



Contents lists available at ScienceDirect

International Journal of Surgery Case Reports

journal homepage: www.casereports.com

Limitations in the use of 18F-FDG PET in the pre-operative staging of gastric cancer: A case series

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ARTICLE INFO

Article history:

Received 26 April 2017

Accepted 20 May 2017

Available online 26 May 2017

Keywords:

18F-FDG-PET

Gastric cancer

Initial staging

Case series

ABSTRACT

INTRODUCTION: Positron emission tomography (PET) is a mainstay in the preoperative evaluation of various cancers. In gastric cancer however, its role in the initial staging remains contentious. Presented is a case series of three gastric patients wherein the use of fluorodeoxyglucose (18F-FDG) PET/CT (computer tomography) as part of the initial staging was inconsequential to treatment, demonstrating its limited role in the staging of primary gastric cancer.

METHODS: We analyzed retrospective data from 12/1/2010 to 10/31/2016 of patient with gastric cancer whose initial staging included a PET/CT. Only patients 18 years and older with gastric and gastro-oesophageal junction cancers were included. The data was derived from a single institution. Management of patients involved both an academic institution and a community practice.

RESULTS: Of the three cases reported, an FDG-avid mass with minimal FDG uptake was reported in a single case and no FDG-avid lesion was reported in the other two. Neither of the patients underwent an endoscopic ultrasound for lack of availability.

CONCLUSION: While various imaging studies such as endoscopic ultrasound have an established role in the initial staging, the role of FDG-PET is yet to be established and its routine use remains contentious. Based on our clinical experience and review of the literature, we believe FDG-PET/CT imaging is of limited clinical and cost effective value in the initial staging workup of gastric cancer.

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1. Introduction

The role of fluorodeoxyglucose (FDG)-PET in the evaluation of various cancers has been established. For malignant gastric tumors, FDG-PET is particularly useful in detecting recurrence post surgical resection [1]. FDG is also extensively used in the preoperative evaluation of gastric tumors although the clinical and cost effective benefit are contentious and yet to be established. Unfortunately, we have experienced the indiscriminate use of FDG-PET in the pre-operative evaluation of gastric tumors by oncologists. We report three cases of primary gastric cancer that presented to our surgical oncology clinic in which the use of FDG-PET in the preoperative workup by an outside facility was inconsequential to the treatment plan. The cases demonstrate the very limited role of FDG-PET in the initial staging workup of primary gastric cancer.

2. Methods

We analyzed retrospective data from 12/1/2010 to 10/31/2016 of patient with gastric cancer whose initial staging included a PET/CT. The data did not include individual identifiers and met requirements of an exempt research. Only patients 18 years and older with gastric and gastro-oesophageal junction cancers were included. The data was derived from a single institution. Management of the patients included both an academic institution and a community practice.

3. Results

An FDG-avid lesion with minimal FDG uptake was reported in only one of the three cases. Endoscopic ultrasound was not performed in either patient for lack of availability. Detailed presentation of the cases is as follows:

Case 1: Patient is a 66-year old Hispanic female who presented with epigastric discomfort, nausea, and melena. EGD showed a linear ulcer in antrum and a deformed pylorus. Biopsy was consistent with adenocarcinoma. CT of abdomen and pelvis showed thickening of distal stomach without evidence of metastasis or lymph node involvement. PET showed an FDG-avid mass in the antrum with a 5.2 SUV but without evidence of metastasis (Fig. 1). Pathology

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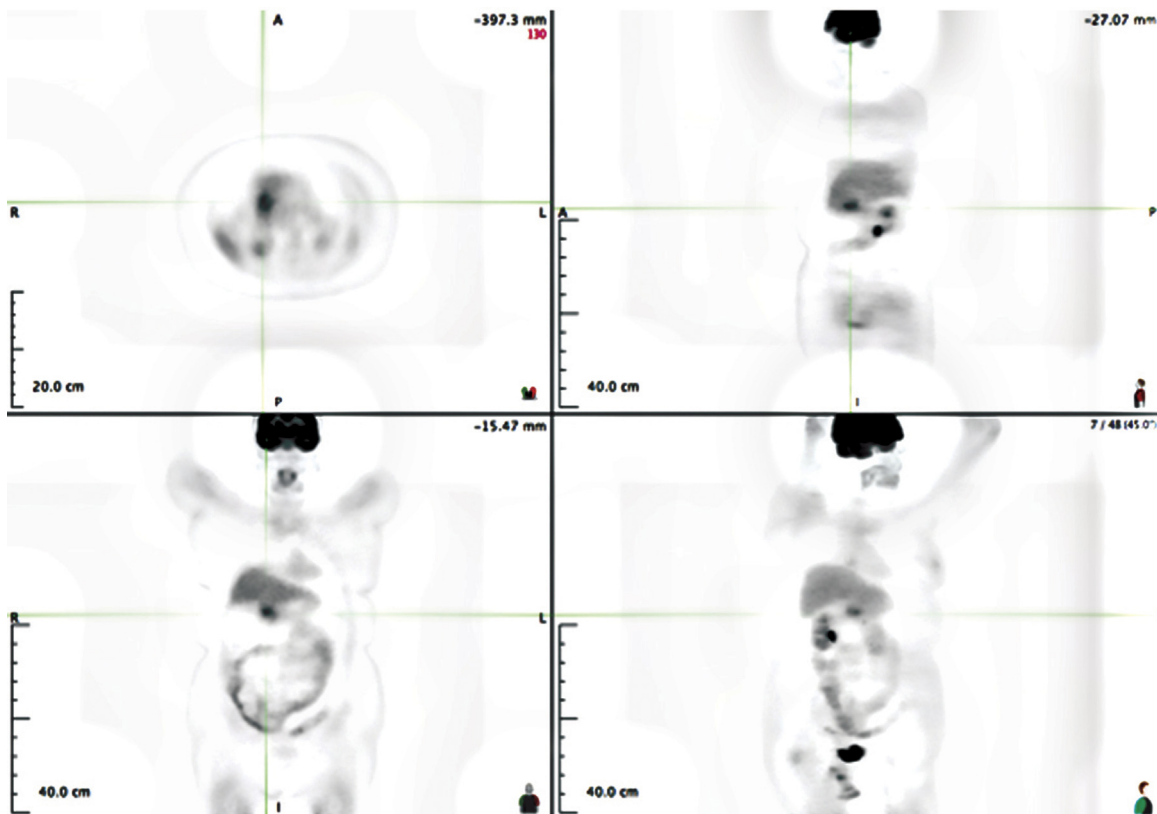


Fig. 1. PET scan showing minimal uptake at distal stomach.

reported a G3, diffuse, poorly differentiated gastric carcinoma pT3, N3a, M0 consistent with stage III B. A 4.0*3.5*1.1 cm tumor invading the muscularis propria was observed with metastasis involving 7/14 greater curvature and 1/1 lesser curvature nodes. Immediate recovery post subtotal gastrectomy with negative margin resection was uncomplicated.

Case 2: A 55 year-old African-American male with longstanding history of smoking and multiple strokes that presented with nausea and hematemesis. EGD showed a large ulcer along the lesser curvature with biopsy consistent with infiltrating undifferentiated adenocarcinoma. CT scan of abdomen and pelvis showed thickened gastric and duodenal mucosa. PET/CT showed homogenous hypermetabolism throughout the stomach without any intense focus with the uptake being within the normal physiological tracer accumulation. Intraoperatively, two different tumors were seen extending into gastric serosa one measuring 3.3 cm and another 1.7 cm in greatest dimension as noted in Fig. 2. Examination of the tumors showed G3 poorly differentiated gastric adenocarcinoma pT4a, pN2, M0 consistent with stage III B. Metastasis was noted in 5/38 perigastric nodes. Immediate recovery post subtotal gastrectomy with negative margin resection was uncomplicated.

Case 3: A 51 year-old Caucasian male whose preoperative workup included an EGD showing signet ring cells and no FDG avid lesion on PET/CT. Gross pathology showed a single 3.4 cm grade 3-adenocarcinoma lesion at the gastric body and antrum with a pathological stage of IIB. No lymph node metastases were noted (Table 1). Patient underwent surgery out of area and the details are missing.

4. Discussion

Surgical resection is the optimal treatment modality for gastric cancer provided there is no systemic involvement [2].

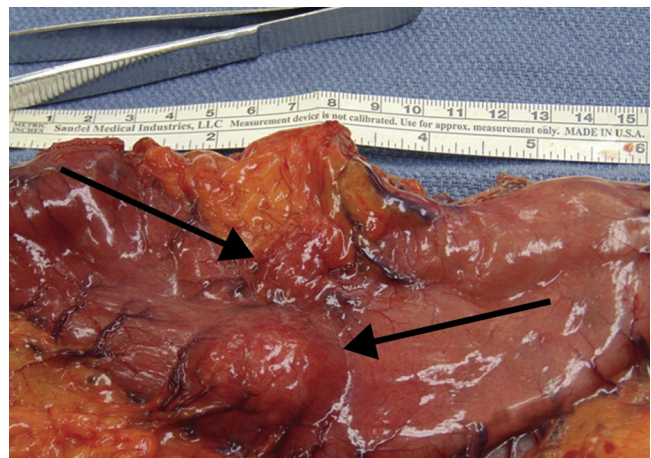


Fig. 2. Intra-operative picture of a 3.3 cm and a 1.7 cm mass.

Chemotherapy is also an integral part of treatment with one study suggesting improved rates of R0 resection with neoadjuvant chemotherapy (NAC) albeit with no significant improved outcome for late-stage disease and potential detriments for early-stage disease [11]. Preoperative workup and staging is necessary to guide treatment choices. CT scan is the conventional imaging modality of primary gastric cancer but has limited capacity to identify peritoneal dissemination and its accuracy depends on lymph node size [2,3]. Given the limitations of CT scans, PET is increasingly being considered in the evaluation of various tumors including those involving the stomach. FDG-PET detects altered glucose uptake by malignant tumors that exhibit an increased expression of the GLUT-1 glucose transporter [1].

Table 1
Showing Imaging and Histologic findings.

Parameters	Case # 1	Case # 2	Case # 3
Age	66	55	51
Gender	Female	Male	Male
Race	Hispanic	African American	Caucasian
Histology and Tissue Diagnosis	Adenocarcinoma with signet ring cells	Adenocarcinoma without signet ring cells	Adenocarcinoma with signet ring cells
PET findings	FDG-avid mass in gastric antrum, SUV 5.2	Homogenous hypermetabolism throughout stomach, no focus of intense activity	No evidence of FDG-avid lesion
Pathological Stage	pT3, N3a, M0	pT4, pN2, M0	II B
Tumor Size, Number and Location	Single 4.0*3.5*1.1 cm lesion in body and antrum	Two tumors in antrum; 3.3 cm and 1.7 cm	Single 3.4 cm in body and antrum
Lymph Node Involvement	7/14 greater curvature nodes and 1/1 lesser curvature nodes	5/38 perigastric nodes	None

The utility of FDG-PET in the staging of primary gastric cancer is influenced by factors including tumor size, histological subtype, tumor location and physiological FDG uptake by normal gastric wall [10].

Tumor size contributes significantly to FDG-PET detection of primary tumors. A study demonstrated a sensitivity of 76.7% for tumor sized 30 mm or more opposed to 16.8% for tumors less than 30 mm [7]. Recent evidence also suggests that tumor size is the main determinant of the standardized uptake value, SUV [9]. Late stage tumors are often larger with deeper invasion making advanced gastric cancers (AGC) to have higher yield with FDG-PET compared to early gastric cancers (EGC) with sensitivities ranging from 26% to 63% for EGC and 93% to 98% for AGC [6]. In fact, Youn et al. [12] retrospectively analyzed 396 cases on the use of PET-CT for preoperative staging of gastric tumors and found sensitivities of 20.7% and 74.2% for EGC and AGC respectively and concluded that PET-CT has a limited role in the preoperative tumor and nodal staging of gastric cancer.

FDG-PET has varying sensitivities for the detection of gastric tumors owing to tumor biology. Various studies have reported higher detection rates in intestinal-type gastric adenocarcinoma and tubular adenocarcinoma compared to diffuse type mucinous adenocarcinoma and signet-ring cell carcinoma [1,4,5] with differences mostly attributed to infiltrative growth pattern, high mucus content and low concentration of cancer cells. In fact, the study by Stahl demonstrated 83% detection rate of intestinal carcinoma opposed to 41% detection rate of non-intestinal types. Expression of hypoxia-related genes including hypoxia-inducible factor 1 (HIF-1) has been shown to contribute to FDG uptake in gastric cancers [9].

Anatomically, the prevalence of intestinal tumors at the proximal regions of the stomach and gastro-esophageal junction render FDG-PET more sensitive for these anatomic tumors than for distal gastric tumors [8]. Uptake of FDG by normal gastric wall can display SUV greater than 2.5, obscuring the background for comparison [1]. This uptake also varies from one anatomic region of the stomach to another. Average FDG uptake decreases oro-anally, suggesting that a stronger FDG uptake at the anal end most likely represents a diseased state [7].

The most striking observation in the cases is the discordance between the size of the tumors and the negative result of the FDG-PET. The cases exhibited tumors that exceeded the threshold size for FDG-PET detectability. Also the findings in the patients further consolidate the low yield of FDG-PET in the initial staging workup of gastric cancers. As such, biopsy finding of poorly differentiated and infiltrating undifferentiated adenocarcinomas might sufficiently preclude PET imaging. The small size of our series precludes the creation of a logarithm to establish the role of PET/CT in the initial staging of gastric cancer. Therefore, a larger series is needed to establish such role.

5. Conclusion

The yield of FDG-PET in the staging workup of gastric cancer is influenced by factors including tumor size, histology, and tumor location. Even tumors that bear features consistent with increased yield can however be undetected on FDG-PET as shown in the cases above. Based on our clinical experience and review of the literature, we believe FDG-PET/CT imaging is of limited clinical and cost effective value in the initial staging workup of gastric cancer. A larger series might help in establishing the role of PET/CT in the initial staging of gastric cancer.

This project is compliant with the PROCESS guidelines [13] and neither did we receive any funding nor do we have any conflict of interest to report.

Conflicts of interest

None.

Sources of funding

None.

Ethical approval

Texas Tech University Health Sciences Center, IRB# A16-3979, Reference # 070516.

Consent

Consent was obtained from the patients.

Author contribution

Dr. Ernest Fonocho–Wrote manuscript. Involved in analysis of patient and literature.

Dr. Subhasis Misra–Involved in treatment of patient. Conceived the project.

Dr. Nail Aydin–Involved in analysis of patient and literature, and also assisted with manuscript preparation and its approval.

Guarantor

Nail Aydin, MD, FACS.

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