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CLINICAL IMAGING

FDG PET or PET/CT in patients with pancreatic cancer: when does it add to diagnostic CT or MRI?

Omar Javery [a], Paul Shyn [b,*], Koenraad Mortele [c]

[a] Department of Radiology, Brigham and Women's Hospital, Harvard Medical School, 75 Francis Street, Boston, MA 02115, USA
[b] Department of Radiology, Division of Abdominal Imaging and Intervention, Brigham and Women's Hospital, Harvard Medical School, 75 Francis Street, Boston, MA 02115, USA
[c] Department of Radiology, Division of Abdominal Imaging and Body MRI, Beth Israel Deaconess Medical Center, Harvard Medical School, 330 Brookline Avenue, Boston, MA 02115, USA

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Abstract

Objective: Assess the impact of FDG-PET or PET/CT (PI) on pancreatic cancer management when added to CT or MRI (CDI). **Materials and Methods:** Forty-nine patients underwent 79 PI exams. Discordant findings on PI and CDI were assessed for clinical impact. **Results:** Fifteen of 79 PI-CDI pairs were discordant. Ten of 79 PI favorably and 5 of 79 unfavorably altered management. PI favorably altered management more often when ordered for therapy monitoring compared to staging [risk ratio 13.00 (95% CI 1.77–95.30)] or restaging [risk ratio 18.5 (95% CI 2.50–137.22)]. **Conclusion:** PI favorably alters management more often when used for therapy monitoring compared to staging or restaging.

Keywords: PET/CT; Pancreatic cancer; Clinical management

1. Introduction

Pancreatic ductal adenocarcinoma is the fifth leading cause of cancer death in the developed world and leads to over 265,000 deaths yearly worldwide [1]. Surgical resection offers the only chance for long-term survival; however, only 10–20% of patients present with operable tumors [2,3]. Chemotherapy, radiation therapy, and palliative surgery in the remaining patients are of variable benefit but not curative [2]. Accurate imaging of pancreatic cancer is essential for initial surgical management decisions and may help guide the appropriate use of other therapies such as chemotherapy and radiation therapy [2].

Contrast-enhanced CT and MRI are established imaging tests used for the initial staging of pancreatic cancer. CT and MRI are particularly effective in determining tumor resectability [4]. The excellent anatomic detail of these modalities provides optimal assessment of vascular encasement and local organ involvement, characterizations not readily made using ^{18}F-fluorodeoxyglucose (FDG) PET [2–4]. The role of FDG-PET and PET/CT is an area of active investigation with some studies suggesting improved detection of distant metastases or nodal involvement [2,3,5,6] and other studies suggesting little clinically relevant gain compared to CT or MRI [7–9]. Given the primary role of CT and MRI in the imaging of pancreatic cancer, the question of how and for which indications FDG PET or PET/CT might improve clinical management of patients with pancreatic cancer is raised. Therefore, the purpose of this study was to assess the potential incremental impact of FDG-PET or unenhanced PET/CT imaging (PI) on the clinical management of patients with pancreatic cancer when performed as an adjunct to conventional diagnostic imaging (CDI) using CT or MRI scans.

2. Methods

This retrospective study was performed in compliance with the Health Insurance Portability and Accountability Act and

* Corresponding author.
E-mail addresses: ojavery@partners.org (O. Javery), pshyn@partners.org (P. Shyn), kmortele@bidmc.harvard.edu (K. Mortele).

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after institutional review board approval. Patient informed consent was waived. Medical records review identified 365 consecutive patients with pancreatic cancer diagnosed using histopathology specimens obtained from biopsy or surgical procedures performed at our institution between January 2000 and September 2009. Three hundred fourteen patients who did not have at least one pancreatic cancer-related PI study at our institution were excluded. Two additional patients were excluded who did not receive further clinical care at our institution and lacked the follow-up necessary to assess the clinical significance of PI findings. The final study population included 49 patients, 24 males and 25 females, ranging in age from 44 to 84 years (mean, 66 years).

The 49 study patients underwent 79 PI exams including PET (n=8) or PET/CT (n=71); 36 patients underwent one scan and 13 patients underwent multiple scans (mean 1.6, range 1 to 10). Indication categories included staging (n=26), restaging after completion of therapy (n=37), therapy response monitoring during chemotherapy or targeted therapy (n=14), and biopsy planning (n=2).

PI included PET scans performed on an Advantage PET scanner and PET/CT scans performed on a Discovery ST or VCT PET/CT scanner (GE, Milwaukee, WI, USA). Unenhanced CT (for PET/CT) was performed using 140 kVp, 40–120 mA, 1.675 pitch factor, and 0.8-s rotation time, and reconstructed with 3.75-mm collimation. PET images were acquired 60–80 min after the intravenous administration of FDG (mean dose 20.1 mCi, range 15.0 to 25.0 mCi), using 2D mode and 4 min per bed position. PET images were reconstructed with 3.75-mm collimation. Patients fasted for 4–6 h prior to scans. The mean glucose level was 104 mg/dl (range 53 to 238 mg/dl).

CDI included contrast-enhanced CT (n=55), unenhanced diagnostic CT (n=2), or contrast-enhanced MRI (n=8) scans performed within 1 month before or after 65 of the 79 PET or PET/CT scans in 48 of 49 patients. In the remaining 14 PET/CT scans among 6 patients, no contemporaneous diagnostic CT or MRI scans were available, and PET findings were then correlated with the unenhanced CT portion of the PET/CT exam. Unenhanced diagnostic CT (n=2) was performed in patients with severe renal insufficiency. In the case of multiple contemporaneous exams, the exam closest in time to PI was used. If both MRI and CT were performed on the same day, CT was used. The time interval separating PI-CDI scan pairs ranged from 0 to 33 days (mean 7.3 days).

Abdominal CT scans were obtained using various multidetector-row (16 to 64) CT scanners (Siemens Healthcare, Erlangen, Germany, or GE Healthcare, Madison, WI, USA) following oral and intravenous contrast. Nonionic intravenous contrast (300–370 mgI/ml) was administered by power injector for a standard volume of 100 ml but reduced to 75 ml in cases of mild to moderate renal insufficiency. Technique parameters included a kilovolt peak of 120 or 140 and a milliampere range of 100 to 250. The reconstructed transaxial collimation ranged from 3 to 5 mm.

MRI scans were performed on 1.5- or 3.0-T MRI scanners (Siemens Healthcare or GE Healthcare). Common to all MRI protocols were T2-weighted fast spin-echo, T1-weighted in-phase and out-of-phase gradient-echo, dynamic contrast-enhanced T1-weighted spoiled gradient-echo fat-suppressed, and T2-weighted cholangiopancreatography sequences. Gadolinium-based contrast material was administered using a dose of 0.1 mmol/kg body weight with a maximum dose of 10 mmol.

Dictated formal reports of contemporaneous PI and CDI were initially reviewed by a radiology resident for findings with the potential to influence patient management. All clinically significant findings, i.e., with the potential to influence patient management, were then confirmed by two readers who reviewed in consensus all contemporaneous PI and CDI on a PACS workstation (GE Centricity). The study readers included a third-year radiology resident and an attending radiologist with 11 years' experience reading oncologic PET and 20 years' experience reading body CT and MRI. PI and CDI were deemed concordant when the clinically significant findings were readily detectable on both studies and independently expected to influence patient management identically. PI and CDI were considered discordant when clinically significant findings were missed or substantially different on one study in comparison to the other or expected to influence clinical management differently.

To assess the incremental impact of PI in comparison to CDI alone, discordant findings were classified as favorable (leading to appropriate management based on true positive or true negative PI findings with corresponding false negative or false positive CDI findings) or unfavorable (leading to inappropriate management based on false positive or false negative PI findings with corresponding true negative or true positive CDI findings). PI findings were used to guide clinical management over CDI findings in all cases where discrepancies were identified (n=15). Confirmation of discrepant imaging findings was based upon pathology (n=4) or follow-up imaging findings, with or without corresponding changes in carbohydrate antigen (CA) 19-9 levels (n=11). Imaging confirmation included unequivocal tumor progression and/or new tumor foci on follow-up CDI or PI scans (n=2). The combination of stable or decreased tumor burden on follow-up CDI, decreased FDG uptake on PI, and decreasing CA 19-9 was used to confirm lack of disease progression and favorable response to therapy (n=9, range 16 to 118 weeks, mean 35.9). Invasive testing would not have been clinically appropriate in these nine patients.

The fraction of PI leading to a favorable clinical impact, compared to all discordant PI-CDI pairs, was computed with 95% exact confidence intervals. The difference between the observed fraction and 0.5 (0.5 being the fraction indicating an equal number of favorable and unfavorable changes in management) was tested using an exact binomial test. Discordant findings were further analyzed based on indication. The ratio of PI with a favorable impact to PI with unfavorable or no influence on management for a