Direct Comparison of ^{18}F-FDG PET and PET/CT in Patients with Colorectal Carcinoma

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The purpose of this study was to compare ^{18}F-FDG PET and PET/CT in a population of patients with colorectal cancer. **Methods:** PET and PET/CT images from 45 patients (17 women, 28 men; mean age ± SD, 60.8 ± 11.1 y) with known colorectal cancer referred for PET from June to November 2001 were retrospectively reviewed. Images were acquired with a PET/CT scanner, and ^{68}Ge attenuation correction was applied. PET images and fused ^{68}Ge attenuation–corrected PET and CT images were independently and separately interpreted by a moderately experienced reader unaware of the clinical information. Certainty of lesion characterization was scored on a 5-point scale (0 = definitely benign, 1 = probably benign, 2 = equivocal, 3 = probably malignant, 4 = definitely malignant). Lesion location was scored on a 3-point scale (0 = uncertain, 1 = probable, 2 = definite). The presence or absence of tumor was subsequently assessed using all available clinical, pathologic, and follow-up information. Analysis was provided for lesions detected by both PET and PET/CT. **Results:** The frequency of equivocal and probable lesion characterization was reduced by 50% (50 to 25) with PET/CT, in comparison with PET. The frequency of definite lesion characterization was increased by 30% (84 to 109) with PET/CT. The number of definite locations was increased by 25% (92 to 115) with PET/CT. Overall correct staging increased from 78% to 89% with PET/CT on a patient-by-patient analysis. **Conclusion:** PET/CT imaging increases the accuracy and certainty of locating lesions in colorectal cancer. More definitely normal and definitely abnormal lesions (and fewer probable and equivocal lesions) were identified with PET/CT than with PET alone. Staging and restaging accuracy improved from 78% to 89%.

Key Words: ^{18}F-FDG; PET/CT; PET; CT; colorectal carcinoma

J Nucl Med 2003; 44:1797–1803

PET/CT scanners combining in-line PET and CT cameras are new devices with considerable diagnostic potential (*1*,*2*). ^{18}F-FDG PET has been reported to be accurate in the imaging of colorectal cancer, especially for evaluation and staging of cancer recurrence (*3*–*6*). In comparison to CT, PET provides increased sensitivity for the detection of intraabdominal extrahepatic disease. ^{18}F-FDG PET is also efficient for the evaluation of liver metastases (*7*,*8*) and their resectability (*9*,*10*).

However, ^{18}F-FDG PET suffers from some limitations in the evaluation of the abdomen. Determining the precise location of ^{18}F-FDG–avid lesions by PET can be challenging in the abdomen. Bowel has variable uptake that can be intense and is usually linear but sometimes focal (*11*). Urinary activity can be confounding, particularly if focal retention in the ureters occurs and is misinterpreted as lymph node activity. Diuretics and hydration have been suggested to decrease urinary activity (*12*,*13*) but are not invariably successful.

The impact of PET/CT on the evaluation of colorectal cancer with ^{18}F-FDG has not yet been determined. The aim of the present study was to assess the added value of PET/CT fusion in the evaluation of patients with colorectal cancer by directly comparing PET and PET/CT.

MATERIALS AND METHODS

PET/CT Acquisition

All consecutive clinical patients who were referred from June 2001 to mid-November 2001 for whole-body ^{18}F-FDG PET/CT and had a known or suspected history of colorectal cancer were retrospectively included for analysis. Patients with suspected or documented active coexistent noncolorectal cancer were excluded. PET/CT was performed using a combined PET/CT scanner (Discovery LS; General Electric Medical Systems). Emission data were acquired for 5–7 bed positions, typically from the base of the skull to the mid thigh. Emission data were acquired for 5 min at each bed position. Each bed had 35 scanning planes with a 14.6-cm longitudinal field of view and a 1-slice overlap between scanning bed positions. ^{68}Ge transmission scans were used to generate a transmission map. The transmission time at each bed position was 3 min. A segmented attenuation map was then generated. PET images were reconstructed using ^{68}Ge for attenuation correction with the ordered-subsets expectation maximization algorithm (2 iterations, 28 subsets) and an 8-mm gaussian filter using a 128 × 128 matrix. Non–attenuation-corrected images were not reviewed for this analysis, nor were the CT-corrected emission images. The CT portion of the Discovery LS consisted of a multidetector helical CT scanner (LightSpeed Plus; General Electric Medical Systems). Imaging parameters were as follows for a 5-bed-position acquisition: 140 kVp, 80 mA, 0.8 s per CT rotation,

Received Dec. 2, 2002; revision accepted Apr. 2, 2003.

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a pitch of 6, a 22.5 mm/s table speed, 722.5-mm coverage, a 31.9-s acquisition time, and arms at the side of the torso. The CT slice thickness was 5 mm. The CT acquisition was done before the PET emission acquisition. CT data were resized from a 512 × 512 matrix to a 128 × 128 matrix to match the PET data in order to fuse the images. CT was also used for attenuation correction, but these images were not analyzed in this study. Patients fasted for at least 4 h before the PET acquisition. Blood glucose levels were checked before ^{18}F-FDG injection, and if they were less than 11.1 mmol/L, the patients were injected intravenously with 555–740 MBq of ^{18}F-FDG. A tracer uptake phase of about 60 min was implemented in which the patients were instructed to sit in a quiet room without talking. No oral or intravenous contrast agent was administered. No intravenous diuretics or intravenous hydration was given, and no bladder catheterization was performed.

Image Interpretation

Studies were interpreted using a computer workstation (eNTEGRA; General Electric Medical Systems). Studies were interpreted independently by a board-certified, moderately experienced nuclear medicine physician unaware of patient name and identification; study indication, except that the patient was referred for colorectal cancer evaluation; correlative imaging; and history. All PET studies were interpreted sequentially in randomized order. Subsequently, PET/CT studies were interpreted in a separate reading session in another randomized order, without availability of the previous PET-alone reading. We assessed ^{68}Ge attenuation–corrected PET images instead of CT-corrected PET images in order to evaluate the added value of CT in the interpretation of PET/CT images over the generally available ^{68}Ge-corrected PET images, not the impact of CT attenuation correction. Artifacts, such as "increased activity" in the presence of metallic objects, have been reported with CT attenuation correction (*14*) and represent confounding issues that could have rendered the evaluation of the impact of PET/CT more difficult. CT in the PET/CT reading session was used for interpretation and localization of the PET data, not for attenuation correction. Each study was reviewed for lesion identification. A lesion-by-lesion analysis was performed. Any discrepancies between lesion number found by the 2 techniques were then analyzed. Each lesion was evaluated regarding certainty of characterization and certainty of location, as explained below. Lesion location was assessed for each lesion identified and scored on a 3-point scale (0 = uncertain location, 1 = probable location, 2 = definite location). Each lesion identified was characterized using a 5-point score: 0 = definitively benign, 1 = probably benign, 2 = equivocal, 3 = probably malignant, 4 = definitively malignant.

Consensus Evaluation for Lesion Etiology

The impact of PET/CT over PET alone regarding lesion localization and characterization was analyzed on lesions identified by both techniques. All available patient records were reviewed. Lesions were scored using a consensus of 3 nuclear medicine physicians, based on all available data (correlative imaging findings, histologic proof, and clinical and radiologic follow-up). This consensus was scored on a 5-point scale: 0 = definitely benign with histologic proof; 1 = probably benign with CT and PET concordant findings or benign evolution on follow-up; 2 = equivocal with no histologic proof or follow-up; 3 = probably malignant with CT and PET concordant, with malignant evolution on follow-up, or with progression on therapy; and 4 = definitely malignant with histologic proof. Histologic proof was considered definitive if biopsy or surgery was performed less than 1 mo before and less than 2 mo after PET and there had been no intervening therapy. Concordant findings on PET and CT (or MRI) meant that both PET and CT were most consistent with malignancy (score 3 consensus).

Lesion-by-Lesion Analysis

For the accuracy analysis, equivocal (score 2) lesions by consensus were excluded. Score 3 and 4 consensus lesions were considered positive for malignancy, whereas score 0 and 1 lesions were considered negative for malignancy. For the PET and PET/CT readings, lesion characterization was dichotomized, with scores 2, 3, and 4 grouped as a positive test and scores 0 and 1 grouped as a negative test. When patients had multiple liver metastases, a maximum of 5 lesions were included for analysis.

Patient-by-Patient Analysis

The accuracy of PET and PET/CT was evaluated regarding the following items: presence of active cancer in the patient, detection of the primary cancer, detection of intraabdominal disease (excluding primary cancer and liver metastasis), detection of liver metastasis, detection of metastasis (M status), and overall correct staging. If each liver, intraabdominal extrahepatic region, and extraabdominal region were correctly assessed by PET and PET/CT, the overall staging was considered to be correct. A true-positive or true-negative result had to correctly be characterized for primary disease, liver status, and intraabdominal extrahepatic and extraabdominal disease. Under- and overstaging according to these anatomic regions were considered false-negative and false-positive, respectively. To dichotomize the data, for the PET and PET/CT readings, lesion characterization scores 2, 3, and 4 were considered a positive test, whereas scores 0 and 1 were considered a negative test. Extraabdominal lesions suggestive of malignancy but classified as unrelated to colorectal cancer were analyzed separately and not included in the overall staging. Sensitivity, specificity, and accuracy were expressed along with an estimate of the 95% confidence interval. Differences in accuracy between PET and PET/CT for the by-lesion and by-patient analyses were tested with the McNemar test. $P < 0.05$ was considered significant.

RESULTS

Patient Population

Fifty-four ^{18}F-FDG PET/CT examinations were performed on 52 consecutive clinical patients with colorectal carcinoma. Seven scans were excluded from analysis because ^{68}Ge-corrected images were not available. One patient with active metastatic thyroid and colorectal cancer was also excluded. One patient with active lung and colorectal cancer was also excluded from analysis. Thus, a total of 45 patients (45 scans) were included for analysis. Mean age was 60.8 ± 11.1 y (range, 36–83 y). There were 17 women and 28 men. One patient was referred for primary staging. Forty-four patients were referred for restaging (9 to rule out recurrence, 16 to stage a known recurrence, and 19 to assess therapy response). The histologic type of the primary or recurrent cancer was available from the history or medical records for 33 patients. There were 4 cases of mucinous carcinoma, 1 of well-differentiated carcinoma, 22 of moderately differentiated carcinoma, 4 of moderately to poorly

TABLE 1
Comparison Between PET/CT and PET Regarding Certainty of Lesion Location

Certainty	Lesion location score	Number of lesions		Change: PET/CT vs. PET
		PET	PET/CT	
Definite location	2 = definite location	92	115	+25%
Imprecise location	0 = uncertain location	28	14	
	1 = probable location	14	5	
	Total	42	19	−55%

Total number of lesions detected by both techniques was 134 among 45 patients.

differentiated carcinoma, and 2 of poorly differentiated carcinoma. The location of the primary cancer was not specified in the records of 1 patient. Primary cancer originated from the right colon ($n = 12$), transverse colon ($n = 2$), descending colon ($n = 4$), or rectosigmoid colon ($n = 26$). Two patients received intravenous insulin 60 min before ^{18}F-FDG injection to lower glucose levels before ^{18}F-FDG injection. The average serum glucose level for all patients at the time of injection was 6 ± 1.7 mmol/L (range, 4.3–9.8 mmol/L).

Location and Characterization Certainty

PET/CT identified 138 lesions; PET, 141; and both modalities, 134. Localization results are shown in Table 1. Figure 1 shows an example of improved location certainty with PET/CT. Lesion characterization results are shown in Table 2. Figure 2 shows an example of improved diagnostic certainty with PET/CT. Seven lesions were identified on PET only. Six of these lesions were additional liver metastases found in 5 patients with multiple liver metastases. The other lesion was an equivocal bone lesion. Four lesions were found on PET/CT only. One was a liver metastasis missed on PET alone, 1 was a liver metastasis not described on PET in a patient with multiple liver metastases missed on PET alone, and 1 was a liver metastasis not described on PET in a patient with multiple liver metastases. One tonsillar lesion with an equivocal characterization and 1 ureteral focus (definitely benign) were not described on PET.

Accuracy Analysis

Seven patients were excluded from the accuracy analysis because no pathologic confirmation, no congruent correlative imaging, and no follow-up were available. Thirty-eight patients had follow-up, histologic confirmation of at least

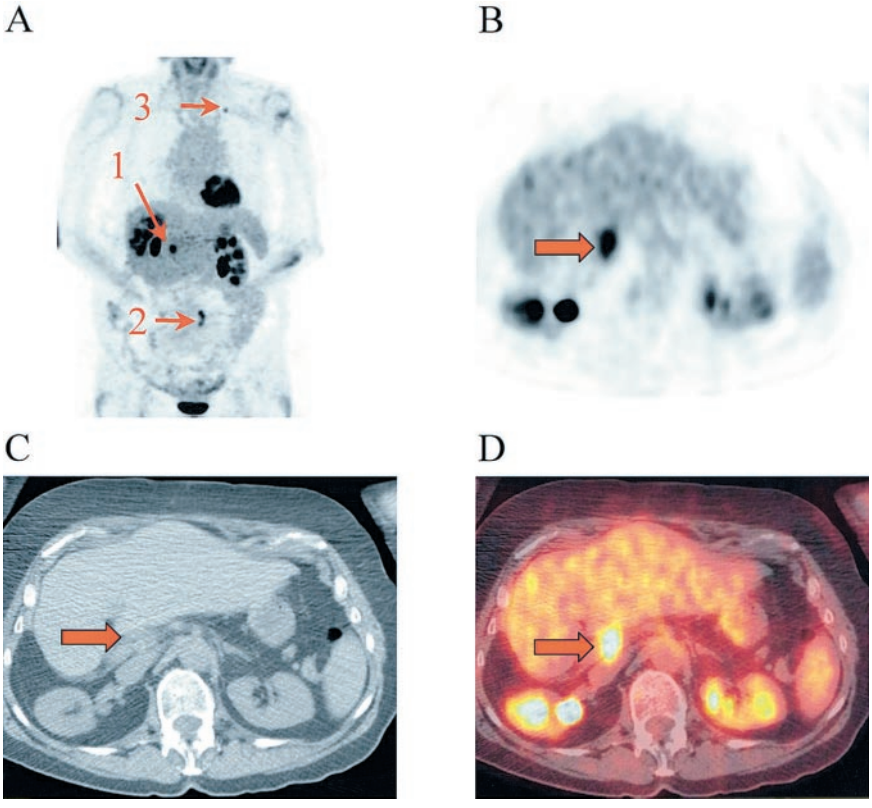

FIGURE 1. ^{18}F-FDG PET images in anterior projection display (A) of patient with foci of increased tracer uptake near inferior border of liver (1), left paraaortic lymph nodes (2), and left upper lung nodule (3). Lung nodule and paraaortic lymph nodes were correctly localized and characterized with PET alone. However, precise location of lesion (1) was difficult to determine, and level 0 was assigned (uncertain; liver or porta hepatis). Transverse PET images (B) at level of lesion (1) clearly showed that activity (arrow) had corresponding lymph node on CT image (C) and fused image (D). Localization was thus improved from uncertain to definite (score 2) with PET/CT.

TABLE 2
Certainty of Lesion Characterization with PET/CT and PET

Certainty	Lesion characterization	Number of lesions		Change: PET/CT vs. PET
		PET	PET/CT	
Definite lesions	0 = definitely benign	0	15	
	4 = definitively malignant	84	94	
	Total	84	109	+30%
Probable lesions	1 = probably benign	19	9	
	2 = equivocal	12	9	
	3 = probably malignant	19	7	
	Total	50	25	−50%

Total number of lesions detected by both techniques was 134 among 45 patients.

some of the lesions, or congruent correlative imaging findings. Two patients were excluded from the patient analysis because, after consensus evaluation, some lesions were scored as equivocal and the overall staging could not be determined. Thus, 36 patients were analyzed for the patient analysis. Twenty-five patients had a follow-up of at least 6 mo (mean, 8.6 ± 1.6 mo; range, 6–12 mo). Eleven patients had a follow-up of less than 6 mo. Four had previously documented liver metastases, and 1 had a brain metastasis. These 5 patients had congruent findings on correlative imaging.

Lesion-by-Lesion Analysis

The number of lesions defined by consensus was 140. By consensus, 18 lesions were classified as benign (6 with score 0 and 12 with score 1), 18 lesions were classified as equivocal, and 104 were classified as malignant (37 with score 4 and 67 with score 3). Thus, a total of 122 lesions were analyzed. Results are displayed in Table 3. With PET, there were 91 true-positives, 10 true-negatives, 13 false-negatives, and 8 false-positives. Of the 13 false-negatives with PET, PET/CT correctly identified 4 lesions as positive. Of the 8 false-positives with PET, PET/CT correctly identified 3 lesions as true-negative. With PET/CT, there were 89 true-positives, 12 true-negatives, 15 false-negatives, and 6 false-positives. Of the 15 false-negatives with PET/CT, PET correctly identified 6 lesions as positive. Of the 6 false-positives with PET/CT, PET correctly identified 1 lesion as negative.

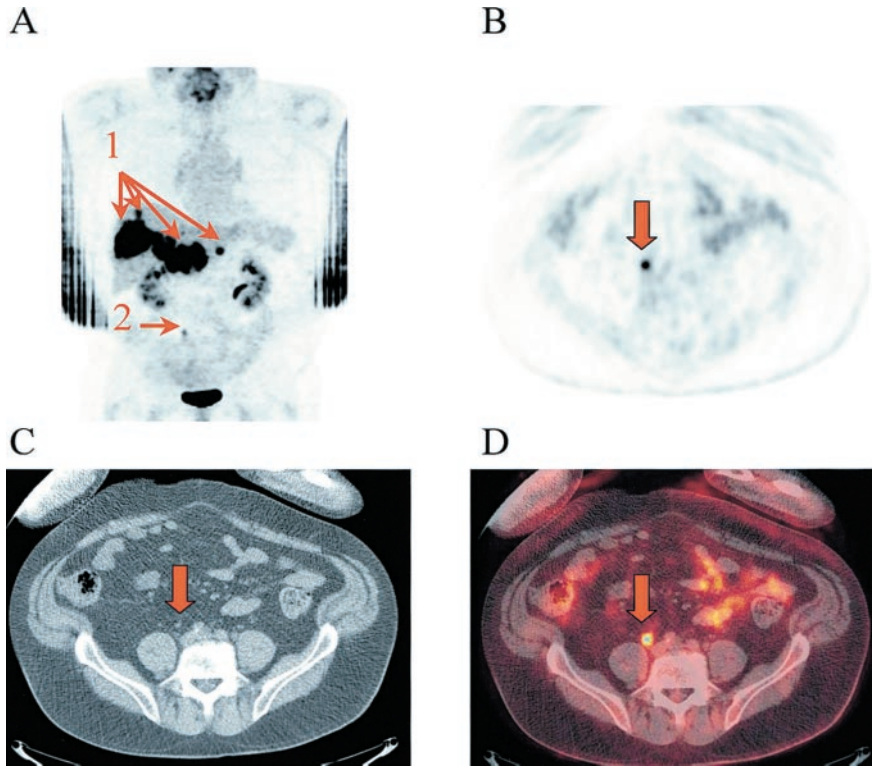

FIGURE 2. ^{18}F-FDG PET images in anterior projection display (A) of patient with multiple liver metastases (1). For small focus of moderate metabolic activity (2) in right mid abdomen, equivocal diagnostic impression (score 2) was given because focus could represent benign activity (ureter) or malignancy (metastatic lymph node). Transverse PET images (B) at level of lesion 2 clearly showed that activity (arrow) on PET image corresponded to ureter on CT image (C) and fused image (D). Lesion characterization was thus improved to definitely benign (score 0) with PET/CT.

TABLE 3
Lesion-by-Lesion Analysis: Sensitivity, Specificity, and Accuracy of PET vs. PET/CT

Index	PET	PET/CT	*P**
Sensitivity	88% (91/104) 95% CI: 80%–93%	86% (89/104) 95% CI: 77%–91%	0.8
Specificity	56% (10/18) 95% CI: 34%–75%	67% (12/18) 95% CI: 44%–84%	0.6
Accuracy	83% (101/122) 95% CI: 75%–89%	83% (101/122) 95% CI: 75%–89%	0.8

*Obtained with McNemar test.
CI = confidence interval.
Total number of lesions with follow-up, histologic confirmation, or congruent correlative imaging was 122 among 38 patients.

PET and PET/CT both had an overall accuracy per lesion of 83% ($P = 0.8$) when equivocal lesions were characterized as positive. PET and PET/CT had an overall accuracy of 82% and 85%, respectively, when equivocal lesions were characterized as negative ($P = 0.2$).

Patient-by-Patient Analysis

Both PET and PET/CT correctly assessed the status of the primary lesion or local recurrence in all patients. The liver status was incorrectly assessed in 1 patient with PET/CT and in 2 with PET. In 1 patient, a focus of increased activity in the liver was incorrectly interpreted with PET and PET/CT as metastatic disease. Histologic examination of this lesion resected at surgery showed postsurgical inflammation. One patient with liver metastases from mucinous carcinoma was incorrectly classified as without active cancer with PET (Fig. 3), whereas with PET/CT, 1 liver metastasis was correctly identified.

The extrahepatic intraabdominal tumor status was incorrectly assessed for 5 patients with PET and 3 patients with PET/CT. One myelolipoma of the adrenal was falsely interpreted as malignant with both PET and PET/CT. One metastatic periportal lymph node was found at pathologic examination in a patient evaluated for liver metastasis resectability but was missed by both PET and PET/CT. Peritoneal tumor implants were incorrectly interpreted as bowel activity with PET/CT in another patient. In one patient, bowel activity was incorrectly interpreted as a pelvic lymph node with PET but correctly classified as benign with PET/CT. In another patient, a focus of pelvic activity was incorrectly classified as a metastatic lymph node with PET. It was shown to be localized in bone with PET/CT and thus was characterized correctly as a bone metastasis. In another patient, a porta hepatis lymph node was missed on PET but identified on PET/CT.

The distant metastasis status (extraabdominal) was incorrectly assessed for 2 patients with PET. In contrast, the status was correctly assessed for all patients with PET/CT. Degenerative spine changes were incorrectly interpreted as metastatic bone disease with PET for 1 patient. A bone metastasis was incorrectly interpreted as a metastatic pelvic lymph node with PET. The presence or absence of malig-

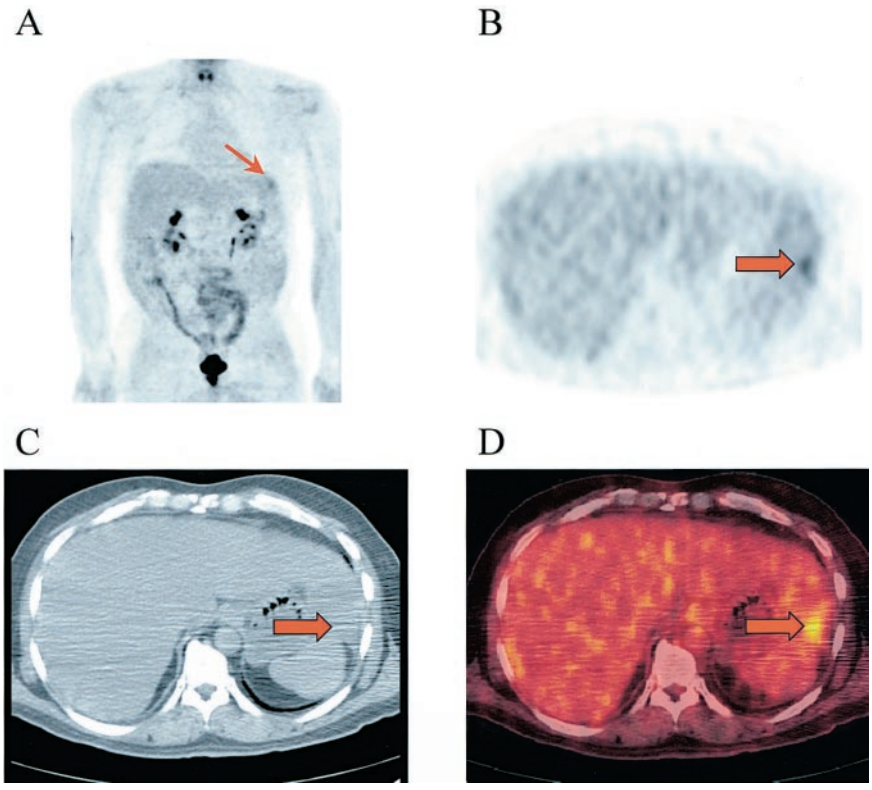

FIGURE 3. ^{18}F-FDG PET images in anterior projection display (A) of patient evaluated for suspected recurrence did not clearly show abnormal foci of uptake in abdomen. Focus of moderate activity in left upper quadrant of abdomen was interpreted as splenic activity (arrow). Diagnostic impression was definitively benign. Transverse PET image (B) and fused image (D) at level of liver clearly showed small focus of mild activity at edge of a lesion on CT image (C). This lesion was interpreted as clearly malignant, and patient was classified as having metastatic liver disease. Metastasis from mucinous colorectal carcinoma was confirmed at surgery. With PET/CT, disease was correctly staged, unlike false-negative interpretation with PET alone.

TABLE 4
Comparison of Overall Staging with PET and PET/CT: Discrepant Results

Patient no.	Overall staging*		Cause of incorrect staging
	PET	PET/CT	
1	Incorrect	Correct	FN Porta-hepatis lymph node
2	Incorrect	Incorrect	FP Postsurgical liver inflammation
4	Incorrect	Incorrect	FP benign adrenal tumor (myelolipoma)
6	Incorrect	Incorrect	FN Periportal lymph node
14	Correct	Incorrect	FN Peritoneal implants
21	Incorrect	Correct	FP Bowel activity
25	Incorrect	Correct	FN Liver mucinous metastasis
29	Incorrect	Correct	FP Degenerative spine changes
34	Incorrect	Correct	FN Bone metastasis misinterpreted as pelvic node

*Correct overall staging means that disease status of primary tumor/local recurrence, liver, intraabdominal/extrahepatic regions, and extrahepatic regions was correctly assessed. Incorrect overall staging means that any region was incorrectly assessed.

FN = false-negative; FP = false-positive.

Total of 36 patients had follow-up, pathologic proof, and correlative imaging allowing assessment of overall staging of disease.

nancy was correctly assessed for all patients with PET/CT, except for 1 with a false-positive result. PET had 2 false-positive and one false-negative results.

Overall staging was incorrectly assessed for 4 patients with PET/CT and 8 patients with PET (Table 4). PET/CT had 2 false-positives and 2 false-negatives, whereas PET had 4 false-positives and 4 false-negatives. Three of these incorrect stagings were congruent for both PET and PET/CT. PET and PET/CT had an accuracy for overall staging of 78% (95% confidence interval, 62%–89%) and 89% (95% confidence interval, 74%–96%), respectively ($P = 0.4$).

For lesions unrelated to the colorectal cancer but suspected to be malignant, there were 4 false-positives with PET/CT and 3 false-positives with PET. False-positive interpretations occurred with both PET and PET/CT for 3 patients (1 with an ^{18}F-FDG–avid Warthin's tumor, 1 with an ^{18}F-FDG–avid benign thyroid nodule, and 1 with focal physiologic oropharyngeal uptake). Markedly asymmetric physiologic tonsillar activity was incorrectly interpreted as malignant with PET/CT for 1 patient.

DISCUSSION

The major impact of PET/CT over PET alone in this study was an improvement in the certainty of lesion location and characterization. In comparison with PET alone, PET/CT reduced the number of lesions having an uncertain location by 55% (from 42 to 19) and the number of equivocal and probable lesion characterizations by 50% (from 50 to 25). This reduction in uncertainty in PET should decrease the number of equivocal reports, which can limit the clinical utility of PET to the referring physician. The performance of PET/CT was comparable to that of PET on a lesion-by-lesion analysis, with an identical 83% accuracy, though more uncertainty was present with PET. Interestingly, the impact of the use of PET/CT over PET resides in an improvement of the overall correct staging. Better staging occurred with PET/CT than with PET alone for 4 of the 36 patients (11%) included in the accuracy analysis. This result stemmed from a reduction by half (from 8 to 4) in the number of patients with incorrectly staged disease with PET/CT, in comparison with PET. The overall accuracy of staging thus increased from 78% to 89%. Although this increment (11%) is not tremendously high, it shows that PET/CT provides, with fused CT data, additional diagnostic information that will alter the correct staging in a significant proportion of patients. This added value of PET/CT over PET is incremental to the already known high accuracy of ^{18}F-FDG PET alone in the evaluation of recurrent colorectal cancer (*15*). The benefits of PET/CT over PET appeared to be more marked for the evaluation of extrahepatic disease, both intraabdominal and extraabdominal, than for liver evaluation. In these regions, better localization of ^{18}F-FDG–avid lesions is potentially more beneficial. The proportion of our patients (19%, $n = 7/36$) with intraabdominal extrahepatic disease was relatively limited. It is possible that in a population with a high risk of intraabdominal extrahepatic disease, the benefit of PET/CT will be more substantial.

A small discrepancy between the number of lesions found on PET and the number found on PET/CT was observed in this study. Half of the lesions seen on one modality alone were clearly benign lesions not detected on the other modality (bowel, urinary, or degenerative bone disease). The importance of these "missed" benign lesions is negligible. The disease of 3 patients was incorrectly staged on both PET and PET/CT. Two of these patients had false-positive results due to focal, clearly defined, ^{18}F-FDG–avid nonmalignant lesions. One had false-negative results due to a malignant periportal lymph node discovered at pathologic examination but missed by all preoperative imaging. Six other patients had incorrectly staged disease, 5 by PET and 1 by PET/CT. Uptake in peritoneal implants was misinterpreted as bowel activity with PET/CT in 1 patient. Use of

oral contrast agent on the CT portion of the PET/CT in this situation could probably have been helpful. PET resulted in 5 other incorrectly staged cases, which were due to 2 false-positive and 3 false-negative interpretations. PET/CT correctly staged all of these cases because of better localization of pelvic activity in bone (bone metastasis), better correspondence between a left upper abdominal focus of activity and a liver lesion on CT (liver metastasis), identification of a porta hepatis lymph node, and identification of degenerative changes in the spine and pelvic activity in bowel. The liver metastasis missed on PET was from a mucinous carcinoma, which not infrequently can have relatively low metabolic activity, causing false-negative ^{18}F-FDG PET findings (*7,16*). PET/CT demonstrated a clearly defined lesion on the CT scan, with some moderate focal activity at the edge of the lesion on the PET scan.

CT scans alone from the PET/CT study were not interpreted independently in our study but were used to help interpret and localize the PET findings. The present study did not compare the accuracy of PET with that of CT, as such a comparison has been performed previously (*17,18*). Further, some patients had undergone CT at outside institutions using variable techniques and qualities. A direct comparison of state-of-the-art ^{18}F-FDG PET/CT with technically variable CT scans would not have been particularly meaningful. The non–contrast-enhanced CT from PET/CT is certainly not optimal for diagnostic interpretation, and comparing PET/CT with the CT from PET/CT would have had little clinical relevance.

For the current study, only a single reader's diagnostic interpretation is reported. Additional analysis of the incremental benefits of PET/CT over PET in multiple readers with varying degrees of experience in interpreting PET is under study, as it is possible that PET/CT is of greatest benefit for less experienced readers. Because the use of contrast agents was not yet implemented in our routine clinical practice, we did not evaluate the impact of intravenous or oral contrast agents on diagnostic accuracy. Adding an oral contrast agent will likely help to better delineate normal bowel activity and demonstrate pathologic intraabdominal activity (peritoneal implants). Use of an intravenous contrast agent may improve the display of liver metastases on CT and will likely be required if the exact segmental liver location must be determined before resection of a liver metastasis.

CONCLUSION

The major impact of PET/CT over PET alone in the evaluation of colorectal cancer was a significant increase in the certainty of lesion localization and characterization. These 2 parameters are linked, as better localization of a lesion likely improves the accuracy of its characterization as benign or malignant, leading to fewer equivocal lesions and fewer lesions that are considered probably benign or probably malignant. The number of definitely benign or malignant lesions was thus increased by PET/CT. Because ^{18}F-FDG PET is already an excellent technique for assessing colorectal cancer, only a limited improvement in overall diagnostic accuracy could be expected. Staging in 4 patients in our series changed considerably. Overall, the accuracy of staging increased from 78% to 89% with PET/CT. Thus, in our series, PET/CT improves on PET and appears to be a valuable method for assessing recurrent colorectal carcinoma.

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