multimodality imaging strategy. The American Joint Committee on Cancer's TNM approach is the accepted staging technique for colon cancer and is based on three critical elements: the tumor's size (T), its spread to nearby lymph nodes (N), and the existence of distant metastases (M). The prognosis of colon cancer patients can be predicted by a number of variables, including histological subtype, TNM stage, blood tests, and carcinoembryonic antigen level, but these factors' precision and accuracy have yet to be demonstrated[3] (**Zhao *et al*. 2021**).

Preoperative staging utilizing various imaging modalities is critical for developing the treatment strategy and predicting the patient's prognosis in patients with colon cancer. Because of its advantages of being globally available and easily reproducible, there is a hypothesis that radiologists, surgeons and pathologists who are well organized in colon cancer therapy can use CT to arrive at a significantly more accurate preoperative staging. The American College of Surgeons required the use of CT scans and the AJCC-8th edition TNM staging criteria to define the radiological stage. T1, tumour invades submucosa; T2, tumour invades muscularis propria; T3, tumour invades peri colon tissues through the muscularis propria; T4a, tumour penetrates to the surface of the visceral peritoneum and T4b, tumour directly invades or is attached to other organs or structures. (N1) metastases to one to three regional lymph nodes; (N2), metastasis to four or more regional lymph nodes[4] (**Tong *et al*. 2018**)

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Multidisciplinary team (MDT) management is gaining acceptance as a way to individualize care for oncological patients and has been proved to enhance oncological outcomes. Surgeons, oncologists, radiologists, pathologists and coordinators are among the team members' medical specialties. To enhance diagnosis, treatment planning, and outcomes for malignant diseases, the MDTs have been suggested as a new standard of care.

PATIENTS AND METHODS:

Research design and setting:

This Diagnostic accuracy testing study was carried out at Kobri El-Qoba military complex and Maadi military complex over the course of 11 months, from October 2021 to September 2022.

Participants

Colon cancer patients were recruited from outpatient clinics, emergency department and inpatient wards. The inclusion criteria set for enrollment in this study were all consecutive patients with CT done to stage colonic cancer preoperatively that provided information on the tumor spread of bowel wall and histopathological analysis post-operative used as reference standard. Patients were excluded if they had other types of cancer (e.g., ovarian cancer, cervical cancer, anorectal cancer, prostate cancer, or familial adenomatous polyposis), multiple colonic lesions (synchronous or metachronous), were inoperable (no resection done), or post-operative histopathological diagnosis doesn't reveal any malignant criteria despite radiological findings suggesting colon cancer.

Procedures

After institutional review board approval, a database of consecutive individuals who had a colonic malignant tumour resected was examined. In these institutions preoperative CT scanning is considered as the preferred technique for locoregional staging of colon tumours. All of these patients had a CT scan. CT results were compared with the eventual post-operative histopathology report regarding T stage as the gold standard.

Before undergoing the abdominal multidetector computed tomography (MDCT) scan, the patients were informed about the procedure. On a 160-detector CT (Toshiba Medical Systems, Tokyo, Japan), all MDCT scans were carried out. Following the non-enhanced images, all patients received the single-phase imaging regimen acquired in the portal venous phase. Patients were asked to fast for at least 10 hours. With the exception of emergencies involving partially obstructed patients, 90 minutes prior to the examination, patients were given 50 milliliters of an oral contrast medium (diatrizoic acid, Urografin 76% 50 milliliters) along with 1000 milliliters of water. Following that, 30-40 ml saline and 90-110 ml of nonionic iodinated contrast medium was infused intravenously. Imaging began roughly 65 seconds after the contrast agent was injected, when its concentration in the abdominal aorta reached 180 Hounsfield units. The following imaging settings were adjusted: collimation 64 × 0.5 mm, slice thickness 1 mm, interval 1 mm, tube voltage 120 kV, tube current 200-440 mA, and gantry rotation time 0.5 s. The information collected from the MDCT examination was sent to a different computer system for processing and image analysis, and was then examined by two qualified radiologists. The tumor's site, the extent of its invasion into the intestinal wall, and the invasion of nearby organs were all determined. Using the TNM staging approach, MDCT was used to stage the tumours. Stage T1/T2 tumours were classified as being restricted to the intestinal wall, stage T3 tumours as having spread through the intestine wall and implicated pericolonic adipose tissue, and stage T4 tumours as having invaded a nearby organ. The specimens from all the patients underwent histopathologic staging and inspection utilizing standard paraffin embedding, slicing, hematoxylin and eosin staining, as well as microscopy.

Sampling and sample size

A convenient sampling method was adopted. Sample size was calculated using PASS 11.0 and based on a study carried out[5] (**Olsen *et al*. 2021**). The two-sided binominal test has 3% power to detect a change in sensitivity from 0.5 to 0.61 and 92% power to detect a change in specificity from 0.5 to 0.85 with a total sample size of 50 patients. The desired level of significance is 0.01. The specificity test's true significance level was 0.0094, while the sensitivity test's was 0.0074.

Statistical analysis

Data were entered into a Microsoft Excel spreadsheet for Windows and analysed with SPSS version 26 (**IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp**). Categorical variables were presented as frequency (n) and percentage (%), whereas quantitative variables were presented as mean, standard deviation (SD). A level of significance of 5% was set for all statistical analyses ($\alpha = 0.05$). Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) were calculated.

Ethical considerations

The study proposal was approved by the Armed Forces College of Medicine Ethical Review Committee (IRB: 37; meeting September 25, 2021; serial number: 87). All participants in the study submitted written, informed consent. The study was conducted in accordance with the Revised Helsinki Declaration on Biomedical Ethics.

The data confidentiality policy was properly adhered to. Collected data were used only for research purposes; all personal and medically identifiable data were collected, coded, and exported into an Excel file format that was password-protected. The confidentiality of the data was assured.

RESULTS:

The study included 50 patients with histopathologically confirmed colon cancer who attended the Kobri El-Qoba Medical Complex and the Maadi Armed Forces Medical Complex. The patients' ages ranged from 33 to 77 years old, with a mean age of 57.84 ± 9.77 years old. Regarding the anatomical site of the primary tumor, the sigmoid colon was the most common site of tumor with 28% of included patients (14 patients), followed by the cecum, which was the site of tumor in 26% of cases (13 patients). Ascending colon came into the third rank and was the site of tumor among 22% of included patients (11 patients). Also, 8% of patients (4 patients) had tumor in the hepatic flexure, whereas the splenic flexure was the site of tumours in 4% of included patients (2 patients). The descending colon was the least found tumor site, presenting only in 1 patient (2% of included patients), as shown in (Table 1 and Figure 1).

Table 1: Anatomical site of colon cancer among patients (n = 50)

Site	count	Percentage %
Cecum	13	26
Ascending colon	11	22
Transverse colon	5	10
Descending colon	1	2
Sigmoid colon	14	28
Hepatic flexure	4	8
Splenic flexure	2	4
Total	50	100

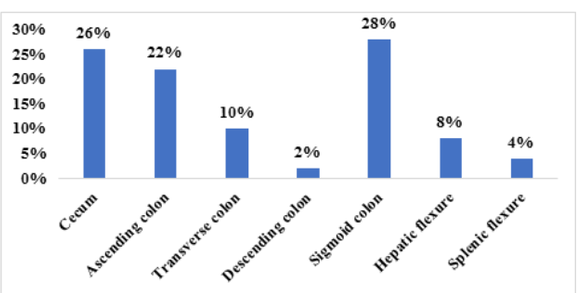

Fig. 1: Anatomical site of colon cancer among patients (n = 50)

Radiological staging

Concerning radiological staging, the highest percentage of patients (44%) had T3 stage radiological staging. This was followed by T1/T2 staging, which was presented in 38% of patients (19 patients). On the other hand, T4 staging was the least commonly found stage among included patients, with only 18% of patients (9 patients), as shown in (Figure 2).

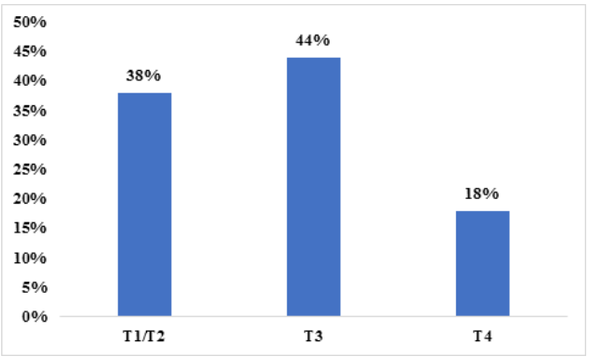

Fig. 2: Radiological staging among included patients (n = 50).

Pathological staging

Concerning pathological staging, we found that T3 was the highest pathological stage with a percentage of 46% of included patients (23 patients), followed by T2 with 26% of patients (13 patients). Moreover, T1 was the least observed pathological stage among patients, representing 8% of included patients (4 patients), as shown in (Table 2 and Figure 3).

Table 2: Pathological tumor staging of colon cancer among patients (n = 50).

Stage	Count	Percentage %
T1	4	8
T2	13	26
T3	23	46
T4	10	20
Total	50	100

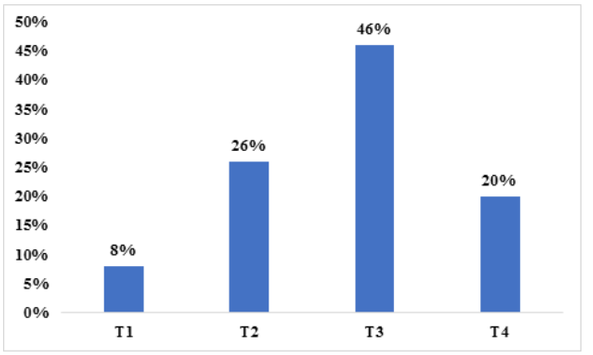

Fig. 3: Pathological staging among included patients (n = 50).

Diagnostic accuracy:

When comparing both radiological and pathological staging, we found that 70.6% of patients with T1/T2 stages were diagnosed as T1/T2 stages via both pathology and radiology. On the other hand, there was overstaging of 29.4% of T1/T2 patients as T3 stage via radiology. Moreover, 69.6% of stage T3 patients were diagnosed as T3 via both; pathology and radiology, while there was a downstaging of 30.4% of stage T3 patients as T1/T2 stages via radiology. Also, 90% of stage T4 patients were diagnosed with stage T4 via pathology and radiology. However, there was downstaging of 10% of stage T4 patients to a T3 stage via radiology, as shown in (Table 3).

Table 3: Relation between pathological and radiological staging among patients (n = 50).

Radiological	Pathological			Total
	T1/T2	T3	T4	
T1/T2	12 (70.6)	7 (30.4)	0	19 (38)
T3	5 (29.4)	16 (69.6)	1 (10)	22 (44)
T4	0	0	9 (90)	9 (18)
Total	17	23	10	50

Regarding the diagnostic accuracy, we found that radiology showed a 70.58% sensitivity and 78.8% specificity in the diagnosis of T1/T2 tumors. This was followed by T4, which showed a sensitivity of 90% and specificity of 100% for the diagnosis. On the other hand, the T3 stage showed the lowest sensitivity score among all stages, with a sensitivity of 69.6% and a specificity of 77.78%. The overall sensitivity, specificity, PPV, and NPV were 76.73%, 85.53%, 78.6%, and 85.4%, respectively. (Table 4 and Figure 4).

Table 4: Diagnostic accuracy of CT staging for colon cancer compared to pathological staging

Tumor T stage	Sensitivity	Specificity	PPV	NPV
T1/T2	70.58%	78.8%	63.16%	83.87%
T3	69.6%	77.78%	72.73%	75%
T4	90%	100%	100%	97.56%
Overall	76.73%	85.53%	78.63%	85.48%

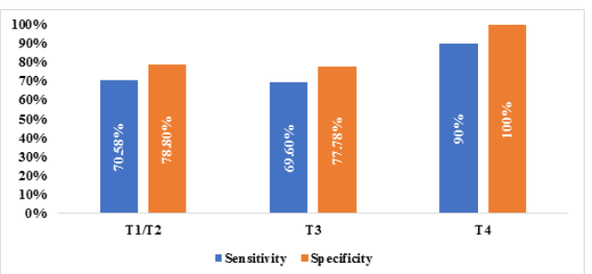

Fig. 4: Diagnostic accuracy of radiology in diagnosis of Colon cancer among included patients.

DISCUSSION

The most frequent malignant gastrointestinal tumour is colon cancer. It is the third most prevalent carcinoma worldwide. The westernization of nutrition and shifting lifestyle trends are to blame for the increased incidence rates of colon cancer in young people around the world. Nearly equal numbers of men and women have colon cancer (1:1). while the incidence of colon cancer is generally 1.7:11. In the age range of 41 to 60, colon cancer incidence is higher[6].

Recent randomised clinical studies have demonstrated the importance of preoperative staging in determining which patients are not candidate for laparoscopic surgery in advanced stages of colon cancer and which patients may benefit from neoadjuvant chemotherapy in locally advanced colon cancer. High-risk individuals were identified in these trials using CT. Thus, locoregional staging will gradually become more common when used to stage colon cancer patients[7]. Computed tomography reveals the capacity to observe the features of local tumors in addition to its usefulness in diagnosing any distant metastatic cancer. Its accessibility and reproducibility are advantages. With advancements in CT software and technology, it has shown promise as a staging tool and a prognosis predictor[8].

The present diagnostic accuracy testing study included 50 colon cancer patients conducted at Kobri El-Qoba military complex and Maadi military complex in the period between October 2021 and September 2022. Regarding age distribution, the age of the patients ranged between 33 and 77 years old, with a mean age of 57.84 ± 9.77 years old which was lower than the study conducted by Flor and his colleagues in 2013 that involved 69 patients with colon cancer, as patients were aged between 43 and 86 years with a mean age of 68 years[10] (**Flor *et al*. 2013**). Also, in the study carried out by Malmstrøm and his colleagues on 501 consecutive patients operated on for colon cancer, the mean age of the patients was 69.4 years old[9].

Concerning the site of colon cancer in our study, the sigmoid colon was the commonest site of tumor that included 28% of patients (14 patients), followed by the cecum (26%), the ascending colon (22%), the hepatic flexure (8%), the splenic flexure (4%), and lastly the descending colon was the least found tumor site. This was in accordance with a retrospective study reported by Hong and his team that included 600 colon cancer patients. The sigmoid colon (35.2%) and cecum (35.2%) were the most common sites of tumors, followed by the ascending colon (9.1%) and the transverse colon (2.3%) as the least common tumor types[7]. On the contrary, according to Bedrikovetski, the sigmoid colon (52.7%), descending colon (21.5%),

and transverse colon (9.7%) were the three most typical tumor sites. The least frequent tumor type was the ascending colon (7.5%)[10]. This disparity might be accounted for by the following; the anatomical site distribution differed slightly between males and females, many theories have been put out in an effort to explain the disparate distribution including the reason why women are more likely than men to have proximal cancer. These variables include variations in the bile salt and other chemical concentrations, the degree of oxygenation and the microbial ecology in various colonic regions. Different embryological origins give rise to the proximal and distal colons. In general, women live longer than men do and the incidence of colon cancer shifts from distal to proximal as we become older. It is also suggested that sex hormones play a role[11].

As regard the radiological staging of colon cancer, the present study found that T3 was the most common radiological staging among patients, as it was prevalent among 44% of the included patients (22 patients), followed by T1/T2 staging that included 38% of patients, and T4 staging was the least common staging, with only 18% of patients. In a similar manner, Horvat and his associates discovered that depending on radiological findings, the majority of patients had category T3 and then T4 tumors[12].

With reference to the pathological staging of colon cancer, this study found that 46% of included patients had the T3 stage, followed by T2 (26%), and T1 as the least common stage among patients (8%). This was in agreement with a prospective study conducted by Veit-Haibach[13] and his colleagues between May 2004 and June 2006 included 47 individuals with clinical signs and an optical colonoscopy suggesting primary colon cancer. T3 was shown to be the most prevalent pathological stage among the 30 patients, followed by T2 and T4 (5 patients in each stage). Similarly, Tezcan *et al* found that in the histopathological examination, 0.6% of the cases was staged as T1, 10.1% were T2, 76.1% were T3, and 13.2% were T4[14]. Also, Horvat ***et al.*** reported that T3 was the most common pathological stage in the studied group followed by T2 and T4[12]. The similar results were reported by (**Hong *et al*.**[7]).

Concerning comparison between radiological and pathological staging, the current study reported that 70.6% of patients were diagnosed with T1 or T2 via both; pathology and radiology, with over-staging of 29.4% of patients as T3 via radiology. On the other hand, 69.6% of patients were diagnosed with T3 stage via both; pathology and radiology, with downstaging of 30.4% of patients with T1/T2 stages via radiology. It was also found that 90% of patients were diagnosed with T4 via pathology and radiology. However, there was downstaging among 10% of the included patients who were diagnosed with T3 via radiology. In the same way, Tezcan and his peers compared the radiological and pathological staging and discovered that 76.5% of the cases that were staged as T1 or T2 in the histopathological examination were accurately staged with the MDCT, whereas 3.3% of cases were staged as T3. On the other hand, 95.8% of cases with a T3 stage were appropriately staged with MDCT, 4.1% of cases were incorrectly staged; they were staged as T1/T2 due to underestimation or as T4 due to overestimation[14].

Regarding the diagnostic accuracy in the current study, MDCT showed a 70.58% sensitivity and 78.8% specificity in diagnosis of T1/T2 tumors. Also, the MDCT showed a sensitivity of 90% and specificity of 100% for diagnosis of T4 stage. On the other hand, T3 stage showed the least sensitivity score among all stages with a sensitivity of 69.6% and specificity of 77.78%. However, the overall sensitivity was 76.73% and specificity 85.53%. The diagnostic precision of CT in the preoperative staging of colon cancer has been the focus of several investigations. Standard T categories, nodes, and distant metastases were evaluated as part of these research, and it was discovered that accuracy was acceptable for both T and N categories and extremely high for metastases. In a meta-analysis involving four trials that used conventional CT, Nerad and his colleagues found that overall sensitivity was 77% (95% CI, 66-85%) and specificity was 70% (95% CI, 53-83%)[15].

The discrepancy between our study and previous studies were due to various factors of which were different study populations and different imaging techniques. Tezcan *et al*. utilized MDCT for colon tumour staging, which demonstrated significant sensitivity and specificity for the detection of nodal involvement (N0 vs. N+) and tumour growth beyond the gut wall (T1-T2 versus T3-T4). The aggregate values for sensitivity and specificity rose to 96% and 70%, respectively, with the adoption of a thin imaging slice (5 mm)[14]. Also, Horvat *et al*. used CT that avoided partial-volume effects and utilized smaller section thickness[12]. This variance has been explained by quality of stool preparation, oral and rectal distribution of contrast agent, air distention of the colon, and use of intravenous contrast. The accuracy of CT for colon cancer staging is significantly impacted by each of these variables.[16,17]

RECOMMENDATIONS

We recommend more studies to investigate bigger number of patients and to evaluate the technical problems as bowel preparation and its effect on radiological results.

Bowel preparation:

It is advised that all patients follow a low-fiber diet for two days before switching to a clear liquid diet for one day, Fecal tagging is performed using 8 mL of oral diatrizoate meglumine and diatrizoate sodium solution at each meal (a maximum of three times per day) for two days prior to the CT scan. A rectal enema of 250 mL sodium phosphate is given before to computed tomography. The bowel preparation procedure should be supervised by colon surgeons and radiologists.

CONCLUSION

The present study showed that CT might be a feasible imaging modality for preoperative local staging of colon cancer.

ABBREVIATIONS

CT: computed tomography

MDCT: multidetector computed tomography

MDT: Multidisciplinary team

NPV: negative predictive value

PPV: positive predictive value

CONFLICT OF INTEREST

There are no conflicts of interest.

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