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The Role of Computed Tomography in Detection of Lung Metastases in Patients with Colorectal Carcinoma

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Abstract

Objective
At the time of diagnosis, 20% of colorectal carcinomas (CRC) are metastatic, and 1-9% of these metastatic patients have lung metastasis. Current guidelines recommend thoracic computed tomography (TCT) for preoperative staging, but this is costly and involves significant radiation exposure. Additionally, in most cases, the treatment plan does not change. Therefore, a comparison between chest X-ray (CXR) and computed tomography (CT) in patients with CRC was conducted.

Material and Method
In this study, 630 patients admitted to our hospital between May 2019 and May 2023 for CRC were retrospectively screened. According to follow-up records, the presence of lung metastasis was confirmed based on biopsy, CT, and/or PET/CT results. Thirteen patients with lung metastasis were classified as Group 1, and 31 patients without lung metastasis, identified using propensity score matching, were classified as Group 2, totaling 44 patients for analysis.

Results
Preoperative screening revealed that metastatic lesions were detected by CXR in 4 out of 13 patients in Group 1, with an average lesion diameter of 1.5 cm (min: 0.5, max: 5.0 cm). The average diameter of lesions detected by TCT in the remaining 9 patients, which were not visible on CXR, was 7 mm. The sensitivity and specificity of TCT and CXR were found to be 30.77% and 100%, respectively (Table 2). The positive predictive value and negative predictive value of CXR were 100% (39.76%-100%) and 77.50% (70.57%-83.19%), respectively.

Conclusion
Although current guidelines recommend TCT for screening, our study found that TCT did not lead to a change in the treatment plan for patients. The use of TCT in the staging of CRC patients may need to be reconsidered.

Keywords: Colorectal Cancer, Chest X-ray, Thoracic Computed Tomography

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Introduction

Colorectal carcinomas (CRC) are the third most common type of cancer worldwide, with 20% of patients being metastatic at the time of diagnosis (1). Among metastatic cases, only 1-9% involve lung metastases (2–4). In the diagnosis and follow-up of lung metastases, posteroanterior chest X-ray (PAACG), computed tomography (CT) (whether high-resolution or not), and positron emission tomography/computed tomography (PET/CT) are used, with CT having high sensitivity in detecting metastases (5). However, due to the relatively low incidence of lung metastasis in CRC patients, the use of thoracic computed tomography (TCT) is not highly recommended (2,6).

Another issue with TCT is that it detects nonspecific nodules in 20-30% of cases, which are rarely malignant (5,7). Consequently, the detection of nodules on TCT rarely leads to a change in the treatment paradigm (7). Therefore, the routine use of TCT for screening purposes in all CRC cases presents challenges such as time consumption, additional costs, and radiation exposure. Some studies have found TCT screening to be ineffective based on these factors (8,9). For similar reasons, PET/CT is recommended only in special circumstances, such as when CT, magnetic resonance imaging (MRI), and contrast agents are contraindicated, or to assess suspicious areas identified on CT/MRI (6).

At our center, routine TCT is requested for CRC patients by guideline recommendations. This study aims to evaluate the necessity and utility of imaging methods for detecting lung metastases in patients diagnosed and treated at our center.

Material and Method

In this study, patients admitted to our hospital between May 2019 and May 2023 for CRC were retrospectively screened. Ethical approval numbered E1-23-3547 was obtained from the Ethics Committee of the Hospital for this study. Demographic data, laboratory, radiological parameters, and pathology reports of the 630 patients admitted during this period were examined, and their stages were determined. The patients' treatment processes were then reviewed, and their follow-up records were examined.

The lung metastasis status of CRC patients was obtained from oncological follow-up records. The presence of lung metastasis was confirmed based on biopsy, CT, and/or PET/CT results. Thirteen patients with lung metastasis were classified as Group 1, and 31 patients without lung metastasis, identified using propensity score matching, were classified as Group 2, totaling 44 patients for analysis. The chest X-rays and computed tomographies of the patients were re-evaluated by a radiology specialist working specifically in this field. The location, size, and PET/CT involvement of the nodules in the radiological examinations were re-evaluated.

The clinical features, laboratory values, radiological examinations, and treatments of patients diagnosed with lung metastasis were examined in their subsequent follow-ups.

Statistics Analysis

Descriptive statistics were used to summarize the demographic and clinical characteristics of the patients. Continuous variables were expressed as mean ± standard deviation (SD) or median (IQR) depending on the distribution. Categorical variables were expressed as frequency and percentage. Data analysis was performed using SPSS (Statistical Package for Social Sciences) version 26.0. The normality of continuous variables was evaluated using the Shapiro-Wilk test. Descriptive statistics were presented to provide a comprehensive overview of the data. Since the study was observational and did not include group comparisons or hypothesis testing, no inferential statistical tests were performed.

Results

The average age of the 44 patients included in the study was 64 years (min: 42, max: 82), with 17 (38.6%) female and 27 (61.3%) male patients. The average age of patients in Group 1 was 60 years (min: 45, max: 73), and in Group 2, it was 65 years (min: 42, max: 82). When looking at the tumor localization of the patients, the tumor locations in Group 1 and Group 2 were as follows: cecum and ascending colon, transverse colon, descending colon, sigmoid colon, rectum; with 5 (38.5%) and 12 (38.3%), 0 (0%) and 1 (3.2%), 0 (0%) and 2 (6.4%), 1 (6.9%) and 4 (12.9%), 7 (53.4%) and 12 (38.3%) respectively. According to the preoperative CT TNM classification, the number of patients with T1 tumors in Group 1 and Group 2 were 0 (0%) and 3 (9.7%), T2 tumors were 0 (0%) and 2 (6.5%), T3 tumors were 7 (63.6%) and 20 (64.5%), and T4 tumors were 4 (36.4%) and 6 (19.4%) respectively. In the pathology specimens, Group 1 and 2 had 3 (27.3%) and 16 (51.6%) N0 patients, 6 (54.5%) and 9 (29.0%) N1 patients, 0 (0%) and 3 (9.7%) N2a patients, and 2 (18.2%) and 3 (9.7%) N2b patients respectively (Table 1). All patients with lung metastasis detected on preoperative scans also had liver metastasis.

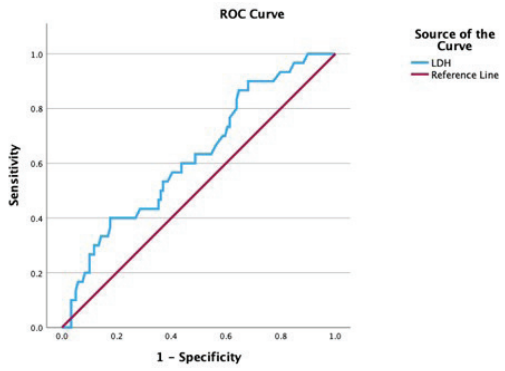

Figure 1
ROC analysis of LDH for Bowel Resection

Preoperative screenings revealed that metastatic lesions were detected by CXR in 4 out of 13 patients in Group 1, with an average lesion diameter of 1.5 cm (min: 0.5, max: 5.0 cm). The average diameter of lesions detected by TCT in the remaining 9 patients, which were not visible on CXR, was 7 mm. In two of the metastatic patients, the diagnosis was confirmed by biopsy, and the rest were confirmed to be metastatic by PET/CT. None of the patients with lung metastasis underwent lung resection. Nine of the patients underwent palliative surgery, and three symptomatic patients underwent palliative/resective surgery. The concordance analysis between TCT and CXR in detecting lung metastasis showed a kappa value of 0.760, indicating high concordance. The sensitivity and specificity of TCT and CXR were found to be 30.77% and 100%, respectively (Table 2). The positive predictive value and negative predictive value of CXR were 100% (39.76%-100%) and 77.50% (70.57%-83.19%), respectively (Figure 1).

Table 1 Demografic Characteristics of Patients

N		Lung Metastasis +					Lung Metastasis -				
		N	Mean	Min	Max	Column%	N	Mean	Min	Max	Column%
Age		13	60	45	73		31	65	42	82	
Gender	Female	7				53,8	10				32,3
	Male	6				46,2	21				63,7
Tumour Localisation	Rectum	2				15,4	10				32,3
	Rectosigmoid	5				38,5	2				6,5
	Hepatic Fleksura	0				0	7				22,6
	Sigmoid Colon	1				7,7	4				12,9
	Splenic Fleksura	4				30,8	1				3,2
	Caecum	1				7,7	4				12,9
	Ascenden Colon	0				0	1				3,2
	Descenden Colon	0				0	1				3,2
	Transvers Colon	0				0	1				3,2
T Stage	T1	0				0	3				9,7
	T2	0				0	2				6,5
	T3	7				63,6	20				64,5
	T4	4				36,4	6				19,4
N Stage	N0	3				27,3	16				51,6
	N1	6				54,5	9				29
	N2	0				0	3				9,7
	N3	2				18,2	3				9,7

Table 2 Cohens Kappa Statistics

Negative		X-Ray Metastasis		Total	Kappa	Sensitivite %	Spesifite %
		Negative	Positive				
TCT Metastasis	Negative	31	0	31	k:0.760	69.2	100
	Positive	4	9	13			
Total		35	9	44			

Discussion

Even though current guidelines and literature acknowledge the rarity of lung metastasis and the lack of impact of thoracic computed tomography (TCT) on treatment modalities, TCT is still recommended for preoperative staging (6,10,11). However, in this study, it was observed that TCT did not have any effect on surgical treatment strategies at the time of initial diagnosis.

The primary goal of staging in colorectal cancer (CRC) and other cancers is to select the most appropriate treatment method for the patient (7). TCT has been reported to detect metastases with high sensitivity (73%) and specificity (74%) (12–14). This is attributed to TCT's ability to reveal even 2-3 mm nodules in appropriate slices of the lung. The problems that arise here are that TCT also shows nonmetastatic and insignificant lesions in the lungs and that these small lesions are not always easily identifiable, necessitating additional procedures (5,14). In patients with indeterminate lung lesions, three different approaches are followed: (1) incisional or excisional biopsy of the lesion, (2) performing PET/CT, and (3) follow-up with re-evaluation when the lesion exceeds 1 cm (3,15,16). Most CRC patients with lung metastasis already have liver metastasis, initially receive adjuvant chemotherapy, and only 21.1-32.5% undergo metastasectomy (6,17,18). Additionally, the treatment plan for patients with lung metastasis rarely changes, and definitive treatment for lung metastasis is typically received by the patient only after a certain period (3,7,19). In the study conducted by Grosman et al. (7), out of 200 patients, lung metastasectomy was performed in only 2 patients ten months after the initial diagnosis. Similarly, in a study by Lazzoron et al. (3) involving 223 patients, metastasectomy was performed in only 5 patients, on average, one year later. In the present study, TCT was performed on all 630 patients, but only 13 had lung metastasis, and these patients continued with adjuvant chemotherapy, with no lung metastasectomy performed.

In colorectal cancers, the rate of lung metastasis without liver metastasis is reported to be 5-6%, while in rectal cancers, this rate is reported to be 10-18% (7,19,20). In the study conducted by Kim et al. (21), it was reported that patients with lymph node metastasis might have lung metastasis without liver metastasis. Contrary to the literature, in this study, all patients with lung metastasis had liver metastasis, and no significant difference was found between rectum-rectosigmoid cancers and other colon segments regarding lung metastases. In another study conducted by Brent et al. (5), 439 patients were prospectively examined, and among them, 45 had indeterminate pulmonary nodules, with only 5 of those having lung metastasis. All patients with lung metastasis were reported as N1 or N2. In another study conducted by Kim Hye et al. (19), it was reported that the rate of pulmonary metastasis was higher in T3-T4 tumors and in cases with positive lymph nodes. In the study by Lazzoron et al. (3), the risk of lung metastasis was reported to be 11 times higher in patients with T4 tumors compared to those with T1 tumors. Although Hogan et al. (2) found no statistical difference between T stage and lung metastasis in their study, the rate of lung metastasis was higher in T3-T4 tumors, and the rate of lung metastasis was statistically higher in cases with lymph node metastasis. In the present study, all thirteen patients with lung metastasis had T3-T4 tumors, but five had no suspicious lymph nodes in their preoperative imaging.

Although posteroanterior chest X-ray (PAACG) is considered a primitive examination, it can detect lesions as small as 7-8 mm and identify them with a

sensitivity of 33-73% (12,13,19). These lesions have a false negative rate of about 20%. However, this rate can be reduced further with repeated imaging (22,23). Despite this disadvantage of PAACG, in a study by McIntosh involving 403 CRC patients, only 3 out of 7 patients with lung metastasis were not detected by PAACG (24). In another study by Povoski involving 100 patients, only 4 out of 11 patients with lung metastasis were not detected by PAACG (12). In another study by Kronawitter, 202 patients with negative PAACG were examined, and 10 of them were found to have lung metastasis on TCT (25). Similarly, in this study, only 4 out of 13 patients with lung metastasis were not detected by PAACG, and the sensitivity rate was found to be 69.2%.

Although TCT does not change the treatment plan at the time of initial diagnosis, lung metastasis usually emerges approximately fifteen months after the initial diagnosis (26). During this period and afterward, it is recommended that patients be followed up with computed tomography. The use of TCT in diagnosis and follow-up increases the radiation exposure that the patient receives, and when contrast-enhanced scans are performed, there is a risk of contrast nephropathy and contrast allergy. Requesting TCT in patients with T3-T4 tumors, those with lymph node metastasis (radiologically or pathologically), and after positive findings on PAACG will not only reduce these types of complications but also unnecessary costs.

The most significant limitation of this study is that it is a retrospective study, and as a result, some information may be missing, and the sample size is limited. Another limitation is the small number of patients diagnosed with lung metastasis. Therefore, the number of patients without lung metastasis to be compared was kept small for the propensity score match analysis. Determining the necessity and cost-performance relationship of TCT with prospective randomized studies would be more valuable.

Conclusion

Although current guidelines recommend thoracic computed tomography (TCT) for screening purposes, the detection of indeterminate nodules and the fact that lung metastasis rarely alters the treatment plan, coupled with the observation that most nodules detected on TCT are also visible on posteroanterior chest X-ray (PAACG), make the use of TCT as a first-line investigation still problematic. It may be considered to request TCT as an additional investigation in patients who have nodules detected on PAACG, those with T3-T4 tumors, and those with liver metastasis, to minimize radiation exposure.

Conflict of Interest Statement
There is no conflict of interest between the authors.

Ethical Approval
Ankara Bilkent City Hospital Ethic Committee 10.05.2023/ E1-23-3547.The study was conducted by the principles outlined in the Declaration of Helsinki.

Consent to Participate and Publish
Because of studies retrospective nature, there is no consent.

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Availability of Data and Materials
Data is available on request from the authors.

Authors Contributions
HFM: Conceptualization (lead), data curation (lead), investigation (lead), methodology (lead), project administration (lead), resources (lead), supervision (lead), writing-original draft (lead) and writing-review and editing (lead);

FS: Conceptualization (equal), resources (supporting), software (equal) and visualization (supporting), writing-original draft,

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BCD.: Conceptualization (equal), resources (supporting), software (equal) and visualization (supporting), writing-original draft,

MT: Conceptualization, resources (supporting), software (equal) and visualization (supporting), writing-original draft,

References

1. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin 2018;68(6):394–424.
2. Hogan J, O'Rourke C, Duff G, Burton M, Kelly N, Burke J, et al. Preoperative staging CT thorax in patients with colorectal cancer: Its clinical importance. Dis Colon Rectum 2014;57(11):1260–6. Available from: https://journals.lww.com/dcrjournal/fulltext/2014/11000/preoperative_staging_ct_thorax_in_patients_with.3.aspx

3. Lazzaron AR, Vieira M V., Damin DC. Should preoperative chest computed tomography be performed in all patients with colorectal cancer? Colorectal Disease 2015;17(10):O184–90.
4. Parnaby CN, Bailey W, Balasingam A, Beckert L, Eglinton T, Fife J, et al. Pulmonary staging in colorectal cancer: A review. Colorectal Disease 2012;14(6):660–70. Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/j.1463-1318.2011.02601.x
5. Brent A, Talbot R, Coyne J, Nash G. Should indeterminate lung lesions reported on staging CT scans influence the management of patients with colorectal cancer? Colorectal Disease 2007;9(9):816–8. Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/j.1463-1318.2007.01229.x
6. Guidelines Detail [Internet]. [cited 2023 Jul 24]. Available from: https://www.nccn.org/guidelines/guidelines-detail?category=1&id=1461
7. Grossmann I, Avenarius JKA, Mastboom WJB, Klaase JM. Preoperative staging with chest ct in patients with colorectal carcinoma: Not as a routine procedure. Ann Surg Oncol 2010;17(8):2045. Available from: /pmc/articles/PMC2899025/
8. Griffiths EA, Browell DA, Cunliffe WJ. Evaluation of a pre-operative staging protocol in the management of colorectal carcinoma. Colorectal Dis 2005;7(1):35–42. Available from: https://pubmed.ncbi.nlm.nih.gov/15606582/
9. Gielen C, Sanli I, Stroeken L, Botterweck A, Hulsewé K, Hoofwijk A. Staging chest radiography is not useful in patients with colorectal cancer. Eur J Surg Oncol 2009;35(11):1174–8. Available from: https://pubmed.ncbi.nlm.nih.gov/19443174/
10. Vogel JD, Felder SI, Bhama AR, Hawkins AT, Langenfeld SJ, Shaffer VO, et al. The American society of colon and rectal surgeons clinical practice guidelines for the management of colon cancer. Dis Colon Rectum 2022;65(2):148–77. Available from: https://journals.lww.com/dcrjournal/fulltext/2022/02000/the_american_society_of_colon_and_rectal_surgeons.7.aspx
11. Argilés G, Tabernero J, Labianca R, Hochhauser D, Salazar R, Iveson T, et al. Localised colon cancer: ESMO Clinical Practice Guidelines for diagnosis, treatment, and follow-up. Annals of Oncology 2020;31(10):1291–305. Available from: http://www.annalsofoncology.org/article/S0923753420399324/fulltext
12. Povoski SP, Fong Y, Sgouros SC, Kemeny NE, Downey RJ, Blumgart LH. Role of chest CT in patients with negative chest X-rays referred for hepatic colorectal metastases. Ann Surg Oncol 1998;5(1):9–15. Available from: https://link.springer.com/article/10.1007/BF02303757
13. Khorasgani SR, Niaghi F, Dehghan P. Diagnostic Efficacy of CXR Compared to Chest CT in Preoperative Staging of Patients with Colorectal Cancer. Iranian Journal of Radiology 2019;16(3):82831. Available from: https://brieflands.com/articles/ijradiology-82831.html
14. Yongue G, Hotouras A, Murphy J, Mukhtar H, Bhan C, Chan CL. The diagnostic yield of preoperative staging computed tomography of the thorax in colorectal cancer patients without hepatic metastases. Eur J Gastroenterol Hepatol 2015;27(4):467–70. Available from: https://journals.lww.com/eurojgh/fulltext/2015/04000/the_diagnostic_yield_of_preoperative_staging.18.aspx
15. Nam JG, Goo JM. Evaluation and management of ındeterminate pulmonary nodules on chest computed tomography in asymptomatic subjects: The principles of nodule guidelines. Semin Respir Crit Care Med 2022;43(6):851–61. Available from: https://europepmc.org/article/med/35803268
16. van den Broek JJ, van Gestel T, Kol SQ, van Geel AM, Geenen RWF, Schreurs WH. Dealing with indeterminate pulmonary nodules in colorectal cancer patients; A systematic review. European Journal of Surgical Oncology 2021;47(11):2749–56.
17. Li J, Yuan Y, Yang F, Wang Y, Zhu X, Wang Z, et al. Expert consensus on multidisciplinary therapy of colorectal cancer with lung metastases (2019 edition). J Hematol Oncol 2019;12(1):1–11. Available from: https://jhoonline.biomedcentral.com/articles/10.1186/s13045-019-0702-0
18. Tampellini M, Ottone A, Bellini E, Alabiso I, Baratelli C, Bitossi R, et al. The role of lung metastasis resection in ımproving outcome of colorectal cancer patients: Results from a large retrospective study. Oncologist 2012;17(11):1430–8. Available from: https://dx.doi.org/10.1634/theoncologist.2012-0142
19. Kim HY, Lee SJ, Lee G, Song L, Kim SA, Kim JY, et al. Should preoperative chest CT be recommended for all colon cancer patients? Ann Surg 2014;259(2):323–8. Available from: https://pubmed.ncbi.nlm.nih.gov/23426347/
20. Tan KK, Lopes GDL, Sim R. How uncommon are isolated lung metastases in colorectal cancer? A review from a database of 754 patients over 4 years. Journal of Gastrointestinal Surgery 2009;13(4):642–8. Available from: https://link.springer.com/article/10.1007/s11605-008-0757-7
21. Kim CH, Huh JW, Kim HR, Kim YJ. Indeterminate pulmonary nodules in colorectal cancer: Follow-up guidelines based on a risk predictive model. Ann Surg 2015;261(6):1145–52. Available from https://journals.lww.com/annalsofsurgery/fulltext/2015/06000/indeterminate_pulmonary_nodules_in_colorectal.19.aspx
22. Aslam R, Kennedy MPT, Bhartia, B. The radiological route to diagnosis of lung cancer patients. In: Thorax. British Thoracic Society Winter Meeting 2018, BMJ Publishing Group DOI:10.1136/thorax-2018-212555.119
23. Bradley SH, Grice A, Neal RD, Abraham S, Rodriguez Lopez R, Shinkins B, et al. Sensitivity of chest X-ray for detecting lung cancer in people presenting with symptoms: A systematic review. Br J Gen Pract 2019;69(689):E827–35. Available from: https://pubmed.ncbi.nlm.nih.gov/31636130/
24. McIntosh J, Sylvester PA, Virjee J, Callaway M, Thomas MG. Pulmonary staging in colorectal cancer is computerised tomography the answer? Ann R Coll Surg Engl 2005;87(5):331-3. doi: 10.1308/003588405X60579. PMID: 16176690; PMCID: PMC1963965.
25. Kronawitter U, Kemeny NE, Heelan R, Fata F, Fong Y. Evaluation of chest computed tomography in the staging of patients with potentially resectable liver metastases from colorectal carcinoma. 1999. Available from: https://onlinelibrary.wiley.com/terms-and-conditions
26. Christoffersen MW, Bulut O, Jess P. The diagnostic value of indeterminate lung lesions on staging chest computed tomographies in patients with colorectal cancer. Dan Med Bull 2010;57(1):A4093. PMID: 20175945.