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FULL PAPER

¹⁸FDG-PET/CT is useful in the follow-up of surgically treated patients with oesophageal adenocarcinoma

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Objective: The purpose of this study was to evaluate fludeoxyglucose-positron emission tomography/CT's (FDG-PET/CT) performance in the follow up of patients with surgically treated oesophageal adenocarcinoma.

Methods: The follow-up FDG-PET/CT scans of 162 consecutive patients with surgically treated oesophageal adenocarcinoma were retrospectively reviewed. Histopathological and/or imaging examinations confirmed recurrent disease. The accuracy, sensitivity, specificity and negative and positive predictive values were calculated.

Results: Recurrence occurred in 71 (43%) patients, usually within the first year following surgery (60%) and in more than one site (76%). The sensitivity, specificity, positive-predictive value, negative-predictive value and accuracy of FDG-PET/CT for anastomotic recurrence were 77, 76, 16, 98 and 76%; for regional nodal recurrence

were 88, 85, 43, 97 and 86%; and for distant metastatic recurrence were: 97, 96, 91, 99 and 96%. In 5 of the 42 patients (12%) with distant metastases, the metastatic sites were outside the area covered by a conventional follow-up chest-abdomen CT and in 4 patients (9%) metastases were barely perceptible on the CT component of the FDG-PET/CT and consequently were unlikely to be detected without the aid of the FDG uptake.

Conclusion: FDG PET/CT is accurate in detecting oesophageal adenocarcinoma recurrence, especially within the first post-operative year when most recurrences occur, and is useful in identifying patients with a solitary metastasis.

Advances in knowledge: FDG-PET/CT should be considered as a valuable tool in the routine follow up of surgically treated oesophageal cancer patients within the first 2 years after surgery.

INTRODUCTION

Oesophageal carcinoma is an aggressive malignancy and one of the most deadly cancers worldwide. In 2015, 15,590 patients died from oesophageal cancer in the USA and 16,980 adults were newly diagnosed with it.¹ Surgical resection remains the main potential curative treatment for these patients. The benefit of surgery is even greater nowadays as in the last few years surgical techniques have been refined, patients are more rigorously selected for surgery and post-operative management has improved, leading to a decrease in post-operative mortality.² However, the 5-year survival rate for surgically treated patients remains relatively poor, around 20–30%.³ This low survival rate is attributed to the high incidence of recurrence after treatment. Post-operative tumour recurrence is categorized as local (anastomotic recurrence), regional (regional lymph nodes) and distant. More than

50% of such patients recur within the first 2 years after surgery^{4–6} and about a half recur as distant metastases.⁷

There is a renewed interest in early diagnosis of recurrent disease after oesophagectomy, in particular for those patients with a single metastasis. One may offer such patients local treatment with surgery or radiation, with or without chemotherapy, for a potential improvement in survival.⁸ It is of paramount importance to diagnose recurrent disease and quantitate it as early as possible to optimize patient treatment. Currently, many institutions routinely perform post-surgery surveillance on oesophageal cancer patients, whether symptomatic or asymptomatic, using conventional imaging such as thoracoabdominal CT, endoscopy and endoscopic ultrasound (EUS). Endoscopy and EUS are useful for the evaluation of the anastomosis and regional lymph nodes.^{9–11} CT can detect regional and distant metastases, but is suboptimal

for the identification of occult metastases, which in patients with oesophageal cancer may occur in unusual sites difficult to identify by CT.¹²

During the last decade, ¹⁸F-fludeoxyglucose (FDG), positron emission tomography (PET), CT scans have been extensively used in patients with oesophageal carcinoma for initial staging, follow up and evaluation of response after chemoradiation treatment.^{12–14} There were earlier studies evaluating the role of ¹⁸F-FDG PET in recurrent oesophageal carcinoma.^{6,15,16} Later, the role of ¹⁸F-FDG PET/CT was evaluated in patients with squamous cell carcinoma¹⁷ or mixed histologic types of oesophageal carcinoma.¹⁸ To the best of our knowledge, no studies have been published regarding the utility of ¹⁸F-FDG PET/CT in detecting tumour recurrence in a large population of patients with surgically treated adenocarcinoma whether symptomatic or not. In this study, our goal was to analyse the performance of ¹⁸F-FDG PET/CT in detecting recurrence in patients with oesophageal adenocarcinoma after surgical resection.

METHODS AND MATERIALS

Patients

After approval of this study by our institutional review board who waived the requirement for an informed consent, we retrospectively reviewed the medical records of patients with oesophageal carcinoma treated at our institution between March 2003 and July 2013. Eligibility criteria for this study included adenocarcinoma histology, previous treatment with surgery (transthoracic oesophagectomy with traditional two-field lymphadenectomy) with or without pre-operative chemoradiation, ¹⁸F-FDG PET/CT performed at our institution after surgery and histological confirmation and/or continued progression by imaging of focal areas of FDG uptake suspicious for recurrence. Patients received routine post-operative surveillance imaging at regular intervals (typically every 3–6 months for the first 2 years after surgery). Variation in the interval of imaging was inherent given differing providers and individual patient requirements.

FDG-PET/CT technique

¹⁸F-FDG PET/CT studies were performed at our institution from September 2003 to November 2013 using one of four scanners (DST, 2 DRX, or DSTE- GE Healthcare, Milwaukee, WI). All patients had fasted 6 h before the FDG injection. A fasting blood glucose level of less than 200 mg dl⁻¹ was a standard requirement for imaging all patients. PET data acquisition was performed in two-dimensional mode before January 2008 and was changed to three-dimensional mode after that date. For two-dimensional imaging, an intravenous injection of 555–629 MBq (15–17 mCi) of FDG was administered in the arm or central venous catheter on the side opposite to the cancer location, and emission scans were acquired at 3 min per field of view 70 ± 10 min after the FDG injection. The same procedure was used for three-dimensional imaging except that the injected dose of FDG was 333–407 MBq (9–15 mCi). The acquired PET data were corrected for scatter coincidences, random coincidences, dead time and attenuation and reconstructed using ordered subset expectation maximization (OSEM) on standard vendor-provided workstations. Non-contrast-enhanced CT images, from

the base of the skull to the midhigh, were acquired in helical mode (speed, 13.5 mm per rotation) during shallow breathing at a 3.75 mm slice thickness, tube voltage of 120 kVp, tube current–time product of 150 mAs and 0.5 s rotation. Daily quality control procedures were performed on all PET scanners to ensure cross-calibration between systems and normalize differences in system performance.

Imaging analysis

PET/CT studies were reviewed by two experienced physicians in FDG-PET/CT interpretation. Images were analysed visually and semi-quantitatively using maximum standardized uptake values (SUV_{max}). FDG uptake was defined to be qualitatively positive when a focal FDG uptake was higher than the normal background. SUV_{max} were obtained using standard GE software. Regions of interest (ROI) were selected on the trans-axial images corresponding to foci of FDG uptake on the PET scan and abnormal findings on the corresponding CT scan.

Suspicious lesions with increased FDG uptake were categorized into three groups: local disease (at the anastomosis), regional lymph nodes and distant metastases (organ metastases and lymph nodes below the celiac axis and non-paesoophageal lymph nodes in the neck). The number and sites of FDG uptake were analysed as well as their corresponding SUV_{max} values. Confirmation of recurrent disease was established by histopathological examination of biopsied FDG avid regions suspicious for recurrence, and if biopsy was not feasible, all follow-up imaging studies were evaluated for confirmation of progression of disease. When multiple suspicious sites of metastases were suspected, the three largest metastases were measured (long axis for organ metastases and short axis for lymph nodes) with their corresponding SUV_{max} values. For patients with non-FDG avid lesions suspicious for recurrent disease, seen on the CT component of their PET/CT, confirmation of recurrent disease was established by histopathological examination, and if biopsy was not performed, by follow up of all imaging studies, confirming progression of disease. These patients were considered as false-negative FDG results (Table 1).

Statistical analysis

The sensitivity, specificity, accuracy, positive-predictive value (PPV) and negative-predictive value (NPV) of FDG-PET/CT for the detection of local recurrence, locoregional lymph nodes and distant metastases were calculated using standard statistical operations. Categorical data are expressed as numbers and

Table 1. FDG-PET/CT results used for calculation of performance of FDG-PET/CT

Number of patients	TP	FP	TN	FN
Local	7	36	119	2
Regional	23	18	118	3
Distant	41	4	116	1

FDG-PET/CT, fludeoxyglucose-positron emission tomography; FN, false-negative; FP, false-positive; TN, true-negative; TP, true-positive.

Table 2. Patients characteristics (all patients $N = 162$)

Characteristics	Number (%)
Gender	
Males	147 (91)
Females	5 (9)
Age (y)	
Mean	60.4
Median	66.4
Treatment	
Surgery alone	38 (23)
Neoadjuvant therapy	124 (77)
Recurrent disease	
Surgery alone	9 (13)
Neoadjuvant therapy	62 (87)
Time to recurrence (days)	
Mean	419
Median	302

percentages. Continuous data were expressed as means and medians. All analyses were performed using SPSS (v. on 23, IBM) and TIBCO Spotfire S + statistical software. $p < 0.05$ was considered significant.

RESULTS

Patient characteristics

There were 162 patients who met the inclusion criteria and formed our study group. Of these, 124 patients (77%) received neoadjuvant chemoradiation because they presented with locally advanced disease at the time of diagnosis, whereas 38 (23%) patients underwent oesophagectomy alone. Patients' mean age was 60.4 years (range 38–83). The majority of patients were males (91%) (Table 2). 71 patients (43%) were confirmed to have recurrent disease. Of these, 87% patients received neoadjuvant chemoradiation. The mean time to recurrence was 419 days, with a median of 302 days (range 55–2754). A total of 22 patients (31%) recurred during the first 6 months after surgery, 43 patients (60%) recurred within the first year and 62 patients (87%) within the first 2 years after surgery (Table 3).

Recurrence was confirmed by histological/cytological examination in 52 patients and imaging follow-up studies in 19 patients. In patients with recurrent disease ($n = 71$), there were 139 sites of recurrence. 54 patients (76%) had more than one site of disease.

Table 3. Recurrence: time of presentation

Recurrence # (%)	Time (months)
43 (60)	0–12
19 (27)	13–24
9 (13)	>24
Total # 71	

Table 4. Sites of recurrence

Site	Number
Anastomosis	9
Regional nodes	45
Distant organs	85
Liver	50
Bone	14
Lung	8
Muscle	4
Nonregional nodes	4
Peritoneum	3
Adrenal gland	1
Brain	1
Total	139

In 17 patients (24%) there was only one site of recurrence: seven patients with recurrence at the anastomosis, six patients with locoregional lymph node involvement and four patients with a solitary metastasis to a distant organ.

For patients with more than one site of disease ($n = 54$), the anastomosis was involved in 2 patients (4%), regional lymph nodes in 20 patients (37%) and distant organs in 42 patients (78%). Recurrent disease was mainly located in distant organs, ($n = 85$ sites), followed by regional nodal disease ($n = 45$ sites) and anastomosis ($n = 9$ sites). Liver, bone and lung were the most common sites of distant metastases (Table 4).

Imaging follow up

The number of FDG-PET/CT scans per patient following surgery was an average of 4.7 (range 1–29). The average interval from surgery to initial follow-up FDG-PET/CT scan was 263 days (range 38–2037). The interval between CT based imaging studies (dedicated CT scans or PET/CT scans) during the post-surgical follow-up period was an average of 170 days, (range 30–450), and specifically for PET/CT the interval between studies during the follow-up period was an average of 210 days.

^{18}F -FDG PET/CT Results

Increased focal FDG uptake at the anastomosis was found in 50 PET/CT studies in 43 patients. Recurrence was confirmed in 7 patients (true-positive) via endoscopy/endoscopic ultrasound-fine needle aspiration (US-FNA), and excluded in 36 patients (false-positive) by endoscopy/endoscopy US-FNA. In two patients without increased metabolic activity at the anastomosis, recurrent disease was diagnosed by endoscopy/endoscopic US-FNA biopsy (Table 1). The sensitivity, specificity, PPV, NPV and accuracy of ^{18}F -FDG PET/CT for the evaluation of the anastomosis were 77, 76, 16, 98 and 76%, respectively (Table 5). Mean SUV_{max} in patients with suspected recurrence was 5.4. In patients with true recurrence, mean SUV_{max} value was slightly higher than in false positive patients. SUV_{max} 6.1 [95% CI (3.4–8.7)] vs 5.4 [95% CI 3.9–6.9]; $p = 0.3$. Of the 9 patients with

Table 5. Performance of FDG-PET/CT for detection of recurrence by site

PET/CT	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Local ^a	77	76	16	98	76
Regional	88	86	45	97	87
Distant	97	96	91	99	96

FDG-PET/CT, fludeoxyglucose-positron emission tomography; NPV, negative-predictive value; PET, positron emission tomography; PPV, negative-predictive value.

^aLocal, at anastomotic site; regional, at regional lymph nodes; distant, at distant sites.

recurrence at the anastomosis, for the majority, 78% ($n = 7$) it was the only site of recurrence (Figure 1).

In the evaluation of regional lymph node metastases, we found 67 suspicious FDG avid lymph nodes in 44 patients. 22 lymph nodes were confirmed to be false-positive secondary to infection and inflammation proven by FNA and/percutaneous biopsy, and 3 were concluded to be benign after resolution of abnormal FDG uptake on subsequent follow-up studies. Three regional metastatic lymph nodes (in three separate patients) were not FDG-avid (Figure 2). However, continued increase in size on axial imaging, either the CT component of the FDG-PET/CT scan or the dedicated CT examination (mean short axis diameter at time of biopsy was 1.2 cm) prompted a biopsy which confirmed metastatic disease. So that finally, there were 26 patients with confirmed regional recurrence involving 45 nodes. Of these 26 patients with locoregional recurrence, 6 (23%) occurred in the supraclavicular region, which led to a tailored biopsy approach to 5 of them. The sixth patient's regional metastatic status was confirmed by a gradual increase of FDG uptake and size of the suspected metastatic lymph node with the subsequent development of mediastinal lymphadenopathy (Table 1). Overall, the sensitivity, specificity, PPV, NPV and accuracy of ¹⁸F-FDG PET/

CT for regional lymph node recurrence was 88, 86, 45, 97 and 87% (Table 5).

The mean SUV_{max} in patients with suspicious FDG-avid lymph nodes was 5.4 (range 3.0–19.4). However, for patients with true recurrence the mean SUV_{max} was 8.4 (range 3.5–19.4) while for those who were false-positive, the mean SUV_{max} was 4.1 (range 3.0–6.4). Patients with true recurrence had a significantly higher mean SUV_{max} (mean SUV: 8.4 [95% CI (6.4–10.4)] vs 4.1 [95% CI (3.7–4.5)]; $p = 0.000$). The mean size (short axis dimension) of the suspicious FDG avid lymph nodes was 1.0 cm. For patients with true recurrence, the mean diameter was 1.4 cm (range: 0.9–4.2 cm) [95% CI (1.0–1.8)] while for those who were false positive, the mean diameter was 1.0 cm (range: 0.7–2.0 cm). [95% CI (0.9–1.1)]; $p = 0.1$.

Focal areas of FDG uptake suspicious for distant metastases were identified in 46 patients ($n = 89$ sites). Four patients showed false-positive results secondary to infection confirmed by biopsy. In only one patient, a patient with peritoneal implants, metastatic distant disease was not identified. The FDG uptake from these small volume metastatic implants was lower than the abdominal background activity and it was consequently missed. Whereas the peritoneal nodularity and increased omental density were subtle, these were better demonstrated on a dedicated abdominal CT with oral and intravenous contrast performed 1 week later owing to abdominal pain (Figure 3). Thus, of our study population, there were 42 patients with confirmed distant metastases at 85 sites. With regards to the location of distant metastases,

Figure 1. Recurrence at the anastomosis in a 65-year-old male, who underwent fludeoxyglucose-positron emission tomography/CT (FDG-PET/CT) examination 9 months after oesophagectomy as part of a routine follow up. (a) Whole body maximum intensity projection PET image show focal FDG uptake in the mediastinum (arrow). (b) Axial fused FDG-PET/CT image demonstrates focal FDG uptake at the anastomosis (arrow). Endoscopy and biopsy were performed to rule out recurrent disease. Biopsy demonstrated local recurrence of malignancy. This was the only site for recurrence in this patient who was treated with chemoradiation. *Surgical staples.

Figure 2. False-negative fludeoxyglucose-positron emission tomography/CT (FDG-PET/CT) examination in a 55-year-old male, 7 months after oesophagectomy with regional lymph node recurrence. (a) Axial CT shows an enlarged 12 mm lymph node adjacent to the oesophageal remnant (arrow). (b) Axial-fused FDG-PET/CT demonstrates lack of increased FDG uptake. Given the size of this lymph node evaluated on the axial component of FDG-PET/CT, FNA was performed and confirmed metastatic disease.

Figure 3. False-negative fludeoxyglucose-positron emission tomography/CT (FDG-PET/CT) examination in a 77-year-old male 8 months after oesophagectomy. (a) Whole body PET maximum intensity projection shows no evidence of suspicious focal areas of increased FDG uptake. (b) Axial CT component of the FDG-PET/CT scan shows subtle nodularity of the mesenteric fat (arrow and *) that was not identified initially, because the FDG uptake from these small volume metastatic implants was lower than the abdominal background activity. (c) Axial CT of the abdomen performed owing to abdominal pain 1 week later, demonstrates increased density and nodularity of the omental fat consistent with peritoneal implants.

five of the recurrence sites occurred outside of the area covered by a conventional chest and abdomen CT (three in the femur and pubis, one in the masticatory muscle and one in the brain), representing 12% of patients with distant metastases. In four of these five patients, these were the only sites of metastatic disease and were asymptomatic (Figure 4). 4 metastases of 85 sites of distant metastases (9% of patients with distant metastases) were difficult to discern without the aid of the FDG uptake, and the 4 of them were solitary metastases, (Figure 5).

For the detection of distant metastases, the sensitivity, specificity, PPV, NPV and accuracy of ^{18}F -FDG PET/CT was 97, 96, 91, 99 and 96% (Table 1). The most common sites of distant metastases were the liver, bone and lung. Mean SUV_{max} for patients with suspected metastases was 8.4. Patients with true recurrence had a higher mean SUV_{max} : 8.5 [95% CI (6.9–10.0)]; compared with patients with false-positive results SUV_{max} 5.5. [95% CI (3.6–7.4)]; ($p = 0.1$).

DISCUSSION

Currently, oesophagectomy remains the best curative option for patients with oesophageal carcinoma. It is indicated as long as there are no distant metastases and when locally, the disease meets criteria for resectability (*i.e.* T_1 – T_2 /N0, T_3 –4a N0, T_1 –4a N1M0).¹⁹ Advances in surgical and anaesthetic techniques, together with improvements in peri-operative management, have led to a decrease in peri-operative mortality. Despite

Figure 4. Solitary bone metastasis in a 62-year-old male, 11 months after oesophagectomy. (a) Whole body positron emission tomography (PET) maximum intensity projection shows focal fludeoxyglucose (FDG) uptake in the left iliac bone (arrow). (b) Axial CT component of FDG-PET/CT shows a subtle area of sclerosis in the left iliac bone (arrow) which had slight FDG uptake (not shown). (c) Follow up 8 weeks after, demonstrates progression of sclerosis (arrow). (d) Axial fused FDG-PET/CT shows increased metabolic activity, suspicious for metastasis that was confirmed by biopsy. The patient was treated with radiation therapy.

this, long-term survival of patients with oesophageal adenocarcinoma, remains relatively poor secondary to the high incidence of recurrence. Over 50% of recurrence occurs during the first 2 years after surgical resection,^{4–6} most commonly manifesting as distant metastases.⁶

Figure 5. Subtle solitary bone metastasis in a 67-year-old male 4 months after oesophagectomy. (a) Whole body positron emission tomography maximum intensity projection image shows slight fludeoxyglucose uptake in the at L1 vertebra (arrow). Note the presence of increased metabolic activity within the stomach (*) that was confirmed by endoscopy to be secondary to gastritis. (b) Axial component of fludeoxyglucose- positron emission tomography/CT shows slight sclerosis within the L1 vertebral body. The findings were considered suspicious for a metastasis which was confirmed by biopsy.

Of our entire cohort of patients with any recurrence, in 17 patients (24% of those with recurrence) it was a solitary site of recurrence. Early detection of recurrence, especially when a single metastasis is present, can potentially improve patient outcome by providing additional treatment with radiation, chemotherapy or surgery. There are several reports in the literature suggesting that in selected patients, surgical resection of metastases from oesophageal cancer combined with chemotherapy is feasible, but further research is required to determine if this can offer a significant survival advantage to these patients. A recent report showed that identifying correctly oligo lymph node recurrence is important, is not a terminal stage event, and when such patients receive combined chemoradiation therapy they have longer survival than those treated with radiation alone.²⁰

Recurrence at the anastomosis or oesophageal remnant has been reported to occur in 12.1 to 21% of patients after radical resection.^{4,21,22} In our study, local recurrence represented 7% of all recurrence sites ($n = 9$), and was an isolated finding in seven patients. This low percentage of local recurrence has been explained by local control of disease provided by pre-operative chemoradiation and the extended nodal dissection performed in these patients.²³ The ability of FDG uptake to accurately identify those patients with anastomotic recurrence is disappointing, although not entirely surprising. The anastomotic site is a region that may be inflamed at the time of imaging owing to inflammation related to the surgery or recent endoscopic biopsy as well as owing to the neoadjuvant therapy as radiation induced inflammation may take months to completely resolve. Finding a SUV_{max} cut-off value to differentiate FDG uptake from tumour as compared with inflammation would have been useful, but could not be found as the amount of FDG uptake within inflammation is often quite high. Our study indeed showed that the range of FDG uptake in anastomotic inflammation overlaps with that found in anastomotic malignancy. Our study confirms that the strength of evaluating the anastomotic site by FDG PET-CT lies in its high NPV of 98%. Lack of focal metabolic activity strongly correlates with absence of recurrent disease.

Recognition of regional lymph node recurrence is limited with conventional imaging as it is solely based on size. It has been reported that only up to 12% of metastatic lymph nodes are larger than 10 mm in diameter,²⁴ which may explain the low sensitivity for nodal involvement in oesophageal cancer by CT ranging from 35 to 55%.^{25,26} Despite the metabolic imaging FDG-PET/CT provides, the PPV for detecting nodal disease by FDG-PET/CT in our study was only 45%, owing to FDG uptake in inflamed lymph nodes. FDG-PET/CT's strength in identifying nodal recurrence is in its high sensitivity, specificity, NPV and accuracy. It should be noted, however, that when comparing the accuracy of FDG PET/CT with that of endoscopy/EUS FNA or percutaneous biopsy, that such comparisons are not performed blindly. FDG-PET/CT is usually performed prior to such biopsies and is used to guide the biopsy location and increase the biopsy yield. Thus, the true accuracy of endoscopic biopsies for detection of locoregional recurrence is unknown. For example, in our study, 23% of patients with nodal disease, locoregional recurrence was proven in the supraclavicular region, a region

not demonstrated or sampled during endoscopic surveillance/biopsy. Furthermore, it is well established that involvement of the supraclavicular lymph nodes is often overlooked by CT, a region in which FDG-PET/CT outperforms CT, owing to the low background normal FDG uptake in this region.^{27,28}

As has been established in many other diseases, FDG-PET/CT's greatest added value is in identifying distant metastases during the initial staging or after neoadjuvant therapy.^{12,16} Our study now confirms the great accuracy of FDG-PET/CT in identifying recurrence in the form of metastatic disease, after surgical resection. This is in accordance with data previously published.^{6,29} We have shown that in this population of oesophageal adenocarcinoma, recurrence in 12% of patients with distant metastatic disease will present with a solitary asymptomatic metastasis. It is well known that musculoskeletal metastases are often missed by clinical evaluation and conventional anatomic imaging modalities (conventional radiograph and CT).³⁰ Our study confirmed this but also showed that in 9% of the patients with distant metastases would have been missed had it not been for imaging with FDG PET/CT as their metastatic foci presented outside of the scanning field of a routine chest and abdomen CT.

Our study has several limitations. First, as a retrospective study it suffers from heterogeneity of the imaging evaluation: variability in the timing of the first follow-up scan and interval, thereafter. However, our patients were imaged often, routinely prior to symptoms with average intervals of 170 days. Second, the definition of true-negative and true-positive FDG-PET/CT study is problematic. What we considered as a true-negative study for recurrence owing to absence of visual disease may have represented microscopic metastatic disease too small to identify by imaging. However, owing to the frequent imaging in our study, we should have picked up most foci initially missed, as was demonstrated in our study with the patient with small volume peritoneal recurrence. Third, not every site of increased FDG uptake was biopsied. For the unbiopsied sites, the truth was established with follow-up imaging. Consequently, the incidence of recurrence of disease in our study is an estimate, although, none of the currently available imaging modalities has 100% specificity or sensitivity, even when combining them all. Finally, this study does not address differences in outcomes in patients with or without post-operative surveillance. Further studies are needed to quantify any survival benefit gained through routine imaging after surgery.

In conclusion, recurrence of oesophageal cancer treatment is high. Regardless of the inherent limitations of imaging with FDG-PET/CT, it is an accurate imaging modality in detecting distant metastatic disease, shows good sensitivity, specificity and a high NPV for local, regional and distant recurrence. Owing to its high NPV for anastomotic recurrence, absence of focal FDG uptake at the anastomotic site virtually excludes local recurrence. For regional disease, the FDG uptake guides biopsy for confirmation of recurrence as this often occurs in regions not imaged by EUS and often overlooked by conventional CT. Because 60% of patients recur during the first year, and half of those within the first 6 months after surgery, we believe FDG-PET/CT should be

considered in the routine follow up of asymptomatic surgically treated oesophageal cancer patients within the first 2 years after surgery. In light of the observed time-interval to progression,

a reasonable imaging regimen would be an initial FDG-PET/CT as early as 3 months post-surgery followed by additional FDG-PET-CT scans at 6-month intervals.

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