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## 特別掲載

LYMPHOGRAPHIC AND VENOGRAPHIC DIAGNOSIS  
OF THE MEDIASTINAL AND  
RETROPERITONEAL TUMORS: EXPERIMENTAL  
AND CLINICAL STUDIES

by

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脈管造影による縦隔及び後腹膜腫瘍診断の実験的  
並びに臨床的研究

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(昭和42年 4 月 18 日 受付)

脈管造影殊にリンパ造影は悪性腫瘍のリンパ節転移並びに系統的リンパ節疾患の解明に光明をもたらし、近年急速に普及しつつある。著者は本造影を後腹膜腫瘍診断に応用し、更にリンパ系と解剖学的に密接な関係にあり、腫瘍による影響を受け易い静脈の造影を併用し、診断能の向上をはかった。又、胸部悪性腫瘍の問題点は、縦隔腫瘍、食道癌、縦隔型肺癌の縦隔浸潤及び縦隔リンパ節転移である。従来は胸部の血管を造影する事により診断の一助とし、更に食道、気管、気管支造影、縦隔充气造影を合せ行つて、かなりの成果をあげた。しかし多くの造影診断の努力にも拘らず、不満足な結果に終る事も多く、胸管並びに縦隔リンパ節造影による診断を行つた。

しかし従来の方法ではすべての縦隔リンパ節像は得難い。従つてその造影を容易且つ確実に得る為に新しい造影法が必要であり、間接的リンパ造影法を試みた。

間接的リンパ造影法は Menkes, P. Ruben Kohler 等により試みられたが、いずれも未だ確実な造影法でない。

著者は新しい造影剤 (Popiodol Emulsion) を試作し、実験的に間接的リンパ造影を行い、後腹膜並びに縦隔リンパ節像を得た。

結論、1. リンパ管外注入によるリンパ節造影剤を新たに考案した。

2. 本造影剤を用い、直接法では困難な胸骨下、縦隔、気管分岐部並びに腹部リンパ節の造影を可能とした。

3. 直接的リンパ造影法は後腹膜腫瘍診断に有力な指針となつた。

4. 静脈併用造影により後腹膜腫瘍の診断能を高めた。

5. 胸管造影により、縦隔腫瘍、食道癌、縦隔型肺癌の縦隔浸潤乃至リンパ節転移の一部を知り得た。

### Introduction

In recent years, diagnostic method of malignant tumors have been greatly improved by the technique of angiography.

In addition, there has been a rapid growth in the application of lymphography for diagnosis of metastases of carcinoma and malignant lymphoma which are hardly possible to diagnose accurately until today.

The lymphographic method in particular, has been applied for the retroperitoneal tumors which can be combined with the venography for evaluation of these tumors. This combined veno-lymphography has done much to contribute the diagnostic accuracy.

For the diagnosis of the metastatic lymphodes of the retroperitoneal tumors, oesophageal cancer, mediastinal infiltration of the lung cancer, the application of these techniques are important and need much to be studies.

Although angiography, fluoroscopic examination of the oesophagus, bronchography and pneumo-mediastigraphy have been also used for diagnosis of the malignant mediastinal tumors, and these radiographic examinations are valuable methods, however, these constitute the routine work which not infrequently miss the accurate diagnosis for which we are aware. For the diagnosis of mediastinal malignancies, it is necessary therefore to use a method to opacify the mediastinal lymphnodes.

Such means as the thoracic ductography and mediastinal lymphography which are so-called direct lymphography are performed for the opacification of the mediastinal lymphnodes. Since complete opacification is not readily available, the diagnosis of these malignancies would be very difficult.

In order to assure opacification which should provide better diagnosis of malignancies, a new indirect lymphography has been tried. Menkes<sup>1)</sup>, Carvalho et al.<sup>2)</sup>, Menville et al.<sup>3)</sup>, Fujimoto<sup>4)</sup>, Tashiro<sup>5)</sup> have tried the indirect lymphography using thorotrast and iodined oily contrast media. In 1963, J. George Telick, Marvin E., Haskin et al.<sup>6)</sup> and P. Ruben Koehler<sup>7)</sup> have reported that they have injected a contrast medium into the peritoneal cavity of the animals for the opacification of the lymphatic system. But they were not successful. The present experimental method is the indirect lymphography by means of employing a new contrast medium.

## I. Experimental Indirect Lymphography

### A. Method

#### 1. The experimental animal

The dogs were anesthetized with 0.5 ml per kg of 0.5 w/v % sodium pentobarbital in all trials.

Table 1

Component	Content of Iodine	Particle of Contrast Medium	Note
Popiodol, 5% Glucose, Tween 20, 10% Sodium Lauryl Sulfate.	16 w/v %	Smaller than 0.5 $\mu$	emulsified by ultrasonic (20 KC) for 5 min. and sterilized. Specific Gravity 1.102 (15.0°C) 1.101 (37.2°C) Viscosity 8.1 cps (15.0°C) 7.7 cps (37.0°C)

## 2. Contrast medium

Contrast medium used was Popiodol Suspension composed of popiodol, 5% glucose, tween 20, sodium lauryl sulfate and span. This is an emulsion of oil in water and has a oily particle of 0.5 to 1.0  $\mu$  in diameter, and contains of 4.6 w/v% to 45.6 w/v% iodine. (Table I)

## 3. Technique and location of injection

### a. Intrapleural studies

Ten to twenty ml of Popiodol Suspension was injected percutaneously into the pleural cavity under the fluoroscope.

### b. Intramediastinal studies.

A long needle adapted to a syringe was introduced to the calina through the bronchoscope. Then contrast medium was injected into the bronchial wall of the calina. In addition, before and after administration of contrast medium, 20 to 50 ml of air was injected into the mediastinal cavity.

### c. Injection into the bronchial wall

The needle was pierced into the right bronchial wall through the bronchoscope under the fluoroscope and the contrast medium was injected.

### d. Intraalveolar studies

Ten ml of contrast medium was injected directly into the right pulmonary tissue.

### e. Intra bronchial studies

According to the technique of bronchography, ten ml of contrast medium was injected into the bronchial lumen through the KIFA green catheter.

### f. Injection into the bronchial artery.

A tip of the KIFA red catheter was inserted into the bronchial artery by Seldinger's technique and 10 ml of the contrast medium was injected slowly.

### g. Intraperitoneal studies

Twenty ml of the contrast medium was injected percutaneously into the right lower abdominal wall. For acceleration of absorption of contrast medium, massaging and use of hyaluronidase have been tried.

## 4. Roentgenography

Roentgenograms were taken immediately and followed up to 68 days after administration of contrast medium. Posterior-anterior and lateral projections of the chest and abdomen were taken. The lymphnodes of serous cavities (pleura, peritoneum), retroperitoneum, and mediastinum were resected in two to sixty eight days after administration of the contrast medium and radiography of these lymphnodes were carried out.

## B. Results

### 1. Intrapleural injection

As demonstrated in Fig. 1, the contrast medium was diffusely expanded in the pleural cavity. Immediately after administration of contrast medium, the lymph vessels and lymph nodes could not be opacified. At 2 hours after administration as shown in Fig. 2, the substernal lymph vessels and lymphnodes were visualized, and lymphnodes were demonstrated more clearly about twenty-four hours later (Fig. 3).

Fig. 4 shows the roentgenographic appearances of the resected lymph nodes in case of Fig. 3.

According to the histological investigation of these nodes, enlargement of the reticulum cell, expansion

Fig. 1 An X-ray film of the chest which was taken immediately after intra-pleural injection of the contrast medium.



Fig. 2 A left oblique view of the chest taken after 2 hours of intrapleural injection.

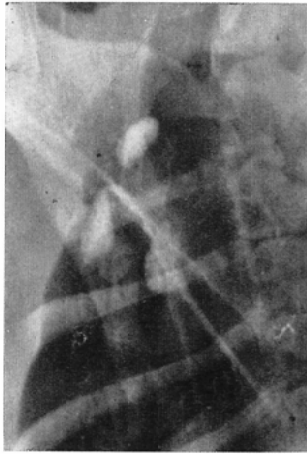


Fig. 3 An X-ray film taken at 24 hours after administration of contrast medium into the right or left intra pleural cavity.

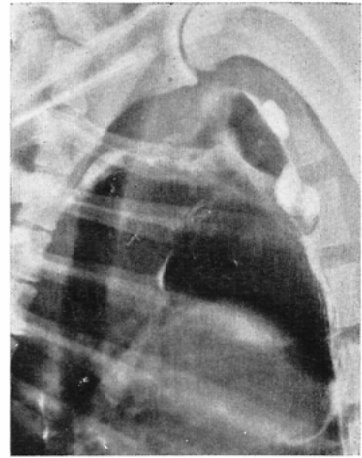


Fig. 4 Resected lymph nodes from the case of Fig. 3.

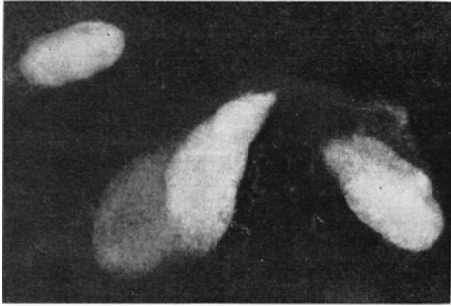


Fig. 5a Histological pattern of the opacified node which was resected from the case of Fig. 3. ( $\times 400$ )

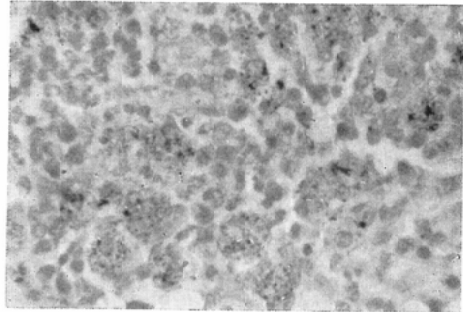


Fig. 6 A roentgenogram taken immediately after the injection into bronchial wall.

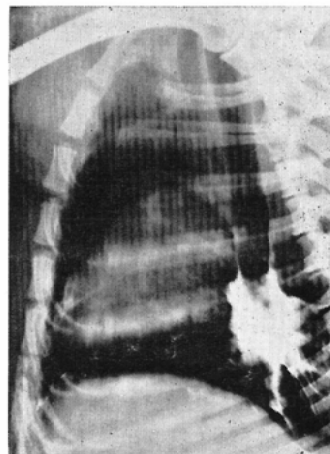
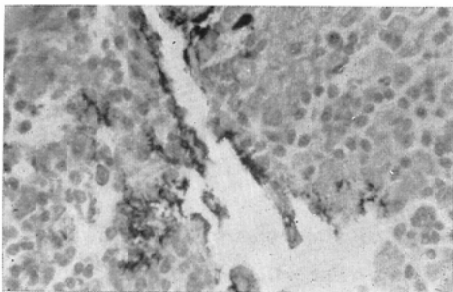


Fig. 5b ( $\times 400$ )



of the lymphatic sinus and phagocytosis of the reticulum cell were observed (Fig. 5). The animals showed no ill effects.

2. Injection into the bronchial wall and the mediastinal cavity

Injection of contrast medium into only bronchial wall was tried but small amounts of contrast medium seemed to have escaped into the peribronchial tissue, mediastinum and bronchus (Fig. 6).

Fig. 7 illustrates the chest x-ray film taken at 24 hours after administration of contrast medium into the bronchial wall and the mediastinum. The substernal and anterior mediastinal lymphnodes were clearly opacified, but small amounts of contrast medium remained in the site of injection.

Remaining contrast media had disappeared from the mediastinal cavity and bronchus within one week after administration.

Fig. 7 Lateral tomogram taken at 24 hours after administration of contrast medium in the case of Fig. 6.



Fig. 8 Resected bronchial lymph nodes.

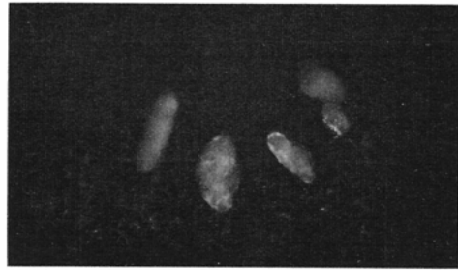


Fig. 9 24 hours chest X-ray film after intraperitoneal administration.

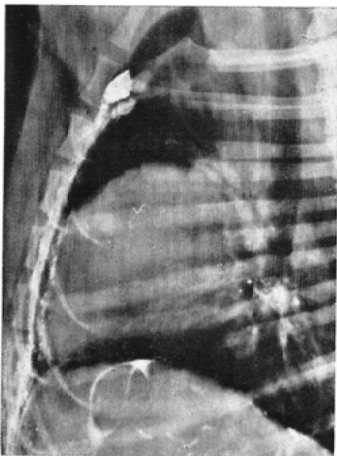
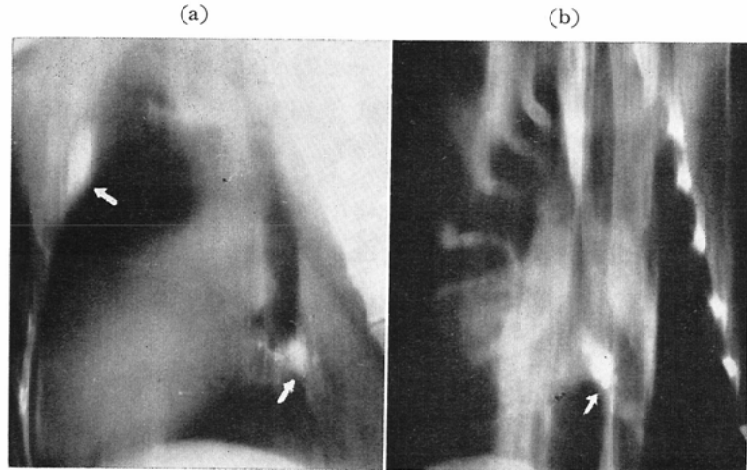


Fig. 10a Lateral tomogram of the chest in the case of Fig. 9.  
10b P-A tomogram of the chest.



The hilar lymphnodes which could not be observed in routine x-ray film were opacified completely (Fig. 8).

### 3. Intraalveolar studies

The mediastinal and hilar lymphnodes could not be opacified by means of these techniques.

### 4. Intraperitoneal studies

By 24 hours after the administration of contrast medium, the substernal lymphatics, the parabronchial and subdiaphragmatic lymphnodes were clearly opacified (Fig. 9, Fig. 10 a, b, Fig. 11).

Small amounts of contrast medium still remained in the peritoneal cavity as long as 24 hours but on the following 6th day, practically the contrast medium had disappeared.

By 68 days after the administration of contrast medium, particles of contrast medium were histologically demonstrated in the substernal, mediastinal, parabronchial and subdiaphragmatic lymphnodes.

The particles of contrast medium were also observed in the paraaortic and mesenteric lymphnodes which could not be demonstrated in x-ray film (Fig. 12).

Fig. 11 An X-ray film taken at 24 hours after intraperitoneal injection.

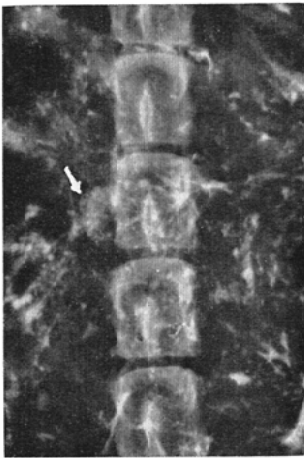
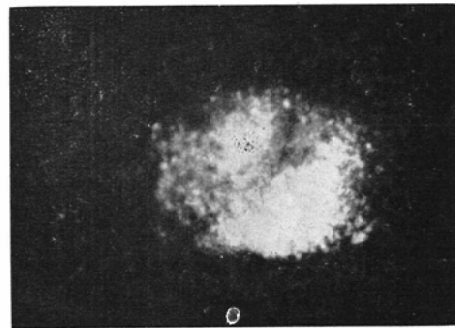


Fig. 12 Resected subdiaphragmatic lymph node.



The rapid removal of the injected contrast media from the peritoneal cavity was rather surprising and no ascites could be seen in the peritoneal cavity, but intestinal adhesion was evident.

### 5. Intrabronchial studies

Small amounts of injected contrast medium had remained a prolong period which made the bronchial lymphnodes opacify.

### 6. Injection into the bronchial artery

No hilar lymphnodes could be visualized.

### C. Side effects

Particles above  $3\mu$  in diameter with high specific gravity showed poor absorbability while adhesion of the tissues was frequently observed.

### D. Discussion

Olof Rudbeck<sup>9)</sup> (1963) has first observed the pleural lymphatic vessels of the dog. Mascagni<sup>9)</sup>

(1787), Cruikshank<sup>10)</sup> (1790) and Miller<sup>11)</sup> (1896) have also studies on the pleural lymphatics. In Japan Kihara<sup>12)</sup> (1924) has reported the classification of the deep pulmonary lymphatics into three classes, and recognized the lymphatic vessels flown to the deep lymphatics from the pleural area. Kutsuna<sup>13)</sup> (1935) has observed the lymphatics of the alveolar wall by injecting the dye into the lung of dog, while, Mori<sup>14)</sup> (1940) has suggested that the pulmonary lymphatics were consisted of the subpleural and bronchial lymphatics.

Higgings<sup>15)</sup> on the other hand, has classified the intraperitoneal lymphatic system into four groups:

- 1) The lymphatics of the peritoneal cavity drain into the diaphragm and intercostal muscle. Two to three lymphatic channels lie along the course of the sternal artery and vein, then drain into the right lymphatic trunk and thoracic via the intercostal lymphnodes.
- 2) Lymph drainage into the hilar nodes via the mediastinum.
- 3) Direct drainage into the thoracic duct.
- 4) Drainage into the lymphnodes around the kidney or pancreas through the diaphragm.

His studies indicated that 80% of the substances injected into the peritoneal cavity had drained sub-sternally into the right lymphatic trunk or thoracic duct. With the pleural, intrabronchial and mediastinal injection of the contrast medium, it is possible to opacity the subdiaphragmatic, mediastinal, sub-sternal and hilar lymphnodes.

It is thought that as the particles of the contrast medium are absorbed into the lymphatic system and are phagocytized by the reticulum cells, opacification of lymphnodes would be the result. These lymphnodes can be visualized only by the technique of indirect lymphography.

Gillian and Conklin<sup>16)</sup> (1938) have reported that the largeness of the particle which could pass through the wall of the lymphatic vessels is  $2\mu$  in diameter. The particle of contrast medium in the present experiments is 0.3 to  $3\mu$  in diameter.

Nothnagel<sup>17)</sup> has explained that the erythrocytes in the bronchus have been observed in the lymphatics 3 to 5 minutes later. While Umeda<sup>18)</sup> also reported that Orange G injected into the bronchus could be observed in the bronchial lymphnodes in 15 minutes after administration.

According to Drinker<sup>19)</sup>, that it is possible to observe Evans blue in the right lymphatic trunk when the dye was injected into the bronchus 20 to 30 minutes after administration, and visualization of the lymphnodes was available 2 hours after administration of the contrast medium. It was observed that adhesion of the organ and retention of the contrast medium in the serous cavity or tissues have occurred as the side effects. It should be noted that these deleterious side-effects caused by contrast medium need to be prevented for clinical uses. Further investigation with the use of animal experiments is undertaken at present to find the minimum dosage necessary for adequate opacification.

## II. Clinical Studies

### A. Direct lymphographic diagnosis of the retroperitoneal tumors<sup>20), 21)</sup>.

#### 1. Technique

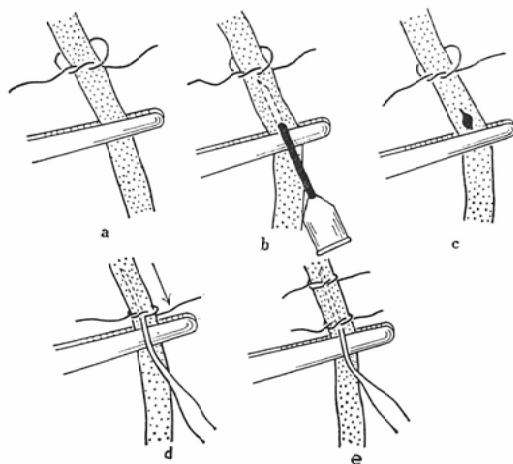
The technique of lymphography described by Kinmonth and his associates in 1954 has been adapted.

Fig. 13 shows the technique in canulation into the lymph vessel. The canula is made of polyethylene tube which is stretched on the burner.

The polyethylene needle is connected to a hand injector or motor driven infusion pump and 10 ml of Popiodol (ethylester of popy seed oil) is injected into the lymphatic channel of each extremity over a



Fig. 13 Technique in canulation into lymph vessel.



30 to 40 minutes period of time.

X-ray films of the pelvis, abdomen and chest in P-A, left or right oblique position are taken immediately after the procedure and repeated in twenty-four hours.

The lymphatic channels are observed immediately after the administration of the contrast medium and the lymphnodes are visualized in 24 hour x-ray film.

## 2. Results

The lymphography was performed in 232 patients. One hundred forty three out of 232 cases had suffered from the retroperitoneal tumors (Table 2).

### a. X-ray findings of the lymphatic vessels

X-ray findings of the normal lymphatic vessels are 0.1 to 0.2 cm in diameter like yarn.

The pelvic lymph vessels are divided into the external iliac group, hypogastric group, and common iliac group.

These lymphatic vessels usually have communications with each other and continue to the paraaortic lymphatic vessels and ascend to the level of receptaculum chyli and ductus thoracicus.

Table 2

Cancer of the Cervix	97
Cancer of the Oesophagus	15
Cancer of the Lung	16
Malignant Lymphoma	20
Seminoma	14
Cancer of the Bladder	8
Cancer of the Breast (Post Operation)	7
Edema of the Extremity	7
Cancer of the Rectum	4
Bone Tumor	4
Mediastinal Tumor	4
Tumor of the Testis	3
Miscellaneous	33
Total	232

Table 3 X-ray Findings

Cases		Lymph Vessel			Lymph Node			
		Dislocation	Stenosis	Collateral Circulation	Enlargement	Filling Defect	Irregularity of Margin	Foamy Pattern
Uterine Cancer with or without Metastases	II-Stage 48	16	1	8	15	21	24	18
	III-IV 25	20	3	8	9	21	18	19
	Recurrence 6	2	5	4	4	3	5	5
Malignant Lymphoma	13	9	2	5	7	6	7	8
Hodgkin's Disease	7	6	0	5	5	3	2	2
Seminoma	7	4	0	3	3	6	5	4
Cancer of the Rectum	6	1	0	1	0	3	3	4
Bone Tumor	4	2	1	1	0	3	2	1
Miscellaneous	33	14	4	13	10	12	15	13
Total	149	74	16	48	53	78	81	74

Fig. 14 Hodgkin's disease. Filling defects of the paraaortic nodes are seen.

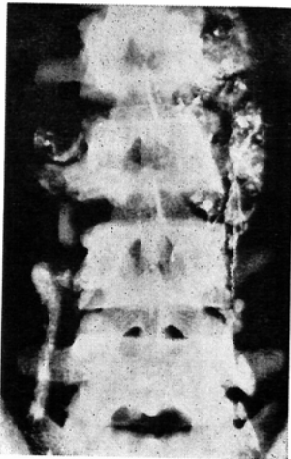
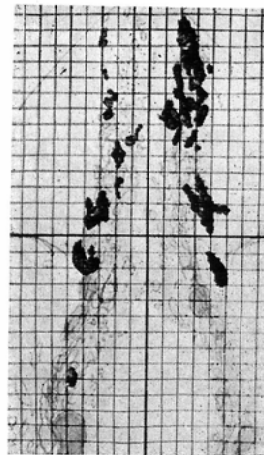


Fig. 15 Hodgkin's disease.



X-ray findings of the abnormal lymphatic vessels are as follows; dislocation, narrowing, stenosis, dilatation, obstruction and increased collateral circulation (Table 3).

b. X-ray findings of lymphnodes

Lymphographic patterns of normal lymphnodes are smoothly margined and have the largeness like a red bean or a soy bean, sometimes show like a sickle or the form of an ellipse.

Lymphographic patterns of the pathological lymphnodes are as follows: enlargement, filling defect, foamy pattern and irregularity of margin (Table 3).

I. Hodgkin's disease

Lymphographic patterns of lymphnodes in Hodgkin's disease show filling defect, enlargement and foamy pattern. And also irregularity of margin of lymphnode can be seen.

New moon like filling defect or central filling defect especially is demonstrated in Hodgkin's disease. Saccular or reticular and mixed aptterns were often observed (Fig. 14).

Fig. 15 shows the schema of the lymphograms of Hodgkin's disease. Many pathological lymph-

Fig. 16 Malignant lymphoma. Enlargement and foamy pattern on the paraaortic nodes are observed.

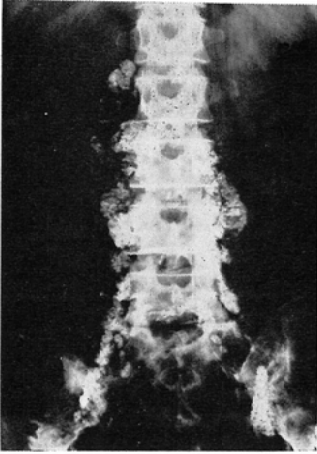


Fig. 18 Seminoma.

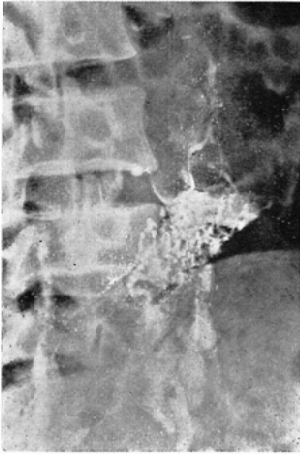
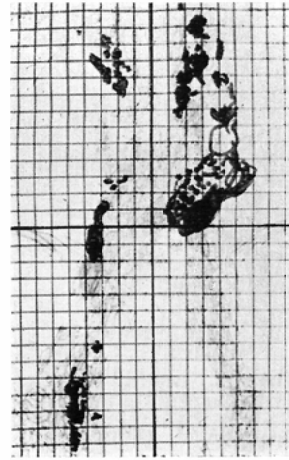


Fig. 17 Schema of lymphographic pattern in malignant lymphoma.



Fig. 19 Schema of lymphographic pattern in seminoma.



nodes are shown in Fig. 15.

## II. Reticulum cell sarcoma and lymphosarcoma

Net like pattern is observed in the lymphograms of reticulum cell sarcoma and enlarged foamy pattern in the lymphosarcoma. However, it is extremely difficult to differentiate these lymphoma from Hodgkin's disease by the lymphographic patterns (Fig. 16).

Fig. 17 shows the schema of the lymphograms of reticulum cell sarcoma and lymphosarcoma.

## III. Seminoma

The lymphographic patterns in seminoma often show enlargement, irregularity of margin and foamy pattern of paraaortic lymphnodes but no filling defect (Fig. 18). Fig. 19 shows the schema of the lymphogram of seminoma.

IV. Uterine cancer

In the lymphograms, filling defect was often demonstrated in the pelvic region. And also marginal irregularity was observed (Fig. 20).

V. Miscellaneous

Fig. 21 illustrates the lymphographic schema of cancer of the bladder. Various abnormal findings could be seen in the pelvic lymphnodes.

Table 3 summarized x-ray findings of lymph vessels and lymphnodes of these tumors. Increased col-lateral circulation, dislocation of lymph vessels and filling defect, foamy pattern of lymphnodes are frequently demonstrated.

Fig. 20 Schema of lymphographic pattern in uterine cancer.

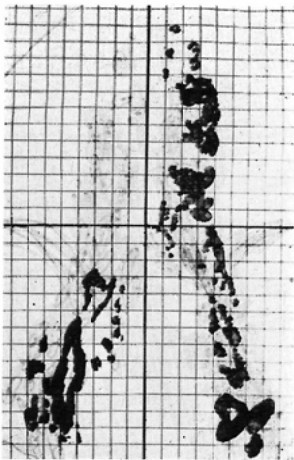


Fig. 21 Schema of lymphographic pattern in bladder cancer.

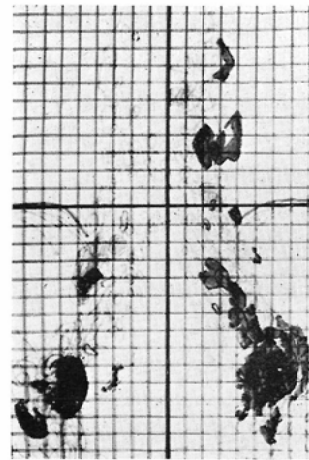
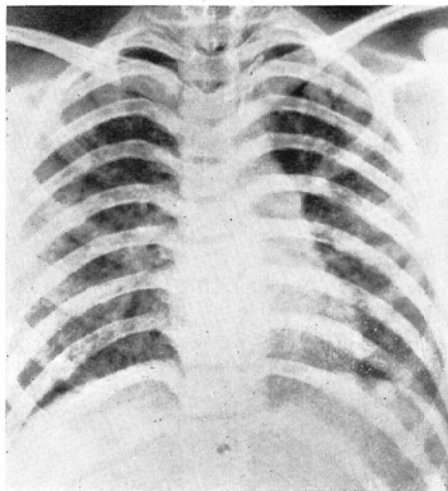


Fig. 22 P-A view of a chest shows embolism caused by contrast medium.



### 3. Complication

Three cases of severe pulmonary embolism and 2 cases of lymphangitis were observed, moreover, an attack of fever, traction pain of the lower limbs by the administration of contrast medium were also recognized. Extravasation of contrast medium and rupture of lymphatic vessels are observed, but no clinical symptoms were presented.

Fig. 22 shows a cases of pulmonary embolism which occurred in one hour after administration of oily contrast medium. This patient presented the symptoms of shock such as dyspnea, cyanosis and bradycardia.

### B. Combined veno-lymphographic examination<sup>20), 21)</sup>

Intraosseous venography is combined within 24 hours after performing lymphography.

#### 1. Method

##### a. Technique

A bone marrow needle of 105 mm length, 0.8 mm in diameter is introduced into the medullary cavity. The needle was connected to a 20 ml manual syringe by a piece of flexible vinyl tube, and 20 ml of contrast medium (conray) are injected rapidly.

For the visualization of the pelvic vein and inferior vena cava, the needle is introduced into the trochanter and anterior iliac crest. The best injection site of the needle for azygography is the eighth to ninth rib in the middle axillary line.

##### b. Roentgenography

A series of 10 roentgenograms were taken serially after the injection of 20 ml of contrast medium.

#### 2. Results

Intraosseous venography was performed in 183 patients as shown in (Table 4). Combined veno-lymphographic examination was performed in 70 cases of the retroperitoneal tumors. Fig. 23 shows normal venogram.

Filling defect, dilatation, dislocation and increased collateral circulation are observed as the pathological x-ray findings of venograms (Table 5). Fig. 24 shows the combined veno-lymphogram of carcinoma of the uterine cervix. As shown in Fig. 24, left common iliac vein is dislocated to upper lateral side and the lymphnode of this part is not opacified. Then metastasis of this lymphnode was suspected. Then

Table 4

Cancer of the Cervix	97
Cancer of the Oesophagus	12
Cancer of the Lung	11
Malignant Lymphoma	11
Seminoma	7
Cancer of the Bladder	5
Cancer of the Breast (Post Operation)	2
Edema of the Extremity	1
Cancer of the Rectum	0
Bone Tumor	1
Mediastinal Tumor	3
Tumor of the Testis	0
Miscellaneous	33
Total	183

Fig. 23 Normal venogram.



Fig. 24 Combined veno-lymphogram shows dislocation of the left common iliac vein by invaded lymph node.

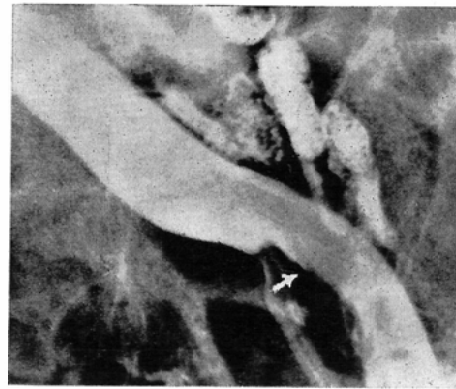


Table 5 X-ray Findings

Cases	Compression	Irregularity of Margin	Stenosis	Obliteration	Delayed Visualization	Collateral Circulation
Uterine Cancer with or without Metastases	II Stage 49	16	15	5	17	11
	III—IV 41	17	13	16	29	8
	Recurrence 13	7	8	6	8	0
Cancer of the Oesophagus and Stomach 12	6	4	3	1	1	3
Retroperitoneal Tumor 10	4	1	0	4	0	5
Cancer of the Lung 7	1	0	2	4	0	3
Mediastinal Tumor 5	1	0	0	1	0	1
Seminoma 4	3	2	0	0	2	1
Miscellaneous 12	0	0	0	4	0	5
Total 153	55	43	32	68	22	50

the suspected lymphnode was dissected by operation and the infiltration of carcinoma of whole area of this node was verified histologically. Although lymphnodes are not opacified in this case, pathological lymphnodes are demonstrated by venography. Table 5 shows the diagnostic accuracy of combined method compared with operative findings. According to this table, the most accurate diagnosis could be obtained by the combined method.

### 3. Complication and side effects

Two patients developed into shock condition immediately after the injection of contrast medium. One patient was operated for the resection of broken needle during the introduction into the medullary cavity. Accidental injection into the pleural and joint cavity sometimes had occurred. No case of complication such as osteoporosis, hematoma, thrombophlebitis and osteomyelitis were recognized in long term observation.

### C. Thoracic ductography and mediastinal lymphography<sup>22), 23)</sup>

Thoracic ductography and mediastinal lymphography, according to the Kinmonth's technique,

were carried out for diagnosis of metastases and infiltration of the mediastinal tumors, such as cancer of the oesophagus and lung.

1. Method

a. Technique

See A-1.

b. Roentgenography

For the visualization of the complete thoracic duct, the radiographic timing should be considered. Table 7 shows the transition of opacification of lymphatic system which is investigated with  $^{131}\text{I}$ -labelled oily contrast medium. As shown in Table 7, thoracic ductogram should be taken at 30 to 40 minutes after injection. The patient was put in supine position with elevated hip. Spot films should be taken

Table 6 Diagnostic Accuracy Proved Clinically or at Operation

Proved at Operation	62 Cases
Lymphography	80%
Venography	74%
Combined Method	83%

Table 7

Time from the Beginning of Injection	Volume of Injected Contrast Medium	Evaluated Sites
3 (min.)	3 (ml.)	Lymph Vessel of Lower Extremity, Femoral Lymph Nodes
5	5	Inguinal Lymph Nodes
10	9	Partial Pelvic Lymph Nodes
17	16	Whole Pelvic Lymph Nodes
22	20 (finished)	Lumbar Lymph Nodes
25		Thoracic Duct negative
30		Cisterna Chyli and Lower Part of Thoracic Duct
40		Whole Thoracic Duct

Fig. 25 Normal thoracic ductogram.

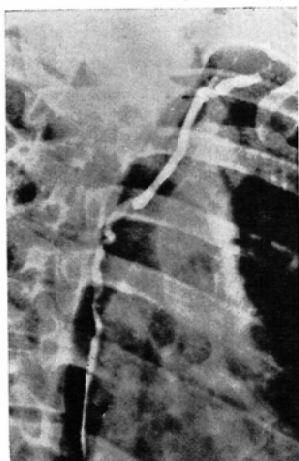
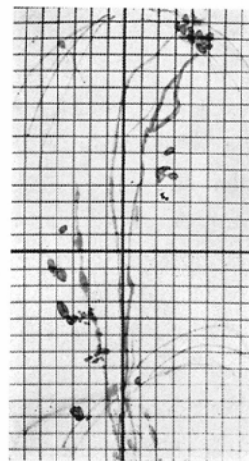


Fig. 26 Schema of normal thoracic ductogram.



under fluoroscopic examination when the complete thoracic duct was demonstrated by contrast medium, because the mediastinal lymphnodes were sometimes opacified by thoracic ductography. The chest x-ray films were taken on 24 hours after the administration of contrast medium. In the cases which the mediastinal nodes are opacified, P-A, lateral tomograms are also taken.

## 2. Results

### a. Normal thoracic ductogram

The Cisterna chyli is a spindle form or an ellipse-shaped. The thoracic duct starts from the cisterna chyli on the level of the supradiaphragm. The thoracic duct, 2 to 3 mm in diameter, ascends to the venous angle; sometimes, 2 to 3 thoracic ducts and normal mediastinal lymphnodes are opacified (Fig. 25). Fig. 25 shows the normal thoracic ductogram. Thoracic duct is divided into 2 to 3 before communication with the venous angle. Fig. 26 shows the schema of thoracic ductogram of several cases. The mediastinal lymphnodes and right thoracic duct are opacified in some cases.

### b. Pathological thoracic ductogram

When the thoracic duct is infiltrated with carcinoma of the oesophagus and lung, such findings as compression, dislocation, obstruction, filling defect, kinking, dilatation and pooling like diverticulum are usually observed in the thoracic ductogram. In addition to these changes, increased collateral circulation of the thoracic duct is also seen. Sometimes many mediastinal lymphnodes are also opacified. Abnormal x-ray findings of the mediastinal lymphograms are enlargement, filling defect and foamy pattern. In mediastinal type of the lung cancer, enlargement, filling defect and foamy pattern or moss eaten appearance of the mediastinal lymph nodes are demonstrated (Fig. 27). And also dislocation of the thoracic duct due to the tumor is seen as demonstrated in (Fig. 28). In the oesophageal cancer, obstruction, filling defect of the thoracic duct were observed in the region where stenosis of oesophagus are recognized fluoroscopically (Fig. 29). Azygography in this patient was also performed; increased collateral circulation and filling defect of azygos vein are demonstrated. Fig. 30 and 31 illustrate the schema of the

Fig. 27 Lymphogram shows metastatic lymph nodes from the mediastinal type of lungcancer. Enlargement, filling defects and foamy pattern are seen in the invaded lymph nodes.

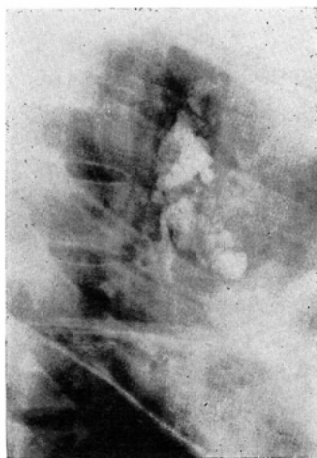


Fig. 28 Thoracic duct is dislocated by the mediastinal type of lung cancer.

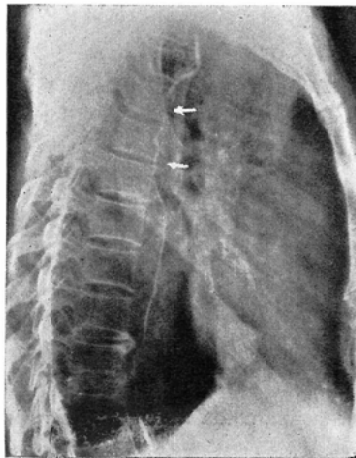




Fig. 29 Cancer of the oesophagus Obliteration of thoracic duct and filling defects in the invaded mediastinal lymph nodes are observed.



Fig. 30 Schema of thoracic ductogram in the mediastinal type of lung cancer.

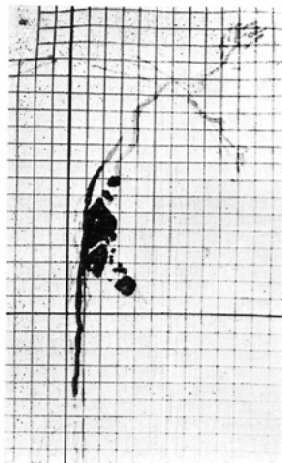


Fig. 31 Schema of thoracic ductogram in cancer of the oesophagus.

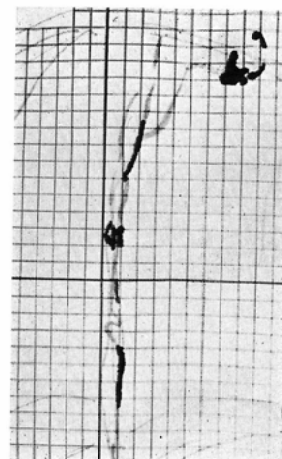


Table 8

Thoracic ductography	140 Cases
Rate of Opacification of Thoracic Duct	109/ 140 (77.9%)
Rate of Opacification of Mediastinal Lymph Nodes	
a) Cases without Pathological Changes in the Mediastinum	5/ 114 ( 4.4%)
b) Mediastinal Tumor, Cancer of the Oesophagus and Mediastinal Type of Lung Cancer	17/26 (65.4%)
Rate of Opacification of Mediastinal Lymph Nodes by Compression at the Venous Angle	
a) Cases without Pathological Changes in the Mediastinum	4/13 (30.8%)
b) Mediastinal Tumor, Cancer of the Oesophagus and Mediastinal Type of Lung Cancer	5/10 (50.0%)

thoracic ductogram of the lung cancer. Dislocation and dilatation of the thoracic duct and abnormality of the mediastinal lymphnodes and back flow of the contrast medium to the supraclavicular lymphnodes are observed in many cases. Thoracic ductography was performed in 140 cases as shown in Table 8. Opacification of the mediastinal nodes were frequently observed in the patients of the oesophageal, pulmonary carcinoma and tumor metastases in the mediastinum.

#### D. Discussion and Conclusion

The lymphography is useful for a diagnostic method of the retroperitoneal tumors, but it is of little value for the differential diagnosis of the malignant lymphoma.

Zuppinger et al.<sup>24)</sup>, Rüttiman<sup>25)</sup> have described the lymphographic patterns of Hodgkin's disease, reticulum cell sarcoma and lymphosarcoma in their recent papers. It appears that these patterns are seemingly identical and no way offers decisive presentation for the differentiation of these malignancies.

X-ray findings of respective disease patterns are summarized in table 3, these revealed nothing of particular pattern of their own. In the investigation of the lymphographic patterns when one lymphogram is sliding over the other in reference to the disease, the metastatic lymphnodes would readily be observed; the method provides valuable means for the differential diagnosis. Ditchek et al<sup>26)</sup>. have described in their paper that the filling defect due to fibrotic changes of the lymphnodes, lack of the injected contrast medium and inflammatory enlargement have presented the similar findings with tumor metastases that the differentiation between these would hardly be possible.

X-ray findings of venography is summarized in Table 4.

Wise et al<sup>27)</sup>. have reported that the venographic findings caused by tumors are obstruction, shunt, dislocation, deformity and collateral circulation.

Diagnostic accuracy of lymphography, venography and with combined method are shown in Table 6. If the spot films were taken in supine position and under compression of the left supraclavicular region, the complete thoracic ductogram could be obtained. But it is difficult to be opacified in cases which the thoracic duct has been infiltrated and the lymph flow is interrupted by tumors. In the case of mediastinal tumors, oesophageal and lung cancers, opacification of the mediastinal lymphnodes by the thoracic ductography seemed to be easier to obtain than in normal. It is assumed that the back flow of the contrast medium to the collateral circulation caused by the shunt of the thoracic duct makes the mediastinal lymphnodes opacify. In the lung cancer, it was proved histologically that sometimes the thoracic duct was filled with carcinomatous cells. In this case, filling defect and obstruction were observed in the thoracic duct. The accurate informations about operability or planning of radiation therapy of the oesophageal carcinoma have been made possible by obtaining the ductogram. Furthermore, if it was combined with the azygography, more significant informations could be obtained. It may fairly be said that the visualization of the mediastinal lymphnodes by Kinmonth's technique is a matter of incidental observation. So far as the author is aware, the present study is the first report designed to visualize the mediastinal lymphnodes by the indirect method.

### III. Conclusion

- 1) The indirect lymphography method employing the radiopaque suspension has been introduced as a valuable diagnostic procedure.
- 2) The substernal, mediastinal, hilar and abdominal lymphnodes were possible to opacify by indirect lymphography with the most suitable radiopaque suspension substance.
- 3) The direct lymphography is found to be useful for diagnosis of the retroperitoneal tumors.
- 4) Combined veno-lymphography is a reliable technique to obtain the better diagnostic accuracy in the retroperitoneal tumors.
- 5) Diagnostic informations on the metastatic mediastinal lymphnodes caused by the mediastinal malignancies, cancer of the oesophagus and lung can frequently be obtained by the thoracic ductography.

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