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DIAGNOSTIC PERFORMANCE OF ^{18}F-FDG PET/CT FOR PRIMARY TUMOR DETECTION IN ESOPHAGEAL CARCINOMA

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ABSTRACT

Background: Detection of primary esophageal lesion is considered an essential step in initial disease assessment since treatment decisions depend on accurate staging. Although contrast-enhanced CT and endoscopic ultrasound continued to be the established imaging methods, ^{18}F-FDG PET/CT provides additional metabolic information that facilitates tumor detection. This study evaluates the efficacy of ^{18}F-FDG PET/CT for primary lesion identification in patients with esophageal carcinoma. **Methods:** Images of 100 patients with histologically proven esophageal cancer who underwent staging ^{18}F-FDG PET/CT between 2019 and 2024 were reviewed retrospectively. PET findings were correlated with endoscopic and pathological results. Tumor detection rates were analyzed according to histologic subtype and tumor stage. **Results:** ^{18}F-FDG PET/CT demonstrated the primary lesion in 91 patients. Detection rates were higher in squamous cell carcinoma than in adenocarcinoma (94.8% vs 85.7%; p = 0.03). Sensitivity was high in advanced disease but decreased in T1 tumors. Most missed lesions were superficial tumors or low-volume adenocarcinomas. Metabolic tumor size exceeded CT-defined tumor length in 37% of patients. **Conclusion:** ^{18}F-FDG PET/CT is considered a reliable non-invasive diagnostic tool for evaluating the primary tumor in patients with esophageal carcinoma. Its major contribution is in locally advanced disease, where metabolic information may complement conventional imaging and assist in planning therapy management.

KEYWORDS: ^{18}F-FDG PET/CT; Esophageal cancer; Primary tumor detection; Initial staging; Diagnostic accuracy; SUVmax.

INTRODUCTION

Despite improvements in diagnosis and treatment, esophageal carcinoma continues to be associated with considerable morbidity and mortality. Since prognosis is closely linked to disease stage, accurate assessment at presentation is essential for selecting the most appropriate therapeutic approach.[1,7]

Contrast-enhanced CT and endoscopic ultrasound are commonly used during staging. Nevertheless, CT may not always distinguish malignant infiltration from benign mural abnormalities, while endoscopic ultrasound can be technically difficult in patients with severe luminal narrowing.[1,3,8]

FDG PET/CT offers the advantage of evaluating metabolic activity together with anatomical information. Since esophageal tumors exhibit increased FDG avidity, PET imaging can identify lesions that may be less apparent on conventional imaging.[2,5]

While PET/CT has been widely studied in the clinical setting of metastatic staging, its role in the identification of the primary tumor remains relevant to the patient, especially in terms of tumor histology and stage. The purpose of this study is to review our institutional experience and evaluate the diagnostic performance of ^{18}F-FDG PET/CT in identifying the primary lesion in patients with the initial stage of esophageal carcinoma.

MATERIALS AND METHODS

Study Population

One hundred patients with histologically confirmed esophageal carcinoma who underwent whole-body ^{18}F-FDG PET/CT between 2019 and 2024 were retrospectively reviewed after institutional review board approval was obtained.

Patients with prior treatment, incomplete imaging data or absent histopathologic confirmation were excluded.

Imaging protocol

All patients fasted for at least 6 hours before imaging, and had blood glucose levels below 170 mg/dL.

^{18}F-FDG was administered intravenously (2.5 MBq/kg), and imaging was acquired 60 minutes after injection.

PET/CT scan was performed, from top of skull to mid-thigh, using PET/CT

scanner (Discovery PET/CT 710mCT 64, GE Medical Systems).

Transmission data were acquired using spiral CT with acquisition parameters of 130 kV, 40 mAs, 0.8 sec. per CT rotation, 5 mm slice thickness and pitch index of 1.5).

Consecutively, PET emission data was acquired in 3D-mode with a 200×200 matrix with 2 min emission time per bed position.

Image Interpretation

Board-certified nuclear medicine physicians reviewed the images.

Any focal or segmental esophageal ^{18}F-FDG uptake exceeded background activity was deemed suspicious for malignancy. SUV_{max} was obtained by placing regions of interest (ROIs) on axial images.

Metabolic tumor length was compared to CT-defined length.

Reference Standard

Endoscopy and histopathology served as the reference standard.

Tumors were classified according to: Histology, location and T stage.

Statistical Analysis

Sensitivity and detection rates were calculated.

Differences between subgroups were assessed using chi-square test.

A p value <0.05 was considered statistically significant.

RESULTS

Patient Characteristics

The cohort included 72 males and 28 females with mean age of 63 ± 10 years.

Histology: Squamous cell carcinoma 58 patients, Adenocarcinoma 42 patients.

Tumor location: Upper esophagus: 18%, mid esophagus: 39% and distal esophagus: 43%.

Primary Tumor Detection:

^{18}F-FDG PET/CT detected the primary lesion in 91 patients with overall sensitivity: 91%.

Mean SUVmax: 9.8 ± 4.1

Subgroup Analysis

Table 1: Primary Tumor Detection Rates.

Subgroup	Detection
Squamous cell carcinoma	55/58 (94.8%)
Adenocarcinoma	36/42 (85.7%)
T1	8/13 (61.5%)
T2	17/18 (94.4%)
T3–T4	66/69 (95.7%)

Difference by histology significant (p = 0.03)

Tumor Length Assessment

Metabolic length exceeded CT in 37 patients (37%)

Mean increase: 1.3 ± 0.6 cm

False Findings

False negatives: 9 cases, 5 superficial T1 lesions, 3 low-volume adenocarcinomas and 1 mucinous lesion.

False positives: 2 cases related to inflammatory esophagitis.

DISCUSSION

In this study, ^{18}F-FDG PET/CT was capable of primary tumor detection in most patients with esophageal carcinoma. The calculated sensitivity is comparable to previously published studies evaluating PET imaging in esophageal malignancies.[1.4]

Squamous cell carcinoma detection rate was more frequent than in adenocarcinoma, where comparable remarks have been reported by other publishers; this may be due to differences in glucose metabolism between these histologic subtypes.[2,4,5] Squamous tumors usually exhibit more FDG avidity, which can correlate with the higher detection rates observed in our study.

Most false-negative results occurred in patients with early-stage disease. Small superficial tumors and lesions confined to the mucosa since it has limited FDG uptake, making detection difficult due to low metabolic activity and partial-volume effects.[1,3,4] Hence, endoscopic evaluation in early disease should not be replaced by ^{18}F-FDG PET/CT.

An added note in this study was the discrepancy between metabolic and anatomic tumor length. In more than one-third of patients, PET-based tumor extent exceeded measurements obtained by CT. This observation may have implications for radiation treatment planning and target volume delineation.[3,5,6,10]

False-positive findings were documented in cases with increased FDG uptake due to an inflammatory process. Therefore, correlation with endoscopic findings and clinical information is still necessary to avoid misinterpretation in patients with esophagitis or post-biopsy changes.[2,4]

Generally, our findings support the complementary role of FDG PET/CT in the baseline assessment of esophageal carcinoma and agree with previous studies demonstrating its value in staging and treatment planning.[1,3,6,10]

This study has several limitations, considering the retrospective design, moderate sample size, and volumetric PET parameters (MTV, TLG) were not analyzed Future prospective studies incorporating quantitative PET biomarkers may improve risk stratification.

CONCLUSION

18F-FDG PET/CT demonstrates high diagnostic accuracy for the detection of the primary tumor in esophageal carcinoma, particularly in locally advanced disease. It provides valuable metabolic information complementary to conventional imaging, supports more accurate staging, and may aid treatment planning.

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