Original article

Preoperative detection of sentinel lymph nodes with hybrid SPECT/computed tomography imaging may improve the accuracy of sentinel lymph node biopsies in patients with early stages of cancer of the oesophagus or gastro-oesophageal junction

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Objectives The aim of this study was to investigate the sentinel lymph node biopsy (SLNB) method in patients with cancer of the oesophagus or gastro-oesophageal junction (GOJ) guided by preoperative hybrid single-photon emission tomography/computed tomography (SPECT/CT) lymphoscintigraphy.

Methods Thirty-nine patients with stage T1–T3, any N-stage, M0 cancer of the oesophagus or GOJ planned for curatively intended esophagectomy underwent preoperative SPECT/CT lymphoscintigraphy following endoscopically guided submucosal injection of radiocolloid and intraoperative radio-guided SLNB using a hand-held gamma scintillation device.

Results The detection rate in preoperative SPECT/CT imaging was 88%. The median number of detected SLN stations in preoperative imaging was 1 (range 0–4). At least one suspected SLN was identified in all intraoperative SLNP procedures. In six cases, no lymph nodes were identified in the SLNB. In six cases, the SLNB was false negative. The sensitivity for successful SLNB procedures was 20%, the specificity was 100% and the accuracy was 75%.

Conclusions Preoperative SLN mapping using SPECT/CT yields a high number of detected SLN stations compared to previous studies using planar imaging. The accuracy of the SLNB method in patients with predominantly ≥T3-stage tumours and with a history of previous neoadjuvant treatment is poor, and the method is not recommended in these patient groups. *Nucl Med Commun* 41: 1153–1160 Copyright © 2020 The Author(s). Published by Wolters Kluwer Health, Inc.

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Introduction

Globally, oesophageal cancer is the ninth most common form of cancer and is the sixth most common cause of cancer-related mortality [1]. Accurate methods for correct staging are essential for the delivery of an individualised therapy.

Currently, standard curatively intended treatment of oesophageal cancer or cancer of the gastro-oesophageal junction (GOJ) consists of esophagectomy, with or without preceding neoadjuvant treatment with chemoradiotherapy or chemotherapy alone, alternatively using perioperative chemotherapy. Lymphatic dissemination of cancer of the oesophagus or GOJ to loco-regional lymph nodes is one of the most important prognostic factors.

It has been shown that extensive lymphadenectomy may provide a survival benefit in lymph node-positive (N+) cancer of the oesophagus or GOJ [2], at least in patients with a limited burden of lymph node metastases [3], whereas in lymph node metastasis negative cancer of the oesophagus, neoadjuvant therapy is possibly of no benefit. Current commonly used methods for clinical N-staging, such as CT, ^{18}F-flourodeoxyglucose (^{18}F-FDG) PET/computed tomography (CT) and endoscopic ultrasound, have moderate sensitivity in detecting lymph node metastases, for instance, the sensitivity for ^{18}F-FDG PET/CT

in the detection of loco-regional lymph node metastasis has been shown to be 66% [95% confidence interval (CI)]: 51–78% [4]. Theoretically, if there existed highly reliable methods for clinical evaluation of lymph node status and in selected cases (i.e. cT1–T2, cN0 tumours), unnecessary lymphadenectomy could be avoided in N– negative patients. Also, patient selection for neoadjuvant treatment with chemotherapy/chemoradiotherapy based on nodal involvement in low T-stages likely could be improved. The development of methods for increasing the accuracy of lymph node metastases staging is, therefore, important.

The sentinel lymph node (SLN) is the hypothetical first lymph node or first echelon of lymph nodes to receive lymphatic fluid drained from the primary tumour. It is defined not necessarily by anatomical proximity to the site of the tumour but rather by the anatomic and physiological drainage by means of lymphatic vessels [5]. The concept implies that in cancers with a primarily lymphatic mode metastatic dissemination, there can be no other sites of lymph node metastasis, provided that the SLN is free from metastasis.

The sentinel lymph node biopsy (SLNB) method has been investigated in several types of gastrointestinal cancer [6]. Even though several studies of varying size and patient characteristics have been conducted, the application of the SLNB method in oesophageal cancer or cancer of the GOJ remains experimental. In a recent meta-analysis including 18 trials of SLNB in cancer of the oesophagus or GOJ, it was found that the detection rates of SLNs varied with regard to T-stage, with detection rates of 94.4% (90.5–96.8%) in T1–T2 tumours and 77.5% (57.4–89.8%) in T3–T4 stages. Previous neoadjuvant chemotherapy had a substantial impact on the detection, with rates of 54% (29.1–77%) in this subgroup of patients. Detection rates for all T-stages were somewhat higher in adenocarcinoma [93.1% (86.9–96.4%)] compared with squamous cell carcinoma (SCC) [90.5% (86.6–93.3%)]. Location of the primary tumour had little impact on detection rates [7]. Similarly, the sensitivity of the SLNB method was affected largely by T-stage and the administration of neoadjuvant treatment. The detection of SLNs is limited by the unpredictable lymphatic drainage pattern in the oesophageal wall. Due to the structure of the submucosal plexus, longitudinal lymphatic drainage may occur leading to so-called 'skip metastasis'. This phenomenon may occur in up to 50–60% of cases and results in unexpected locations of lymph node metastasis, for example, cervical lymph node spread in tumours located in the GOJ [8,9]. Initial studies applied handheld gamma scintillation devices for identifying SLNs following injection of radio-labelled colloid particles into the primary tumour, as established in the clinical staging of breast cancer [10–13]. Later studies have added preoperative lymphoscintigraphy with planar gamma camera imaging with the intent to increase identification of 'hot nodes', particularly in more distant sites than expected and have facilitated intraoperative detection [14–16]. Planar gamma

camera lymphoscintigraphy is limited by the low degree of exact anatomical correlation to sites of lymph node uptake. More precise lymphoscintigraphy with tomographical imaging of SLN radiocolloid uptake may be achieved using single-photon emission tomography (SPECT), which is further enhanced by fusing SPECT images with computed tomography (CT) images of the same anatomical region. The resulting fusion SPECT/CT images offer a basis for more precise anatomical localisation of SLNs and have been shown to improve detection rates in SLN mapping in breast cancer [17]. The feasibility of SLN mapping has also been demonstrated in patients with cancer of the oesophagus and GOJ using hybrid SPECT/CT [18].

Aim
The primary aim of this study is to investigate whether preoperative lymphoscintigraphy using hybrid SPECT/CT imaging can improve SLN detection in patients with cancer of the oesophagus or GOJ undergoing esophagectomy with intraoperative SLNB, and to investigate the overall performance of SLN biopsy.

Methods
Patients
This observational study was conducted in a University Hospital setting between October 2011 and November 2016. Consecutive patients were prospectively considered for inclusion with Stage T1–T3, any N-stage, M0 cancer of the oesophagus or GOJ planned either for direct esophagectomy with curative intent or for esophagectomy following neoadjuvant chemotherapy or radio-chemotherapy. All patients were staged with endoscopically guided biopsies, endoscopic ultrasound, contrast-enhanced CT and ^{18}F-FDG PET/CT. Sixty-one patients agreed to participate in the study, and 41 patients were available for analysis (Fig. 1). The first eight patients included in this study were part of a pilot trial and these results were published in 2013 [18]. Ten of the patients included in this study were also part of a parallel study on the reproducibility of SLN detection using SPECT/CT imaging before and after neoadjuvant therapy. Results from this study were published in 2018 [19].

Sentinel node detection
Detection of sentinel node was performed both preoperatively by SPECT/CT and intraoperatively with a handheld gamma scintillation device.

Preoperative sentinel node detection
On the afternoon of the day before surgery or the morning of surgery, the patients underwent endoscopic submucosal radiocolloid injection of 4×0.5 mL in total of 60 MBq ^{99m}Tc-nanocoll (GE Healthcare Srl., Milan, Italy) peritumourally and intratumourally.

For logistical reasons, patients undergoing surgery on a Monday underwent preoperative sentinel node imaging in

Fig. 1
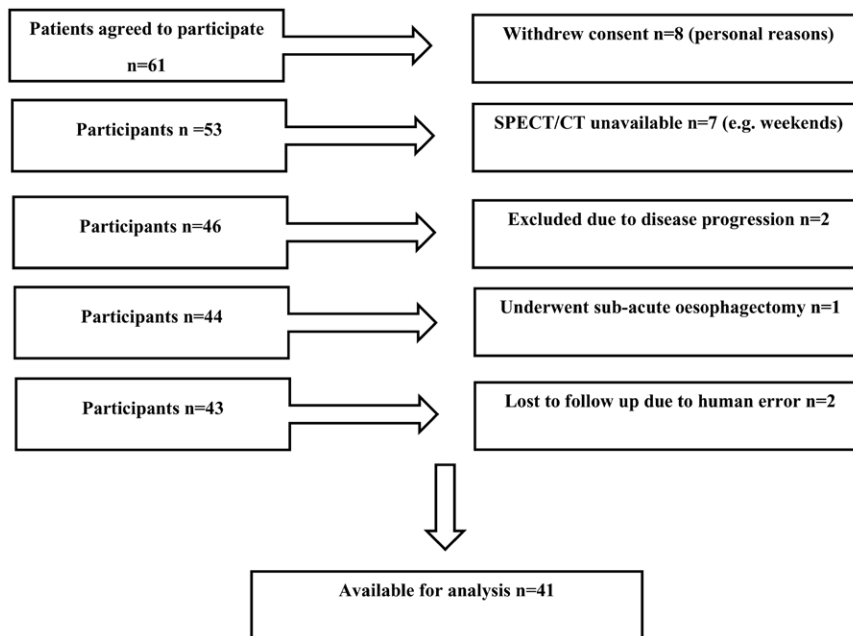
Patient inclusion and availability for definitive analysis.

the week before surgery. These patients underwent a second endoscopic procedure as described above on the morning of surgery to allow for intraoperative SLN detection.

Image acquisition

Whole-body gamma camera imaging was performed 1h after radiocolloid injection to first localise the SLNs using a 256×1024 matrix, 10cm/min. This image was used to centre the SPECT/CT examination. If no discernible SLN uptake was evident at 1h, the same procedure was repeated at 2h. A Siemens Symbia T16 (Symbia^w Siemens, Erlangen, Germany) with low energy, high-resolution collimator was used for all imaging. SPECT imaging was performed using a 128×128 matrix, 64 projections over $360°$ and 40s per projection. CT scans of the same anatomical region were obtained with 110kV, 75mAs and pitch 1.3. Iterative reconstruction of the SPECT data was carried out with an ordered subset estimation maximation method, four iterations, and eight subsets including resolution recovery. A Gaussian postfiltration was applied with 0.75cm full width at half maximum.

Single-photon emission tomography/computed tomography image evaluation

SPECT/CT images were evaluated by experienced dual-trained radiologists and nuclear medicine physicians with experience in SLN lymphoscintigraphy (S.G. or R.A.). All image reconstructions and image evaluation were made using a Hermes Hybrid viewer (Hermes Medical Solutions, Stockholm, Sweden). Using this software, transverse SPECT images were fused with transverse CT images (0.75 mm/0.7 mm recon increment, B31 medium smooth kernel). Multiplanar reconstruction was performed with resulting images in transverse, coronal, and sagittal planes. In SPECT images, sites of injection were masked with a hand-drawn volume of interests in order to accentuate the uptake in SLNs. Any discernible radiocolloid uptake/uptakes in SPECT images with corresponding lymph nodes on CT were considered to be an SLN. For the imaging procedure to be considered successful, at least one SLN station had to be identified.

Intraoperative sentinel lymph node detection

Immediately before surgery, the location(s) of perceived SLNs at SPECT/CT were demonstrated to the operating surgeons. SLN stations were classified according to the Japanese classification of oesophageal cancer 11th edition (Fig. 2) [20].

Before lymph node dissection, the operating field was scanned using a handheld gamma scintillation device (Neoprobe, Cincinnati, Ohio, USA), referred to subsequently in this study as a gamma-probe.

All patients underwent abdominal two-field lymphadenectomy, which included abdominal and mediastinal lymph node stations.

Following en bloc lymphadenectomy, the dissected lymph nodes were again examined 'back table' using the gamma-probe. Any lymph node with gamma radiation exceeding 10 times the background levels was considered to be an SLN.

Fig. 2
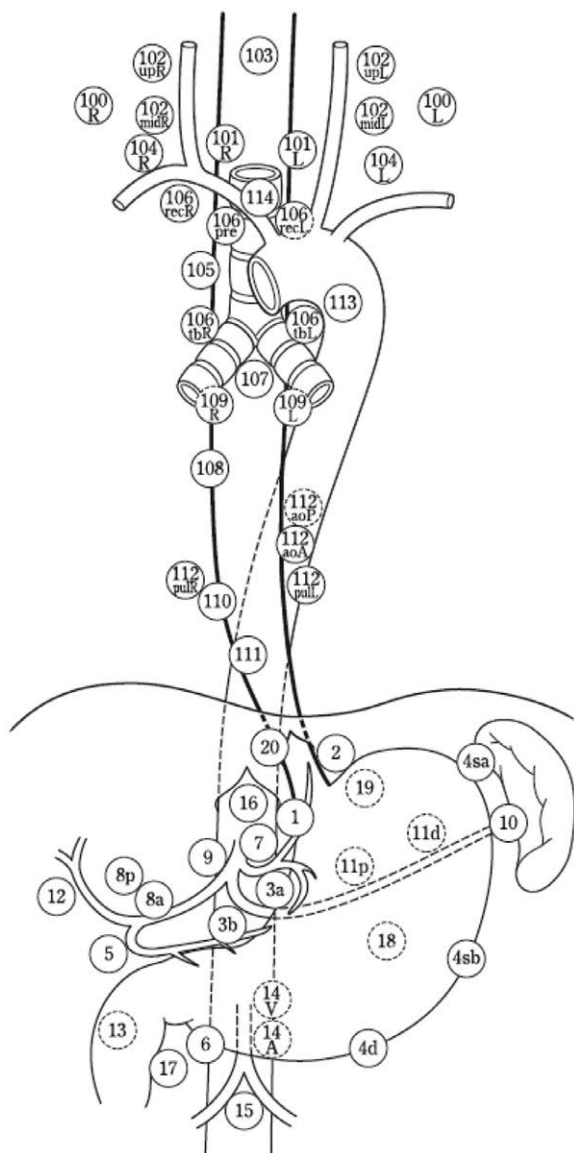
Lymph node stations as per the Japanese Classification of Oesophageal Cancer, 11th Edition: part I, as well as credit to the original authors. This image is reproduced in an unaltered state under the terms of the Creative Commons Attribution 4.0 International License (http://creativecommons.org/licenses/by/4.0/).

All identified SLNs were sent for separate pathological examination.

For an SLNB procedure to be considered successful, the biopsy had to contain at least one lymph node at subsequent pathological examination.

Pathological examination

All SLNB material was paraffin-embedded and sectioned in four levels. First, levels were stained with haematoxylin and eosin and second levels were stained with immunohistochemical staining using a pan-cytokeratin antibody for the detection of micrometastasis, similar to the method routinely used in clinical SLNB evaluation in breast cancer.

All non-SLNs were sectioned once and stained with HE, in accordance with clinical routine.

All lymph node biopsies were examined using light microscopy by experienced pathologists.

Statistical analysis

Differences in groups were calculated using a Chi-square test. A P-value of 0.05 was considered statistically significant.

Ethics approval and consent to participate

This study was approved by the regional ethical review board in Stockholm, and likewise by the Karolinska University Hospital radiation safety board. Registration numbers 2011/347-31 and 4/09. Written consent was required for participation in this study. This trial is registered with the Australian New Zealand Clinical Trials Registry (ANZCTR). Identifier ACTRN12619001653156. Date registered: 08/08/2019 – Retrospectively registered, http://www.ANZCTR.org.au/ACTRN12619001653156. aspx.

Results

Patient and tumour characteristics are listed in Table 1.

Preoperative sentinel lymph node detection with single-photon emission tomography/computed tomography

At least one SLN was detected with SPECT/CT in 88% of procedures (36/41 patients). The median number of SLN stations detected per patient was 1 (range 0–4). The detection rate was similar to the detection rate in SLNB procedures using a gamma-probe [84% of procedures (33/39 patients)] (P =0.68). Figure 3 demonstrates an example of preoperative SLN detection using SPECT/CT lymphoscintigraphy. A total of 53 lymph node stations were detected in the 41 SPECT/CT procedures. The locations of SLN stations in relation to the site of the primary tumour are shown in Table 2.

Intraoperative sentinel lymph node detection

All patients but two (39/41) underwent either open thoracoabdominal esophagectomy or laparoscopic/thoracoscopic minimally invasive esophagectomy with an Ivor Lewis or McKeown approach. The two remaining patients were treated with endoscopic submucosal dissection of a T1 tumour and subsequently did not undergo an SLNB procedure, and only preoperative imaging of SLNs was performed.

A total of 115 SLNs were obtained in the 39 procedures. The intraoperative SLN detection rate was 84% (33/39

Table 1 Patient and tumour characteristics (*N*=41)

Patient and tumour characteristics	Number of patients (%)
Histological type	
Adenocarcinoma	32 (78)
Squamous cell carcinoma	9 5 (22)
Tumour location	
Cervical/upper third	0 (0)
Middle third	7 (17)
Distal third	2 (5)
Siewert 1	11 (27)
Siewert 2	18 (44)
Siewert 3	3 (7)
Neoadjuvant treatment	
No	11 (27)
Chemotherapy	6 (15)
Chemoradiotherapy	24 (58)
Clinical TNM-stage[a]	
T1 N0 M0	2 (5)
T2 N0 M0	5 (12)
T2 N1 M0	2 (5)
T3 N0 M0	11 (27)
T3 N1 M0	13 (32)
T3 N2 M0	6 (15)
T4a N0 M0	1 (2)
T4a N1 M0	1 (2)
pT-stage[b]	
Carcinoma *in situ*	2 (5)
T0 (b)	6 (15)
T1	7 (17)
T2	14 (34)
T3	11 (27)
T4a	1 (2)
pN-stage (39/41)[c]	
N0	27 (69)
N1	8 (20)
N2	1 (3)
N3	3 (8)

[a]Clinical staging was made before any neoadjuvant treatment by endoscopy and ^{18}F-FDG PET/computed tomography.
[b]Histopathological tumour stage.
[c]Histopathological nodal stage.

patients). The mean number of SLNs per procedure was 2.9, the median 2 (range 0–21).

At least one suspected SLN station was identified in all procedures (39/39). The mean number of identified stations was 1.8, the median 1 (range 1–4). At pathological evaluation, it was found that in six cases no lymph nodes were evident in the SLN-biopsies. These unsuccessful SLN biopsies contained fat, vessels, nerve tissue, etc. Of the six cases where SLNB was unsuccessful, three patients had adenocarcinomas of the distal oesophagus and cardia, and three patients had SCCs of the middle or distal thirds of the oesophagus. Of the same six cases, three patients had undergone neoadjuvant treatment and three had not.

There were no statistically significant differences in between the successful and unsuccessful SLNB groups regarding tumour type (adenocarcinoma or SCC) ($P=0.09$), pT-stage ($P=0.96$) or history previous neoadjuvant treatment ($P=0.09$).

Pathological evaluation
A total of 971 lymph nodes were evaluated. The mean and median number of lymph nodes per lymphadenectomy was 24 (range 9–56).

Out of the twelve patients with lymphatic dissemination, we were unable to detect any sign of metastasis in eight. The biopsies in these eight patients were considered false negative. In two out of twelve patients with lymphatic dissemination, the SLNB also showed signs of metastasis. The remaining two patients in which the SLNB procedure was considered unsuccessful, no lymph node was evident in the biopsy material. Both patients with signs of metastatic SLNs had been deemed node-positive at previous PET/CT.

Tumour and lymph node characteristics of the eight false-negative SLNB cases are shown in Table 3. There were no statistically significant differences between patients with false-negative SLNB and remaining patients with successful SLNB procedures as regards Tumour type (adenocarcinoma or SCC) ($P=0.6$), pT-stage ($P=0.87$) or history of neoadjuvant treatment ($P=0.4$).

The sensitivity for the 33 successful SLNB procedures was 20%, the specificity was 100%, NPV 74%, PPV 100% and accuracy 75%.

Discussion
In this prospective study of 39 patients with cancer of the oesophagus or GOJ undergoing radio-guided SLNB following preoperative SPECT/CT lymphoscintigraphy, we found an acceptable detection rate for intraoperative gamma detector-guided SLNB of 84% (33/39 patients). Considering differences in population, the detection rate was similar to the intraoperative detection rate using gamma-probe of 88% (36/41 patients). This is in the same range as in previous comparable studies. The population here differs from most previous studies of SLN in cancer of the oesophagus or GOJ, as the majority, 30/39 patients (77%), had undergone neoadjuvant treatment. Uenosono *et al.* conducted a study of 112 patients with cancer of the oesophagus or GOJ undergoing radio-guided SLNB following preoperative planar lymphoscintigraphy [16]. The SLN detection rate for the population at large was slightly higher than in the present study, 120/134 (90%). However, in 11 patients who had received neoadjuvant CRT, an SLN was only identified in five cases (45.5%). Interestingly, the detection rate with preoperative planar lymphoscintigraphy was only 40.2% (45/112 patients), compared to 88% in our study using SPECT/CT imaging.

Kim *et al.* published similar results in a study of 23 patients undergoing radio-guided SLNB following preoperative whole-body SPECT lymphoscintigraphy [21]. Four out of 23 patients had undergone CRT, and the intraoperative SLN detection rate was 91% (21/23). Both patients where SLN detection was unsuccessful had undergone nCRT. The authors make no mention of the SLN detection rates using preoperative SPECT lymphoscintigraphy.

Takeuchi *et al.* found an even higher detection rate of 95% (71/75 patients) [15], and a successful SLNB mas

Fig. 3
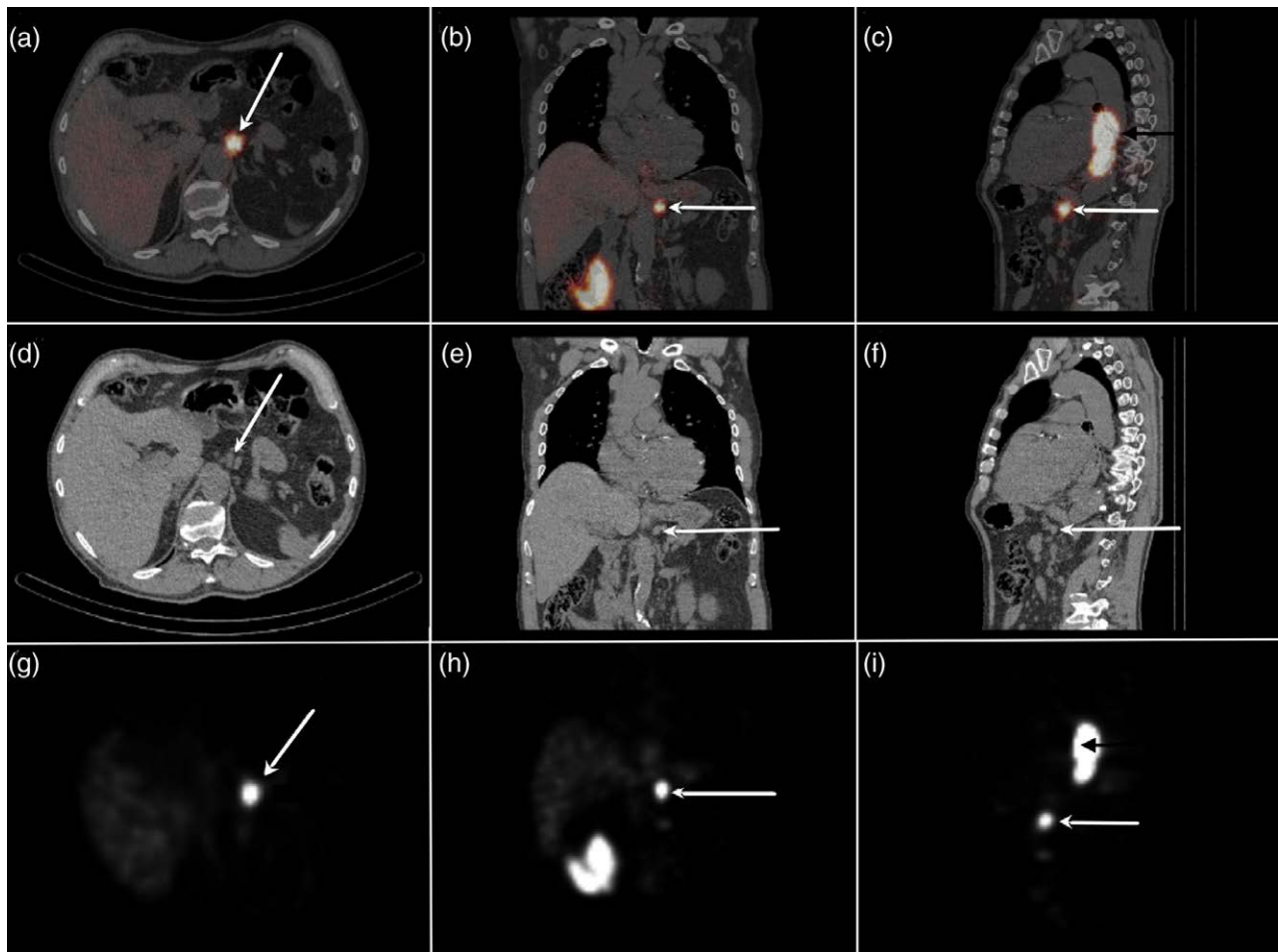
Preoperative SPECT/CT lymphoscintigraphy of an 80-year-old male patient with a T3 adenocarcinoma of the distal oesophagus (Siewert 1). (a–c) Fused SPECT/CT images in transversal, coronal and sagittal planes. (d–f) CT-images in the same orientations. (g–i) SPECT-images in the same orientations. White arrows indicate radiocolloid uptake in a sentinel lymph node located in the abdominal lymph node station 1 as defined by the Japanese Classification of Oesophageal Cancer. Black arrows indicate locations of radiocolloid injection into the primary tumour. SPECT/CT, single-photon emission tomography/computed tomography.

Table 2 Location of sentinel lymph nodes detected with hybrid single-photon emission tomography/computed tomography lymphoscintigraphy in relation to location of primary tumour

Location of tumour (n)	Location of sentinel lymph node stations, n=53 (%)
Middle oesophagus (7)	Cervical 4 (50)
	Mediastinal 2 (25)
	Abdominal 2 (25)
Distal oesophagus/cardia Siewert 1–3 (34)	Cervical 4 (9)
	Mediastinal 29 (64)
	Abdominal 12 (27)

made in all four patients who had undergone neoadjuvant chemotherapy. The authors did not report the SLN detection rates using preoperative planar lymphoscintigraphy. However, they did state that the method was very useful in the detection of SLNs in unexpected locations, distant from the primary tumour.

Regarding exposure to neoadjuvant treatment, the study most similar to ours was conducted by Thompson *et al*. in 2011. In that study, 31 patients with cancer of the oesophagus or GOJ underwent intraoperative radio-guided SLNB [13], where 61% (19/31) had previously received an nCRT regimen similar to that used in our protocol. The SLNB detection rate was 94% (29/31 patients). Using SPECT/CT, we could demonstrate a similar SLN detection rate, 90% (27/30 patients) of the cases that had received neoadjuvant therapy. This demonstrates that it is possible to achieve a fairly high frequency of SLN detection in patients who have received neoadjuvant treatment, which was also the case in the study by Thompson *et al*.

It must be mentioned that since interpretation of SPECT/CT images was done by two separate readers,

Table 3   Patient, tumour and lymph node characteristics in false-negative sentinel lymph node biopsy procedures

Case	Sex/age	Tumour type	Tumour location	pTNM stage[a]	Neoadjuvant treatment	SLNB (*n*, stations)[b]	Total lymph nodes (*n*)	Metastatic lymph nodes (*n*)
1	M/71	Squamous cell carcinoma	Middle third	T0N1M0	CRT	1 (101R)	27	1
2	M/69	Adenocarcinoma	Cardia Siewert 3	T3N3M0	CT	2 (1,3)	19	8
3	M/72	Adenocarcinoma	Cardia Siewert 1	T2N1M0	CRT	3 (111,111,1)	17	2
4	M/78	Adenocarcinoma	Cardia Siewert 1	T2N1M0	None	2 (1,108)	53	2
5	M/61	Squamous cell carcinoma	Middle third	T2N1M0	CRT	1 (106RcL)	19	1
6	M/72	Adenocarcinoma	Cardia Siewert 2	T3N3M0	None	1 (109L)	39	8
7	M/68	Adenocarcinoma	Cardia Siewert 1	T1N2M0	CT	1 (106Pre)	36	6
8	M/70	Adenocarcinoma	Cardia Siewert 2	T2N1M0	CRT	1 (105)	15	2

SLNB, sentinel lymph node biopsy.
[a]Histopathological TNM-stage.
[b]Sentinel lymph node biopsies, lymph node stations as per the Japanese Classification of Oesophageal Cancer, 11th edition.

observation bias may have had an impact on the preoperative SLN detection rate in our study.

It is important to compare previous investigations of the SLNB method in the present patient group with regard to the low sensitivity and accuracy of SLNB in our study.

Uenosono *et al.* showed excellent sensitivity and accuracy for T1 tumours (sensitivity 91.7%, accuracy 98.2%), but more often a false-negative SLNB in T2 tumours (sensitivity 66.7%, accuracy 80.6%), T3 tumours (sensitivity 54.2%, accuracy 60.7%) and in a small subgroup that had received nCRT (sensitivity 0%, accuracy 40%, *n* = 11). On the other hand, Kim *et al.* found no false-negative cases (0/9) in a cohort with higher T-stages, comparable to our study, albeit with only 17% of the patients previously having undergone nCRT.

Takeuchi *et al.* observed a false-negative SLNB in 4/33 cases (sensitivity 88%, accuracy 94%). However, the vast majority of patients in that is study were T1 stage (76%) and 2/4 false-negative SLNBs were found in T3 tumours. The authors observed no correlation between previous neoadjuvant chemotherapy and accuracy in SLNB, but only 4/75 patients had been treated with neoadjuvant chemotherapy and none with nCRT.

The poor sensitivity and accuracy that we found may be explained by the high proportion of patients with advanced ≥T3-stage tumours (78%) and a high proportion with preceding neoadjuvant treatment (73%). Since there were very few T1 tumours or cases that had not received neoadjuvant therapy, an analysis of the influence of these factors was not feasible. It has been hypothesized that alterations or obstruction in the lymphatic vessels due to tumour growth could be the mechanism behind why the SLNB-method has been less accurate in higher T-stages. Another possible explanation could be related to technical aspects when administering radiocolloids. It may be more difficult to achieve an even distribution of radiocolloids in a bulkier tumour compared to a smaller one.

In addition to previously reported findings, albeit no statistically significant relation between T-stage, history of neoadjuvant treatment and ability to successfully identify an SLN intraoperatively could be demonstrated, these two factors were both borderline significant ($P = 0.09$). It is possible that the small sample size could obscure such a relationship, demonstrated in previous studies. Another explanation could be that we were unable to detect SLNs located in the proximity of the tumour and injection site of the radiocolloid, which may have interfered with the detection of SLNs due to so-called 'shine through'. Lamb *et al.* demonstrated an overall accuracy of 96% (55/57 patients) for an SLNB procedure in patients with adenocarcinoma of the oesophagus/GOJ undergoing esophagectomy and two-field lymphadenectomy [12]. It is; however, difficult to compare our results to these findings, as there was no mention of pT-stage or previous history of neoadjuvant treatment in the report.

Thompson *et al.*; however, found only one false-negative SLNB in 29 patients with a sensitivity of 90% and accuracy of 96% in a population similar to the present study. We were thus unable to repeat these results, as the sensitivity was only 20% and the accuracy 75%. Part of this discrepancy may be due to differences in T-stage. In our study, 63% of patients were ≥pT2-stage compared to 43% in the aforementioned study. Considering our findings, further investigation of the SLNB method in cancer of the oesophagus or GOJ has been discontinued at our academic centre.

Conclusion

In conclusion, this study shows that preoperative SPECT/CT imaging combined intraoperative radio-guided detection can yield a high frequency of SLNs detected in patients with cancer of the oesophagus or GOJ. Only one previous study has detailed the SLN detection rates in preoperative SLN lymphoscintigraphy [16]. Compared to these limited previous findings we observed a much higher detection rate (40.2% using planar lymphoscintigraphy and 88% using hybrid SPECT/CT lymphoscintigraphy). It is likely that the increased detail in information afforded by SPECT in combination with CT-attenuation correction of SPECT data, as well as CT correlation to SPECT findings when fusing the two imaging modalities facilitates the detection of SLNs.

Most tumours in this study were ≥T3 and the vast majority of patients had received neoadjuvant treatment. The sensitivity was low and SLNB cannot, therefore, be

recommended as a staging tool in this group of patients. Using the SLNB-method to identify patients with either N− or N+ status or as a potential tool for selecting patients to lymphadenectomy of neoadjuvant treatment does not seem reliable. Preoperative SPECT/CT lymphoscintigraphy may; however, facilitate the intraoperative identification of SLNs, which may be useful for T1 cancer, where there may still be a potential for SLNB staging of oesophageal or GOJ cancer.

Acknowledgements

Conflicts of interest
There are no conflicts of interest.

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