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Dual-phase images with 18F-FDG PET/CT can exhibit new lesions of colo-rectal cancer

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ABSTRACT

OBJECTIVE: Dual-phase 18F-fluorodeoxyglucose positron emission tomography/computed tomography (FDG PET/CT) has demonstrated superiority over conventional imaging methods in various clinical conditions. However, its efficacy in detecting metastases from colorectal cancer is uncertain. We aim to reveal whether dual-phase FDG-PET/CT can be superior in detecting metastases compared to the standard PET-CT study in patients with an established diagnosis of colorectal cancer.

METHODS: This is a single-center, retrospective case-control study involving 35 patients with colorectal cancer who underwent whole-body FDG PET-CT imaging. Late-phase FDG-PET-CT images were obtained 1–2 hours after the standard technique, emphasizing the identification of new lesions or clarified lesions.

RESULTS: Among the 35 patients evaluated, 5 (14.3%) exhibited new cancer lesions, while 6 (17.1%) demonstrated more evident cancer regions at late-phase FDG-PET-CT. New lesions or more evident cancer regions with the dual-phase technique were described within the liver, in regional lymph nodes, and in peritumoral regions.

CONCLUSION: The study findings suggest that dual-phase FDG-PET-CT can reveal new and more evident metastatic lesions in a subset of colorectal cancer patients. This technique, precious in identifying liver metastases and lymph nodes, enhances the accuracy of colorectal cancer diagnosis and staging.

Keywords: Dual-phase imaging; FDG PET/CT; colorectal cancer.

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Dual-phase 18F-fluorodeoxyglucose positron emission tomography/computed tomography (FDG PET/CT) involves acquiring PET images at two different time points, allowing for the assessment of dynamic changes in tracer uptake. It is superior to conventional FDG PET/CT and magnetic resonance and computed tomography (CT) imaging, particularly in assessing various clinical conditions such as the evaluation of metastatic lesions in locally advanced or recurrent cervical cancer, the distinction of benign and malignant solitary pulmonary nodules in granuloma-endemic regions with accuracy, and the detection of bone metastasis [1–3].

FDG PET/CT is considered superior to CT in the detection of liver metastases from colorectal cancer, establishing it as the most sensitive noninvasive imaging technique for this purpose [4, 5]. Bipat et al. [4] sug-

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gested that FDG PET is the most accurate imaging modality for detecting colorectal liver metastases on both a per-patient and per-lesion basis. Furthermore, PET/CT is a promising technique for evaluating the response to chemotherapy in colorectal and liver metastases [6]. Furthermore, a randomized study has demonstrated that PET/CT can enhance the selection of patients for hepatic surgery in cases with colorectal liver metastases [7].

Studies have demonstrated the utility of dual-phase FDG-PET in the management of colorectal cancer, particularly in the detection of recurrent colorectal carcinoma and colorectal liver metastases [8, 9]. However, the literature is scarce in this regard.

We aim to investigate the detectability of colorectal metastasis with the use of dual-phase FDG-PET/CT in patients with an established diagnosis of colorectal cancer.

Highlight key points

- Dual-phase FDG-PET-CT significantly contributes to cancer detection, showing new cancer regions in 14.3% of patients and more evident cancer regions in 17.1% compared to early-phase FDG-PET-CT.
- Dual-phase PET/CT, incorporating delayed imaging, enhances sensitivity and specificity, particularly in colorectal cancer, by improving lesion detectability and lesion-to-background ratio. This reinforces the potential of dual-phase PET-CT as a robust imaging modality for more accurate colorectal cancer diagnosis and staging.

MATERIALS AND METHODS

This single-center, retrospective case-control study was conducted at Diyarbakir Dicle University Medical Faculty, Department of Nuclear Medicine between 05.2021 and 10.2023. The participants were selected from individuals diagnosed with colorectal cancer who underwent whole-body FDG PET-CT imaging for staging purposes. Dual-phase FDG-PET-CT images were obtained by using the images taken from the abdominal region 1-2 hours after the completion of FDG-PET-CT scans. Special emphasis has been placed on recording new lesions or clarified lesions during this process.

Individuals with a second malignancy or those with a primary liver tumor were excluded from the study.

To obtain FDG PET-CT images, patients were required to fast for more than 6 hours and maintain a blood glucose level of 140 mg/dL. FDG, at a dose of 0.1 mCi/kg, was injected intravenously into the patients. After the injection, patients were kept in a specially lead-coated room for 1 hour to allow the medication to spread throughout the whole body. A CT scan of the total body (from vertex to the knees) was then studied. In the following step, whole-body emission scanning was conducted with PET. The imaging utilized a Siemens Horizon PET/CT device of the 2016 model with 3D-TOF technology. The slice thickness of the device was 3 mm, and the images were generated using PET iterative and CT bp-LOR reconstruction processing methods. The low-dose CT device, employed for anatomical detail and attenuation correction, was set to 80 mA and 120 kV (Siemens Healthcare, GmbH, Henkestrasse 127, 91052 Erlangen, Germany).

This study was carried out in accordance with the Declaration of Helsinki. The consent form is not available since the study is retrospective. The study was carried out with the permission of Dicle University Faculty of MedicineEthic Committee (date:15.03.2023, decision no: 91).

Statıstıcal Analysis

We conducted data analysis employing the statistical software package (SPSS for Windows version 17.0, IBM Corp., Armonk, NY, USA). The normality of continuous variables was assessed through the Kolmogorov-Smirnov test and examination of histograms. Descriptive statistics were expressed as mean ± standard deviation for continuous variables and as percentages for categorical variables. Chi-Square test was utilized for comparing categorical variables. Additionally, a logistic regression model was employed to explore the impact of gender on the acquisition of dual-phase PET-CT. Two-tailed p-values less than 0.05 were deemed statistically significant, with a 95% confidence interval.

RESULTS

A total of 35 patients with a diagnosis of colo-rectal cancer were evaluated. Thirteen of those (37.1%) were male, and the remaining 22 (62.9%) participants were female. The mean age was 59.80±16.18. Ten patients had a history of cancer surgery. In 5 patients, new cancer regions were detected at dual phase PET-CT and in 6 patients, the current lessions became more evident. Demogrophical and clinical features of the patients were given in Table 1.

Table 1. The basic clinical features of the patients were given

Age, years	59.80±16.18
Gender, male/female, n (%)	13 (37.1%) / 22 (62.9%)
Cancer surgery, yes/no, n (%)	10 (28.6%) / 25 (71.4%)
New lessions at late phase PET-CT, yes/no, n (%)	5 (14.3%) / 30 (85.7%)
Lessions became more evident at late phase PET-CT, yes/no, n (%)	6 (17.1%) / 29 (82.9)

PET-CT: Positron emission tomography/computed tomography.

Table 2. New cancer regions (cancer regions which was absent at the early phase of PET-CT) and regions which became more evident at the late phase of PET-CT were presented

	Age, gender	Event	Site	Measurements: Suv_{Max}, Suv_{Mean}, MTV, TLG
Case 1	71, female	New lession	Liver segment 3	5.42/1.74/1.47/4.80
Case 2	87, female	New lession	Periportal LN	3.1/1.93/2.69/5.25
Case 3	41, female	New lession	Conglomerate precaval LN	5.6/2.2/2.03/6.9
Case 4	93, female	New lession	Liver segment 7	7.5/3.35/2.54/10.27
Case 5	47, male	New lession	Peritumoral LN	3.6/1.63/0.46/0.81
Case 6	87, female	Evident	Periportal LN activity	1.51/1.11/1.3/2.55 (early) 3.1/1.93/2.69/5.25 (late)
Case 7	56, female	Evident	Liver segment 4	6.65/1.7/2.08/7.28 (early) 8.98/1.54/0.91/4.79 (late)
Case 8	45, female	Evident	Liver segment	13.67/8.04/17.31/147.53 (early) 23.32/10.05/13/176.64 (late)
Case 9	66, female	Evident	Paraaortic LN	3.5/2.2/0.3/0.8 (early) 6.3/4.4/0.3/1.2 (late)
Case 10	45, female	Evident	Peripankreatic LN	5.2/3.06/1.22/3.7 (early) 6.1/2.7/0.81/3 (late)
Case 11	68, male	Evident	Right internal iliac LN	1.5/0.79/1.02/0.97 (early) 2.5/1.47/2.03/2.95 (late)

PET-CT: Positron emission tomography/computed tomography; LN: Lymph node; Suv: Standard uptake value; MTV: Metabolic tumor volume; TLG: Total lesion glycolysis.

Table 2 represents the cases with new cancer regions and more evident cancer regions compared to first images at PET-CT. Female participants demonstrated a higher rate of new cancer lesions at the late phase of PET-CT and more evident cancer regions compared to the images obtained at the early phase of PET-CT (p=0.032 and p=0.019, respectively). A logistic regression model demonstrated female gender has an impact on new lesion determination and more evident cancer region in dual phase PET-CT (p=0.007, OR: 1.54 and CI 95% [0.265–26.861] and p=0.016, OR: 1.214 and CI 95% [0.364–34.185], respectively).

DISCUSSION

The present study demonstrated that dual-phase FDG-PET-CT exhibits new cancer regions in 14.3% of patients and more evident cancer regions in 17.1% of patients compared to the early-phase FDG-PET-CT.

In the management of individuals with cancer, the utilization of positron emission tomography (PET) using 18F-fluorodeoxyglucose (FDG) is an essential diagnostic tool. Its pivotal role extends to tumor staging and restaging, as well as the early and final assessment of treatment response. Furthermore, PET plays a crucial role in discerning between radiotherapy-induced scar tissue and disease relapse, a recognition that has become widespread within the medical community [10, 11]. Consequently, the incorporation of hybrid imaging not only enhances PET accuracy but notably augments PET specificity [11]. This technological synergy underscores the potential for more nuanced and accurate diagnostic information, contributing to enhanced clinical decision-making in the care of cancer patients. While PET/CT is a valuable diagnostic tool in cancer management, its sensitivity has certain limitations. These limitations encompass the biological characteristics of tumors, including low glucose retention or metabolism observed in specific neoplasms such as carcinoid, bronchoalveolar carcinoma, prostate cancer, and hepatocellular carcinoma [9, 12–14]. Furthermore, missed assessments in PET-CT can result from additional factors such as variations in serum blood levels of glucose and insulin, tumor dimensions, and a low lesion-to-background ratio in organs with inherently high background activity levels [9, 15, 16].

There are various techniques that aim to overcome the mentioned false negative assessments. The assessment of the acquisition of FDG in delayed images of PET-CT may be one approach. Kubota et al. [17] reported that primary lung cancer, metastatic mediastinal lymph nodes and lymphoma lesions exhibit a more detectable FDG uptake at 2h that at 1h of PET-CT. A recent study conducted by Boanova et al. [18] revealed that dual-phase PET/CT scan can improves the sensitivity and specificity of colorectal liver metastasis compared to the early images (100% vs 87.7% and 91.0% vs 94.0%, respectively), especially in smaller liver lesions <5 cm^3. Arene at al. reported PET scan of 95 consecutive patients with suspected liver metastases and demonstrated a notable reduction in Standardized Uptake Value mean (SUVmean) values in the background, accompanied by a concomitant increase in SUVmean values of the lesion itself. This dynamic interplay resulted in a significant improvement in the lesion-to-background ratio, highlighting the potential of delayed imaging to uncover pertinent information that may not be apparent in standard PET scans. This approach introduces a valuable adjunct to standard PET protocols, offering an enhanced diagnostic perspective and potentially improving the overall efficacy of PET imaging in clinical settings [9]. The findings of this study are suggestive for previous study; 5 (14.3%) new and 6 (17.1%) more evident metastatic lesion were demonstrated by dual-phase PET/CT. Interestingly, delayed acquisition was more prominent among females. However, in this small cohort, the female gender has dominancy and this result may be related to limited case numbers.

Previous studies have concentrated on evaluating the efficacy of dual-phase PET/CT in detecting delayed acquisition in diverse organs, including the liver, lungs, and regional lymph nodes [19–21]. This current study corroborates these findings, indicating that dual-phase PET-CT can indeed deliver a more precise assessment of colorectal cancer. Specifically, it proves valuable in the identification of liver metastases and lymph nodes, reaffirming the potential of dual-phase PET-CT as a robust imaging modality for enhancing the accuracy of colorectal cancer diagnosis and staging.

Limitations

The study encompasses a relatively small cohort of 35 patients, potentially affecting the generalizability of the findings. The retrospective nature of the study introduces inherent limitations, including the potential for selection bias and the reliance on existing data. The study notes a dominance of female participants, and while logistic regression accounts for this, the imbalanced gender distribution may introduce confounding variables and limit the generalizability of gender-specific findings. Additionally, this study lacks a control group for comparison, making it challenging to delineate the specific contributions of dual-phase FDG-PET-CT in comparison to standard imaging protocols. The study primarily focuses on the detection of new and more evident lesions without extensive follow-up data on the clinical impact of these findings. Long-term outcomes and correlations with patient management would provide a more comprehensive perspective. While emphasizing the benefits of dual-phase FDG-PET-CT, the study does not directly compare its performance with other imaging modalities such as conventional PET/CT or magnetic resonance imaging (MRI), which could provide additional insights into its superiority. The study relies on the interpretation of images for lesion assessment, and subjective interpretations may introduce variability. Objective measures or a blinded review could enhance the objectivity of lesion evaluations.

Conclusion

This study underscores the potential of dual-phase FDG-PET/CT in enhancing the assessment of colorectal cancer, particularly in detecting new lesions and rendering existing lesions more evident. Despite the limitations, including a modest sample size and a retrospective design, the findings align with previous research on the efficacy of dual-phase imaging. The study emphasizes the need for further exploration with larger cohorts, prospective designs, and comparisons with other imaging modalities to validate the clinical impact of dual-phase FDG-PET/CT in colorectal cancer management. Nevertheless, the observed improvements in lesion detection highlight the promising role of this imaging approach in refining diagnostic accuracy and guiding clinical decision-making for patients with colorectal cancer.

Ethics Committee Approval: The Dicle University Non-Interventional Clinical Research Ethics Committee granted approval for this study (date: 15.02.2023, number: 91).

Informed Consent: Written informed consents were obtained from patients who participated in this study.

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