Scintigraphic distribution of lymphatic flow in the mediastinum after oral administration of radiolabeled lipid and its influx into blood circulation

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During thoracic operations, it is sometimes difficult to determine the route of collateral circulation of the thoracic duct, the site of chyle leakage, or both. In addition, the dynamics of lymph flow in the thoracic duct in diseased patients are impossible to understand with routine radiologic examinations, such as plain film, magnetic resonance imaging, and chest computed tomography (CT). Several diseases involve the thoracic duct, such as chylothorax,^{1,2} lymphangiomyomatosis, and lymphangiectasia.³ We herein report the case of a patient with a disorder of the thoracic duct in whom we successfully detected multiple flow routes of chyle, its abnormal accumulation in the mediastinum, and its influx into the blood circulation after the oral administration of iodine 123-labeled (¹²³I) 15-(p-iodophenyl)-3-R, S-methyl pentadecanoic acid (BMIPP).⁴

The patient was a 50-year-old woman who had an abnormal shadow in the medial side of the right lower lung field. Chest CT revealed a tumor-like soft tissue mass 3 × 3 cm in size with fat density in the right lower anterior mediastinum and right thoracic effusion, suggesting diaphragmatic hernia (Figure 1, A). She was transferred to our hospital because of a slight increase of tumor size and dyspnea, and thoracotomy was carried out in June 1999. Operative findings showed a yellow, solid mass with pleural effusion identified as chyle. Macroscopically, we diagnosed her condition as liposarcoma with invasion to the thoracic duct. We removed the tumor and ligated the thoracic duct just above the diaphragm. Her condition was excellent after the operation. However, on postoperative day 13, a chest radiograph and a CT

scan (Figure 1, B) showed dilatation of the mediastinum and right pleural effusion, and thus tube drainage was undertaken. Histologic examination revealed a granulomatous lesion with marked dilatation of the lymphatic vessels, suggesting occlusion or marked stenosis of the thoracic duct.

We performed contrast lymphangiography after cannulation of an afferent lymph vessel on the dorsum of the left foot but failed to detect the lymphatic flow in the mediastinum. Then ¹²³I-BMIPP, a radiolabeled long-chain fatty acid that is usually used for cardiomyoscintigraphy, was administered orally and was subsequently imaged by means of radioisotope scintigraphy. Plasma activities of ¹²³I-BMIPP were also monitored. Figure 1, D, shows a scintiscan of this patient 300 minutes after administration of ¹²³I-BMIPP. There were 3 routes of upward flow from the diaphragm and 3 transverse communications between them. At the left side of the aortic arch, marked accumulation of the isotope was also present. These scintiscans in the upper mediastinum of the patient were visualized 200 minutes after oral administration, whereas those of normal volunteers were visualized about 100 minutes after administration (Figure 1, C). Abnormal accumulation of the isotope was also observed the day after the examination. On the basis of these findings, we speculate that the influx of chyle into the blood circulation from the thoracic duct was severely impaired. However, the plasma activities of ¹²³I-BMIPP after its oral administration gradually increased (Figure 2). This means that the thoracic duct was not obstructed completely. Low-fat diet therapy was carried out for about a month, and the drainage tube was then removed. The patient was discharged from our hospital and had not had enlargement of the mediastinum or pleural effusion as of November 2000.

In this case we initially failed to demonstrate the thoracic duct with lymphangiography, which is generally performed to visualize lymphatic ducts. One of the possible reasons for this was that the lymph flow from the left foot was diluted by the lymph flow from the small intestine. We subsequently attempted to visualize the thoracic duct with scintigraphy using ¹²³I-BMIPP. ¹²³I-BMIPP, which is usually used for cardiomyoscintigraphy, is a long-chain fatty acid. When orally administered, it is absorbed by the intestinal lymphatics and then flows and passes through the thoracic duct. Kettner and colleagues⁵ have also reported lymphoscintigraphy with ¹²³I-iodophenyl pentadecanoic acid (¹²³I-IPPA), another type of long-chain fatty acid, to visualize the thoracic duct and to detect sites of lymphatic leakage.

In our hospital ¹²³I-IPPA is not used for scintigraphy, whereas ¹²³I-BMIPP is commonly used for cardiomyoscintigraphy. We applied ¹²³I-BMIPP to visualize the thoracic duct because both materials are similar in structure.

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This study was partly supported by grants-in-aid from the Ministry of Education, Science, Sports and Culture of the Japanese Government.

Received for publication Feb 2, 2001; accepted for publication Feb 28, 2001.

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J Thorac Cardiovasc Surg 2001;122:838-40

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0022-5223/2001 \$35.00 + 0 12/54/115412

doi:10.1067/mtc.2001.115412

Figure 1. Chest CT and scintiscans after oral administration of ^{123}I -BMIPP. **A**, Chest CT at admission. *Arrows* indicate a tumor-like mass with fat density. **B**, Chest CT 13 days after operation. At the *left side* of the aortic arch, marked accumulation was present. **C**, Scintiscan of a representative normal volunteer at 100 minutes after oral administration. The *small arrow* indicates the normal thoracic duct. **D**, Scintiscan of the patient at 300 minutes after oral administration. There were 3 routes of upward flow (*small arrows*). In the upper mediastinum 3 transverse communications were also detected. At the *left side* of the aortic arch, marked pooling of the isotope (*large arrow*) was also present.

On the basis of our experience, it was easy to visualize the thoracic duct, as well as the collateral circulation, transverse communications, and abnormal accumulation of chyle. In addition, sequential monitoring of plasma ^{123}I -BMIPP activities helped us to understand the dynamics of the chyle flow in this patient. We were afraid of complete loss of lymphatic influx into the venous circulation in the present case, but fortunately, this was denied by the results of the examination with ^{123}I -BMIPP. Although the pathogenesis of the disease is hardly understood, our experience showed the possibility of understanding of the dynamics of lymph flow in

the thoracic duct in diseased individuals. On the basis of the results of scintigraphy, we chose conservative management, resulting in successful control of fluid accumulation in the thorax and mediastinum and eventual discharge of the patient from our hospital.

Our experience showed that lymphoscintigraphy with orally administered ^{123}I -BMIPP and subsequent monitoring of plasma ^{123}I -BMIPP activities is useful for understanding diseases of the thoracic duct without any complications or invasiveness. The thoracic duct, collateral flows, leakage site, and abnormal pooling in the mediastinum can be visualized with this method. Combined

Figure 2. Plasma ^{123}I -BMIPP activities after oral administration.

with subsequent monitoring of plasma ^{123}I -BMIPP activities, the dynamics of thoracic lymph flow can also be elucidated. Thus, these methods may be recommended as safe for patients with diseases of the thoracic duct.

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