

LYMPH DRAINAGE ORIGINATING FROM THE LOWER ESOPHAGUS AND GASTRIC CARDIA AS MEASURED BY RADIOISOTOPE UPTAKE IN THE REGIONAL LYMPH NODES FOLLOWING LYMPHOSCINTIGRAPHY

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ABSTRACT

Lymph drainage originating from the lower esophagus and gastric cardia was determined using uptake of radioisotope (RI) in the regional lymph nodes in 19 patients with primary cancer at these sites. On the day prior to operation, ^{99m}Tc colloid solution was injected submucosally in the distal esophagus or gastric cardia during endoscopy. The regional lymph nodes were removed at operation and RI uptake of individual nodes was measured in a well-type scintillation counter. Uptake was expressed as the amount per nodal weight.

After radioactive colloid was injected into the lower esophagus, high RI uptake was common in both the mid-mediastinal and abdominal nodes, suggesting that lymph originating from the lower esophagus drains in both a superior and inferior direction. On the other hand, after radioactive colloid was injected into the gastric cardia, high RI uptake was never demonstrated in mediastinal lymph nodes suggesting that direct mediastinal lymph flow from the gastric cardia is rare. These results support clinical observations on the distribution of lymph nodal metastases in patients with lower esophageal and gastric cardia malignancies. As a diagnostic tool for lymph nodal metastases, however, lymphoscintigraphy is unreliable.

Besides removal of the primary tumor, regional lymph node dissection is frequently carried out for management of digestive tract cancer. This operative policy extends to tumors arising from the lower esophagus or gastric cardia. To perform proper lymph node dissection it is desirable to map accurately pathways of lymphatic spread from the tumor-bearing site. In this context, the anatomical specificities of lymphatic spread from the lower esophagus and gastric cardia are exceedingly complex and controversial despite a multitude of studies (1-5). Accordingly, we tried to clarify the pathways of lymphatic spread from the lower esophagus and gastric cardia by radioisotope (RI) uptake count of removed regional lymph nodes in conjunction with lymphoscintigraphy of the chest and abdomen.

MATERIALS AND METHODS

Nineteen patients with esophageal and 8 patients with gastric cancer were studied. The patients consisted of 17 males and 2 females with a range in age from 43 to 76 years (mean 65 years). Location, gross appearance, histology, and stage of the tumors are shown in Table 1. Those patients selected were in a relatively early stage of the disease. The

operations were performed by combined thoracoabdominal incision in 17 patients and transabdominally in 2 patients. The radioactive colloid used, procedure of lymphoscintigraphy, and RI uptake count in the lymph nodes were as follows:

Radioactive colloid

The radioactive colloid was prepared by mixing 1ml of ^{99m}Tc colloidal solution, 1ml of rhenium sulfate, and 5ml of pyrophosphate in a boiling water bath for 15-30 minutes. (This radioactive colloid emulsion is phagocytosed by the reticuloendothelial system, is concentrated in regional lymph nodes (6,7), and allows both scintigraphic imaging and quantification of the radioactivity.)

Lymphoscintigraphy and RI uptake count in the lymph nodes

One day prior to operation, 1ml of the isotope (3mCi) was injected submucosally over a period of 1-2 minutes during endoscopy. The site of injection was within 2cm of the esophagogastric junction on either the

esophageal or gastric side. About 3 hours after injection, scintigraphy was taken of the chest and abdomen. At the time of operation lymph nodes were removed and a map of lymph node distribution was made similar to that described for prostate and breast lymphatic drainage (5,8,9). Each lymph node was weighed and radioactivity measured using a well-type scintillation counter. RI uptake in each lymph node was divided into four grades— <200 cpm/g; $>2,000$ cpm/g; $>20,000$ cpm/g; and $>200,000$ cpm/g.

RESULTS

Within one hour after administration, colloid was detected within the regional lymph nodes and radioactive metabolites were excreted through the kidney. Radioactivity of excised lymph nodes were in the range of 457 cpm/g to 6,563,344 cpm/g. No correlation was observed between radioactivity and cancerous involvement in the node. Radioactive background was less than 80 cpm/g and that of 1ml blood was less than 300 cpm/g. High radioactivity was uniformly found in lymph nodes visualized on the scintigram. On the other

Table 1
Clinical characteristics of patients

Case	Age	Sex	Location of Cancer	Appearance	Histology	Stage
1	75	M	lower esophagus	protruded	squamous	I
2	73	M	intrathoracic esophagus	superficial elevated	squamous	III
3	55	M	intrathoracic esophagus	superficial elevated	squamous	I
4	60	M	lower esophagus	ulcerative	squamous	III
5	76	M	upper third stomach	scirrhous	adenoca.	III
6	67	M	cardia	cancerous erosion	adenoca.	I
7	44	F	cardia	ulcerative	adenoca.	II
8	72	M	intrathoracic esophagus	ulcerative	squamous	II
9	71	M	cervical esophagus	superficial elevated	squamous	II
10	67	M	cardia	ulcerative	squamous	II
11	70	M	intrathoracic esophagus	superficial elevated	squamous	I
12	71	M	cardia	ulcerative	adenoca	III
13	59	M	lower third stomach	ulcerative	adenoca	III
14	72	M	lower esophagus	ulcerative	squamous	III
15	69	M	cardia	ulcerative	adenoca	III
16	60	M	intrathoracic esophagus	superficial flat	squamous	III
17	56	M	intrathoracic esophagus	superficial flat	squamous	II
18	70	M	lower third stomach	cancerous erosion	adenoca	I
19	43	F	middle third stomach	scirrhous	adenoca	III

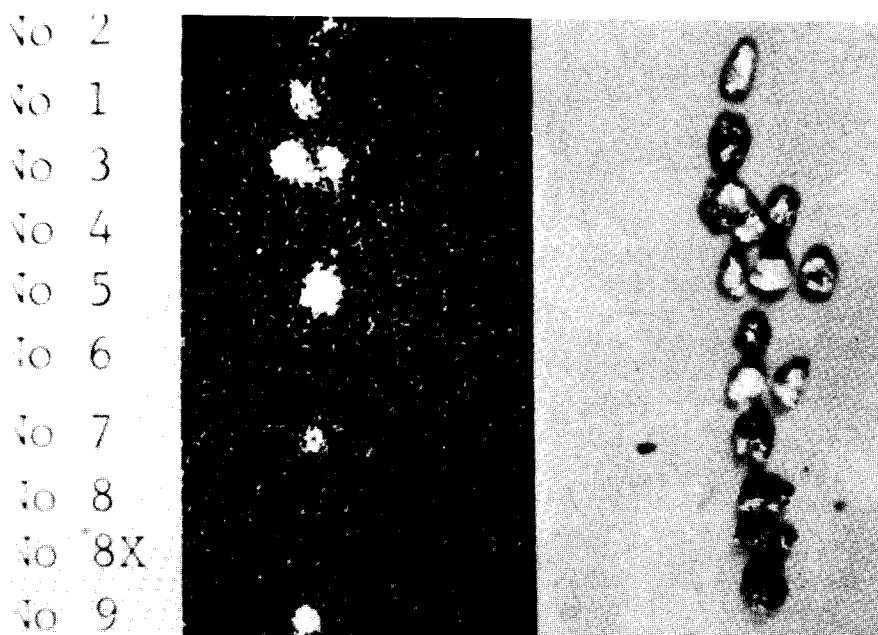


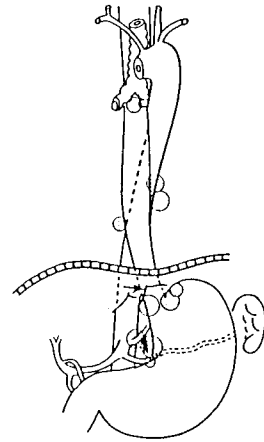
Fig. 1. Lymphoscintigraphy (left) and gross appearance of lymph nodes removed during the course of operative management of cancer of the gastric cardia. Note that high radioactivity is seen in lymph nodes on lymphoscintigraphy but a considerable amount of radioactivity is also detected in "nonvisualized" nodes.

hand, a considerable amount of radioactivity was also detected in nonvisualized nodes (Fig. 1). Figs. 2 and 3 show two examples of the results on RI uptake in the lymph nodes. The patient in Fig. 2 was a 75-year-old male with cancer of the lower esophagus and underwent lower esophagocardectomy (Case 1 in Table 1). Lymph nodes along the lesser curvature of the stomach and adjacent to the cardia were visualized on scintigram and had a high RI uptake; that in the right cardiac lymph node was 3,011,424 cpm/g and those in 3 left cardiac nodes were 2,071,793 cpm/g, 1,253,438 cpm/g, and 632,533 cpm/g respectively. The uptakes in two lesser curvature nodes were 4,177,490 cpm/g and 317,486 cpm/g. High uptakes were also detected in mediastinal and lower esophageal nodes, indicating that both upward and downward lymphatic migration occurred from the lower esophagus. The patient in Fig. 3 was a 67-year-old man with cancer of the gastric cardia (Case 6 in Table 1). High uptake was

demonstrated in lymph nodes adjacent to the cardia and along the lesser curvature. The uptakes in three lesser curvature nodes were 6,563,344 cpm/g, 4,534,736 cpm/g, and 3,382,930 cpm/g and those in three cardiac nodes were 196,405 cpm/g, 94,909 cpm/g, and 17,790 cpm/g respectively. However, the uptake in the thoracic paraesophageal lymph nodes was only 2,631 cpm/g, suggesting less direct lymphatic drainage from the gastric cardia to the mediastinum.

Tables 2 and 3 summarize the results obtained in 19 patients. In patients in whom radioactive colloid was injected into the lower esophagus (Table 2) high uptake was demonstrated in paragastric cardiac lymph nodes, along the lesser curvature nodes, and the lower mediastinal nodes. Although low in radioactivity, some uptake was also detected in the upper mediastinal nodes of 3 patients and in cervical nodes in 2 patients. High uptake was also detected in the paraaortic lymph

Lymph node (LN)	R.I. uptake (cpm/g)
right cardiac LN	3 0 1 1,4 2 4
left cardiac LN	6 3 2,5 3 3
	1 2 5 3,4 3 8
	2 0 7 1,7 9 3
lesser curvature LN	4 1 7 7,4 9 0
	3 1 7,4 8 7
left gastric artery LN	1 9 9 4,6 4 1
	9 3 5,3 2 6
posterior mediastinal LN	2 3 1 3,2 0 8
	2 4 8 2,4 0 2
lower thoracic paraesophageal LN	8 9 4,6 2 4
bifurcation LN	1 3 6 1,8 8 1
	6 9 7,3 1 4
thoracic paratracheal LN	3 6,8 3 2
	7 5,7 2 6



The case injected 2cm above EG-junction (arrow : point of injection)

Fig. 2. Radioactive isotope (RI) uptake in regional lymph nodes removed during operation for management of distal esophageal cancer. Radioactive colloid was injected into the distal esophagus (arrow). Note that high uptake was demonstrable not only in the mid-mediastinal lymph nodes, but also in the abdominal lymph nodes.

nodes near the left renal vein in 2 patients (Table 2).

In patients in whom radiocolloid was injected into the cardia of the stomach (Table 3), high uptake was observed in upper gastric nodes and those around the celiac artery. On the other hand, uptake in mediastinal lymph nodes was much less notable with the values uniformly <2,000 cpm/g (Table 3).

Scintigraphy visualized the regional lymph nodes of the stomach in only 6 of 19 patients. Fig. 4 shows one positive scintigram (Case 13 in Table 1), a 59-year-old male patient with gastric cancer (Borrmann type-3) at the lesser curvature of the prepylorus. Paracardiac nodes, lesser curvature nodes, and less intensely mediastinal nodes are well-delineated. This experience, however, was unusual.

DISCUSSION

Lymphatic drainage of the digestive tract has been studied by a variety of methods including indirect lymphangiography after submucosal injection of a dye into the bowel wall. Using this technique, however, we found

it difficult to quantify lymphatic drainage from the stomach and lower esophagus into the mediastinum or retroperitoneum.

To overcome this limitation, we developed an alternative method with radioisotope emulsion. Initially lipiodol emulsified with ¹³¹I labeled albumin was used, but ^{99m}Tc was subsequently adopted as more useful in that the latter radioisotope had a shorter half-life, thereby avoiding unnecessary irradiation.

The results obtained in this study show two significant findings. First, after the radioactive colloid is injected into the lower esophagus, high radioisotope uptake is frequently detected not only in mid-mediastinal lymph nodes but also in abdominal nodes including those around the celiac artery and abdominal aorta. These findings substantiate that lymph drainage from the lower esophagus occurs both in a cephalad and caudad direction. Second, after radioactive colloid is injected into the gastric cardia, high radioisotopic uptake is not demonstrable in mediastinal lymph nodes. Low radioactive uptake, however, is detected in mediastinal nodes in some patients. These findings sug-

Table 2
Radioisotopic uptake of individual lymph nodes (1)
 —the group injected at the lower esophagus

Case	Mediastinal lymph nodes			abdominal lymph nodes		
	upper	middle	lower	upper gastric	celiac artery	para aortic
1			●	●	●	
2		○	●	●	○	●
3	—	—	●	●	○	
4	○	●	●	●		
5		○	○			○
6			●	●	○	
7		●	●	●	△	
8	○	●	△	○	○	●
9	△	○	○	●	●	
10		—	—	○	△	△

Negative (—) less than 2000cpm/g
 Positive (△) more than 2000cpm/g

Positive (○) 20000cpm/g
 Positive (●) 200000cpm/g

Table 3
Radioisotopic uptake of individual lymph nodes (2)
 —the group injected at the cardia

Case	Mediastinal lymph nodes			abdominal lymph nodes		
	upper	middle	lower	upper gastric	celiac artery	para aortic
11	○	△	△	○		
12		—	—	○	△	
13				●	●	○
14			—	●	●	○
15		△		○		△
16	—	△		○	—	—
17	△	△	△	●	△	
18				●	○	—
19			△	●	●	○

Negative (—) less than 2000cpm/g
 Positive (△) more than 2000cpm/g

Positive (○) 20000cpm/g
 Positive (●) 200000cpm/g

Lymph node (LN)	R.I. uptake (cpm/g)
right cardiac LN	9 4,9 0 9
left cardiac LN	1 9 6,4 0 5
	1 7,7 9 0
	1 0,7 4 2
lesser curvature LN	6 5 6 3,3 4 4
	2 4,4 5 8
	4 5 3 4,7 3 6
	3 2,5 6 5
	3 3 8 2,9 3 0
left gastric artery LN	4,7 1 0
common hepatic artery LN	2,3 4 9
	2,3 9 8
lower thoracic paraesophageal LN	2,6 3 1
bifurcation LN	4 5 7
	1,4 2 7
	1,3 1 4
	1,3 9 3
thoracic paratracheal LN	1,5 7 2
	1,0 6 9

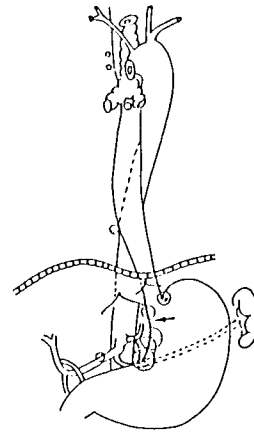
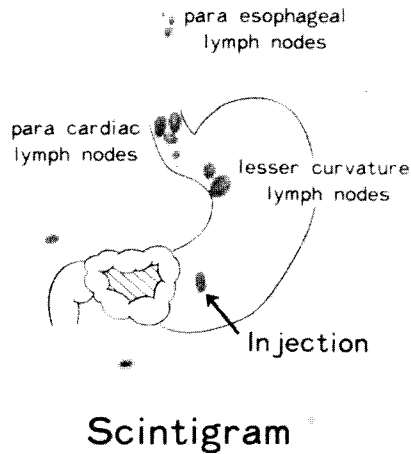


Fig-3 The case injected 1cm below E-G junction (arrow : point of injection)

Fig. 3. Radioisotopic (RI) uptake in regional lymph nodes removed in the course of operative management for gastric cardia malignancy. Radioactive colloid was injected into the cardia of the stomach (arrow). Note the high radioisotopic uptake in the abdominal lymph nodes but low or absent count in the mediastinal lymph nodes.



Scintigram

Fig. 4. Lymphoscintigram (left) and schematic outline (right) visualizing paragastric lymph nodes and to a lesser extent mediastinal lymph nodes in a patient with gastric malignancy (Case 13 in Table 1). Despite the faint visualization of mediastinal lymph nodes in this patient, visualization of mediastinal lymph nodes in patients with gastric carcinoma was rare and the mediastinal nodal uptake of radioactive colloid overall was poor (see Fig. 3).

gest that cephalad lymph drainage from the gastric cardia to the mediastinum directly is rare compared to downward lymph flow from the distal esophagus. Although considerable variation may exist between the flow of radioactive colloids and metastatic cancer cells, the findings support clinical observations on the modes of lymph node metastases in patients with either lower esophageal or gastric cancer. The importance of lymph node involvement around the celiac artery and abdominal aorta should also be considered in operative management of cancer of the lower esophagus and gastric cardia.

Regional lymph nodes were visualized on lymphoscintigraphy in only 6 of 19 patients (31%), and moreover, no difference was detected between the radioisotopic uptake by cancer-free and metastatic nodes. Accordingly, the value of lymphoscintigraphy as a diagnostic tool for diagnosis of lymph nodal metastases is poor.

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