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Oblique view of preoperative lymphoscintigraphy improves detection of sentinel lymph nodes in esophageal cancer

Chikako TANAKA,* Hirofumi FUJII,** Yuko KITAGAWA,*** Tadaki NAKAHARA,* Takayuki SUZUKI,* Yuzuru TANAMI,* Masaki KITAJIMA,*** Yutaka ANDO**** and Atsushi KUBO*

*Department of Radiology and ***Department of Surgery, Keio University School of Medicine, Tokyo
**Division of Hematology/Oncology, Beth Israel Deaconess Medical Center, Boston, MA, USA
****Medical Information Processing Office, National Institute of Radiological Sciences, Chiba

Because sentinel lymph nodes (SLNs) of esophageal cancer can be widely located between the neck and the upper abdomen, lymphoscintigraphy plays an important role in their detection, but some modifications are required to clearly visualize their locations. Recently, we applied the stereoscopic imaging method by adding the 10-degree oblique view to the conventional lymphoscintigraphy for SLNs, so that we could better determine SLN locations on the basis of depth information. In this report, we describe a case in which the oblique view of the lymphoscintigram contributed to improving the visualization of a mediastinal SLN of esophageal cancer. Evaluation of the patient's chest CT image validated the notion that gamma rays from SLN are less absorbed by the surrounding soft tissues and the sternum in acquisition from the oblique view than from the true anterior view. The additional oblique view of the lymphoscintigram is useful for evaluation of the SLNs of esophageal cancer.

Key words: esophageal cancer, sentinel lymph node, lymphoscintigraphy, stereoscopic imaging, oblique view

INTRODUCTION

THE SENTINEL LYMPH NODE (SLN) procedure is widely accepted in breast cancer and malignant melanoma,[1–3] and the feasibility of this procedure in alimentary tract cancers is now being actively studied.[4] As lymph node metastasis is reported to be a significant prognostic factor in esophageal cancer,[5] it is necessary to evaluate lymph node metastasis as accurately as possible, especially when considering optimal treatment. The lymphatic drainage of esophageal cancer is complicated. Skip metastasis (i.e., the presence of disease in the lateral or mediastinal node compartments without disease in the central compartment, where tumor cells typically drain first) seems common and often occurs in unpredictable patterns because lymphatic drainage patterns vary in individuals.[6,7] We believe that lymphoscintigraphy can accurately depict the regional lymphatic basin of the esophageal lesion and that it may improve the accuracy of clinical staging.[8]

We applied the stereoscopic imaging method by adding the 10-degree oblique view to the conventional planar view to observe SLNs with 3-dimensional (3-D) information.[9] This method, which is unfamiliar in nuclear medicine, can easily provide information of depth through the 3-D effect and is useful for lymphoscintigraphy for breast SLNs (manuscript submitted for publication).

Recently, we investigated a case of esophageal cancer in which the patient's SLN could be depicted more clearly in the oblique view. We present the clinical usefulness of the oblique view of lymphoscintigram for SLNs in patients with esophageal cancer as we discuss the following case report.

CASE REPORT

A 75-year-old male patient was referred to the hospital

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For reprint contact: Hirofumi Fujii, M.D., Division of Hematology/Oncology, Beth Israel Deaconess Medical Center, SL-B05, 330 Brookline Avenue, Boston, MA 02215, USA.
E-mail: hfujii@bu.iij4u.or.jp

because of worsening dysphagia. The patient had been in good health except for hypertension. An esophagogastroscopic examination revealed an ulcerative mass extending over half of the esophageal lumen (Fig. 1). A double-contrast esophageal study detected a 3-cm mass with mucosal irregularity and ulceration at the middle thoracic esophagus. Contrast-enhanced CT images revealed diffuse thickening of the wall in the middle thoracic esophagus (Fig. 2A). Several lymph nodes were apparent in the bilateral tracheobronchial, subcarinal, and left recurrent nerve regions (Fig. 2B). Microscopical examination of biopsy specimens revealed squamous cell carcinoma. Taken together, these findings supported a diagnosis of clinically significant stage III esophageal cancer. A preoperative lymphoscintigraphy was performed to evaluate regional lymphatic flow.

Lymphoscintigrams were obtained 3 hours after administration of 148 MBq (4 mCi) Tc-99m tin colloid into the sub-mucosal layer of 2 points each in oral and anal sides of lesion (totally 4 points) using an endoscopic procedure.[10,11] The routine true anterior view and the 10-degree left oblique view were sequentially obtained with 10 minutes of acquisition time. The acquired data were processed as previously reported.[12] The routine true anterior view of the lymphoscintigram failed to visualize SLNs (Fig. 3A), but the additional view of the scintigram obtained from the 10-degree left oblique projection showed a faint accumulation in the upper aspect of injection sites around the aortic arch (Fig. 3B), suggesting uptake in the left recurrent nerve lymph node station (Fig. 4). No accumulation was detected in any other region including the neck and upper abdomen.

Total esophagectomy with 3-field lymphadenectomy was performed under hand-assisted laparoscopic surgery (HALS) and video-assisted thoracic surgery (VATS). Although 45 lymph nodes were dissected in the operation, only one node taken from the left recurrent nerve region was hot with metastasis, as shown in the preoperative lymphoscintigrams. This finding suggested that only the additional oblique view of scintigram could predict the location of the hot node with metastasis. The CT image at the slice of the left recurrent nerve region revealed that gamma rays from the SLN located at the subaortic region were less absorbed when the image was obtained from the left oblique view than when obtained from the true anterior view (Fig. 5).

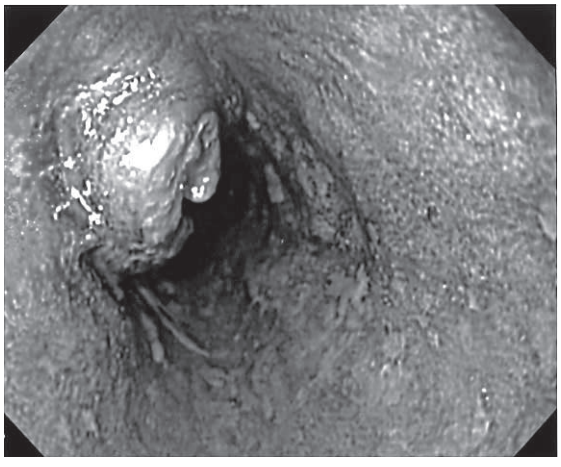
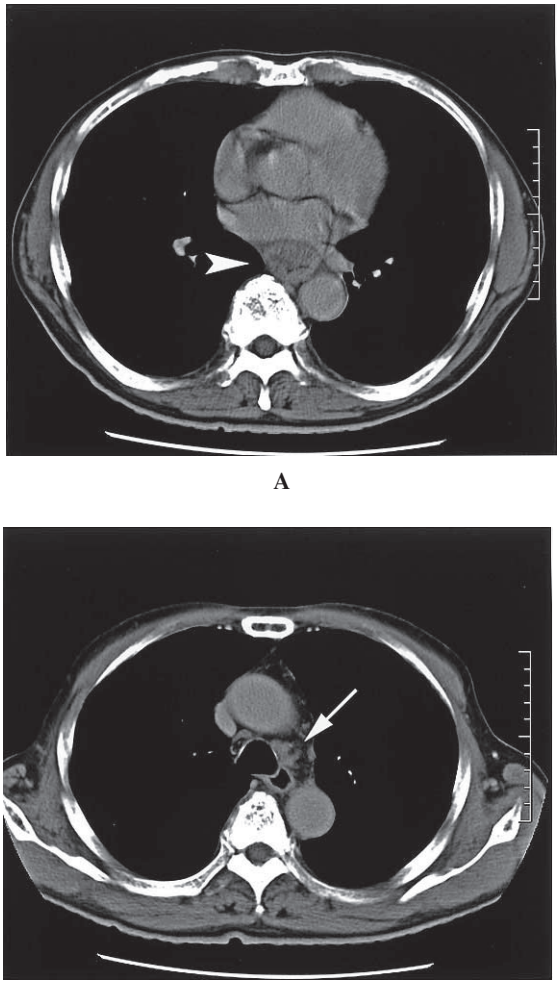


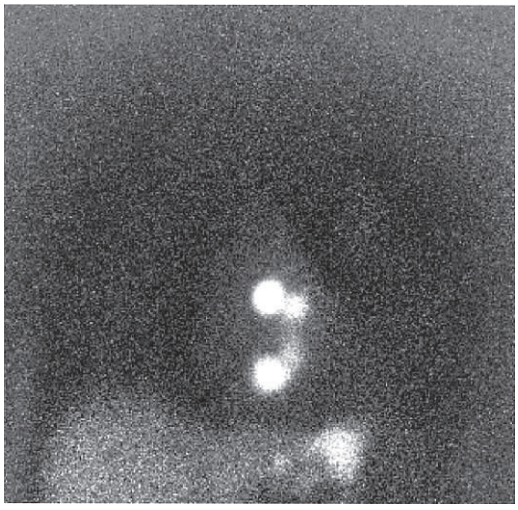
Fig. 1 Esophageal lesion with iodine staining on endoscopy. Endoscopy showed an ulcerative mass extending over half the esophageal lumen. Also shown in the endoscopy were patchy, unstained lesions around the mass. These lesions were suspected to be satellite lesions of esophageal cancer.



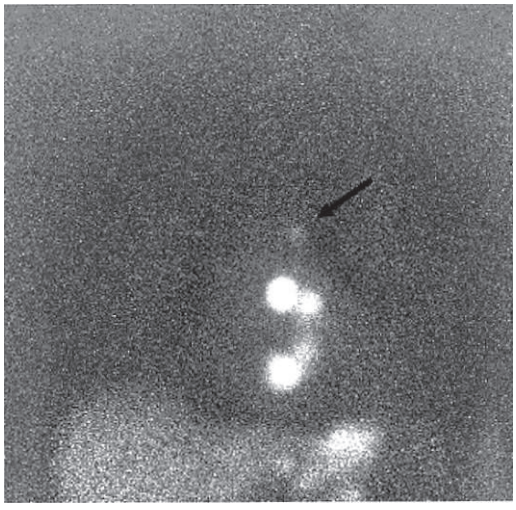
A

B

Fig. 2 Contrast-enhanced CT images (delayed phase). A: diffuse wall thickening of middle thoracic esophagus was detected and thought to be a primary lesion (*arrowhead*), and B: amorphous bizarre-shaped soft tissue was detected in the left recurrent nerve region and seemed to be tangled lymph nodes (*arrow*).



A



B

Fig. 3 Lymphoscintigraphy for SLNs. A: The routine true anterior view of the lymphoscintigram failed to depict SLNs. B: The left anterior-oblique view of the scintigram showed a faint accumulation, indicating the SLN in the upper aspect of the injection sites (*arrow*) around the aortic arch.

DISCUSSION

The clinical significance of sentinel node mapping in gastrointestinal malignancies has not been completely validated, but it is currently being actively studied.[6,13] Lymph node metastasis, especially in esophageal cancer [even if it is microscopic], is a significant prognostic factor[5,14] and the metastasis often appears in a site that is distant from the primary tumor. The feasibility of sentinel node navigation for esophageal cancer is highly expected in cases such as this one.

Lymphoscintigraphy plays an important role in the detection of SLNs for esophageal cancer, because the lymphatic flow in the esophagus is complicated and SLNs

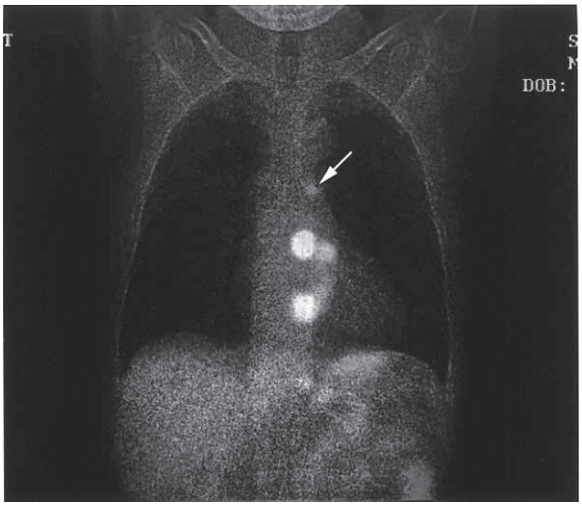


Fig. 4 Fusion image of lymphoscintigraphy obtained from left anterior oblique projection and scout view for CT. Since the lymphoscintigram obtained from anterior projection failed to visualize SLN, we fused lymphoscintigram obtained from anterior lateral projection and a scout view of CT. There was no gap in vertical sides between those two images. The accumulation is suspected to be in the left recurrent nerve lymph node station (*arrow*).

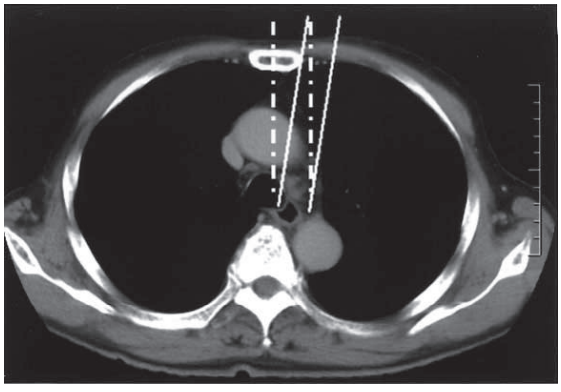


Fig. 5 The course of gamma rays from SLN. Although the distance between the detector and SLN is longer in the oblique view of the image (*unbroken lines*) than in the true anterior image (*broken lines*), the soft tissue between SLN and the surface of the body is thinner in the oblique view of the image than in the true anterior image. In the anterior image, the sternum can absorb most of the photons from the SLN.

can be widely located between the neck and the upper abdomen.[10,11] Because simple acquisition of lymphoscintigrams is often insufficient for the detection of SLNs, we have proposed a number of methods for image processing designed to better visualize SLNs.[11,12]

Recently, we applied the stereoscopic imaging method to lymphoscintigraphy for SLNs to obtain additional information about their depth and 3-D effect without impairing the signal associated with noise ratio. Although

this method is unfamiliar in the field of nuclear medicine, it has often used in interventional radiology and MRI (e.g., magnetic resonance angiography [MRA], magnetic resonance cholangiopancreatography [MRCP]). For stereoscopic imaging, the acquisition of a pair of 2-dimensional (ordinal) planar pictures from slightly different angles (≈10 degrees) is required. When we look at those two views simultaneously, they merge into a single image and we perceive a scene with depth.[9] We have applied this method in sentinel lymphoscintigraphy for breast cancer and have obtained encouraging results (manuscript submitted for publication).

Therefore, we also applied this method to lymphoscintigraphy for SLNs in patients with esophageal cancer. As a result, the 10-degree left oblique view unexpectedly revealed a hot node in the upper portion of the primary lesion, which is also referred to as the left recurrent nerve region. In esophageal cancer, which is different from malignancies that originate in the superficial organs (such as breast cancer or malignant melanoma), SLNs often localize in the deep portion of the body and are surrounded by plenty of soft tissues that can absorb the primary photons from SLNs and increase scattered photons. This means that preventing the absorption of photons from soft tissue and minimizing scattered photons from anatomically complicated mediastinal soft tissue are very important steps in obtaining a better image of the SLNs of esophageal cancer. Namely, the image acquisition from the direction that minimizes the thickness of soft tissue covering the SLN results in clear visualization of the SLNs of esophageal cancer.

In this case, the SLN was located in the left recurrent nerve region and at this level, gamma rays from SLN have to pass through the aortic arch and anterior mediastinal soft tissue as well as the sternum, which might most absorb the photon, from the true anterior projection, but from the oblique projection, gamma rays might not pass through these soft tissue and bony structures before they reach the detector, as shown in Figure 5. The soft tissue and bone between the SLN and the surface of the body was thinner when the image was obtained from the oblique view position than when the image was obtained from the true anterior view position. Consequently, visualization of SLN was possible only when the image was obtained from the oblique view position.

On the basis of our findings in this case report, we recommend addition of the oblique view of imaging when lymphoscintigraphy for SLNs is performed for patients with esophageal cancer. When we examined this case, left oblique image was added because left side thoracotomy is chosen in routine esophagectomy and we thought that the left oblique image would be more useful. But, if the lesion was located at the lower level of mediastinum, addition of the right oblique view, not the left oblique view, might be effective because the heart is located at the left side at the lower level of the mediastinum.

Because SLNs could be located in both sides of the mediastinum, both right and left anterior-oblique view should have performed for better SLN visualization. However, obtaining both sides of oblique views prolongs the total examination time. Further study would be expected to evaluate this point.

However, the true anterior image should not be omitted because we think the true anterior image was useful to confirm whether the SLN was located in the right or the left side of the mediastinum. The anterior view of the image is also essential for stereoscopic observation of SLNs, which can provide information about the depth and 3-D effect.

In conclusion, the oblique projection image should be added to the routine true anterior image on preoperative lymphoscintigraphy for SLN of esophageal cancer because we have shown how it can easily improve the detectability of SLNs.

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