AN INTRODUCTION TO LYMPHANGIOGRAPHY*

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PRESENT-DAY lymphangiography has been evolved by the work of many investigators.

1. In 1930 Funaoka, the Japanese investigator of animals, injected iodine salts into the lymph vessels in vivo and then radiographed them.

2. In 1952 Kinmonth applied lymphography to the investigation of disorders of the human lymphatic system. The first satisfactory radiological technique was described by Kinmonth *et al* (1955). Water soluble iodine compounds, such as 70 per cent sodium diacetrizoate, were injected and these produced good filling of the lymphatic vessels and nodes up to the external iliac region, but because of rapid extravasation of the water soluble medium through the lymphatic wall, useful visualisation of the retroperitoneal nodes was not obtained.

3. Bruuns and Engset (1956) showed that an oily contrast medium such as lipiodol does not diffuse from the lymphatic vessels and nodes and because of this the nodes can be demonstrated satisfactorily.

TECHNIQUE OF LYMPHANGIOGRAPHY

The lymphatic vessels are made visible by injecting patent blue, or a similar aniline dye, into the web spaces between the first two toes or fingers. Ten minutes later the vessels can usually be seen through the skin.

The skin is incised transversely over the lymphatic vessels under local anaesthesia. If the lymphatics cannot be seen a transverse incision approximately 3 cm. long should be made over:—

1. the base of the first metatarsal (foot);
2. the tubercle of the radius (wrist).

This usually reveals at least two lymphatic vessels. One is then carefully dissected and isolated from the surrounding fatty tissue.

The lymphatic vessel is distended by:—(*a*) active and passive movements of the feet or hands; (*b*) proximal compression with a tourniquet, digital compression, or a small clamp on the vessel itself; (*c*) distal massage of the skin from the webs of the toes upwards.

Distension of the vessel to two or three times its original size by these means dispenses with the need for an operating microscope. The local anaesthetic should be combined with adrenalin to create a bloodless field. Adrenalin does not vasoconstrict the lymphatics. A 27 or 30 gauge needle is then introduced into the lymphatic vessel and tied in place with a catgut suture. Leaks are checked for by injecting saline. If the needle is correctly in place the vessels will distend. If not it usually means that the wall of the lymphatic has been torn, and the needle should be threaded along the lymphatic and tied with a proximal ligature.

The contrast medium used is ultra-fluid lipiodol. The simple gravity-feed apparatus used to inject the contrast has been fully described by Dolan and Moore (1962). Special automatic pumps have been developed but they are unneccessary. Ten ml. are injected into each leg, or 5 ml. into each arm, in about one and a half hours. Faster rates of injection may lead to lymphatic rupture and systemic complications, and a slower rate is often complicated by blockage of the needle.

Several investigators have tried to simplify the technique and dispense with the need for direct injection of the contrast medium into exposed lymphatic vessels. Malek (1959) describes a technique for injection of the contrast medium into the subcutaneous tissues adjacent to the lymphatic nodes, and some workers prefer to inject the medium directly into the node by percutaneous puncture. But the uptake of contrast medium is unpredictable unless it is injected directly into the lymphatic vessels.

Radiographic technique.—A.P. films of the pelvis and abdomen during the injection will demonstrate the contrast medium in the lymphatic vessels and the extent of filling of the retroperitoneal vessels. The filling of the nodes at the end of the injection is usually poor. Similar films next day are important for the best visualisation of the nodes with only small amounts of contrast in the vessels. The lymph nodes may retain the contrast for many months but they progressively become more blurred.

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RADIOGRAPHIC APPEARANCES OF NORMAL LYMPH VESSELS AND NODES

Lymph nodes.—The maximum size of normal lymph nodes is approximately 2·5 cm. They are globular or kidney shaped in configuration, with marginal indentations at the hilum. The normal nodes show a homogenous reticular pattern. There are two exceptions to this rule:—

1. The inguinal lymph nodes, because they are normally subject to chronic inflammatory changes, may be larger than 2·5 cm. and have irregular margins. These appearances are produced by fatty infiltration with non-specific filling defects. It is well known that the inguinal nodes are undesirable for biopsy because of these changes. The pelvic nodes are sometimes similarly affected.

2. In old people, other lymph nodes may show some marginal irregularity which is without significance.

Lymph vessels.—The lymphatic trunks in the body run with the venous system. In the lower limb the inguinal nodes drain into the external iliac and common iliac lymph nodes. At the level of the upper border of the sacrum it is common to find some crossing of the lymphatic trunks to the opposite side of the body.

With oily contrast media the para-aortic nodes fill up to the level of L.2 (Fig. 1A). A lateral x-ray of the abdomen shows the para-aortic nodes well (Fig. 1B) and indicates if displacement has occurred. The para-aortic nodes drain into the cisterna chyli which continues as the thoracic duct usually draining into the left subclavian vein. The left supraclavicular nodes frequently take up the medium (Fig. 2), which accounts for their frequent involvement in visceral carcinoma (Troisier's sign).

The two main indications for lymphangiography are to demonstrate involved lymph nodes in metastatic carcinoma and the reticuloses (Table 1). Each has a distinctive pattern of lymph node involvement.

Metastatic involvement of lymph nodes.—In secondary carcinoma, the lymph nodes, if not completely replaced by tumour, appear enlarged and ragged. This characteristic so-called 'moth-eaten' appearance is because the afferent lymphatics drain into the subcapsular lymph-space surrounding the node, from where the carcinoma cells infiltrate and produce an irregular margin to the node.

Case 1.—A patient with, clinically, stage I carcinoma of the cervix. The external iliac lymph nodes on both sides of the pelvis are enlarged and have multiple filling defects (Fig. 3A). Involvement of these nodes by tumour was confirmed at operation (Fig. 3B). A subsequent radiograph of the pelvis (Fig. 3C) showed that the enlarged nodes had been removed. This case illustrates that another application of lymphangiography is checking the completeness of block dissections.

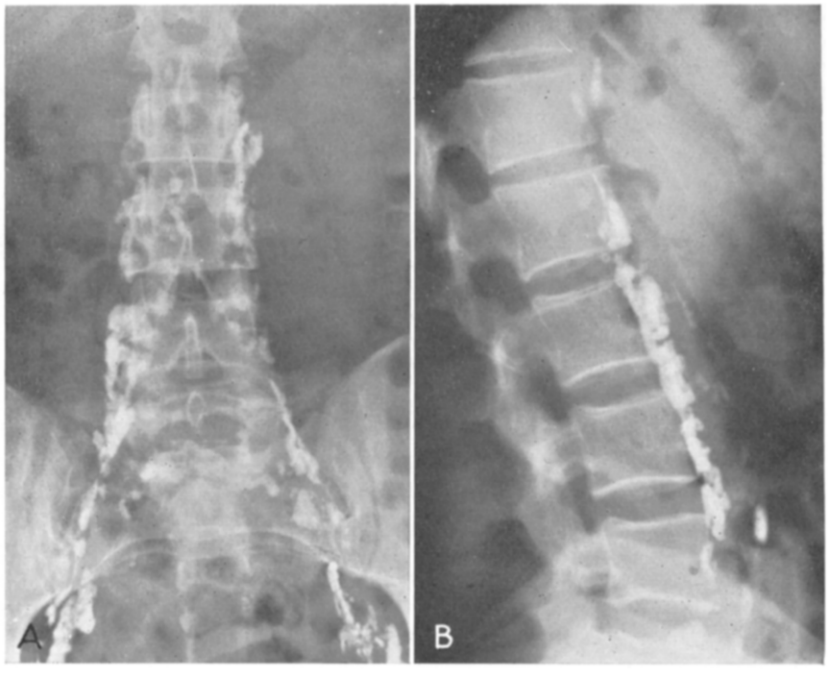

FIG. 1

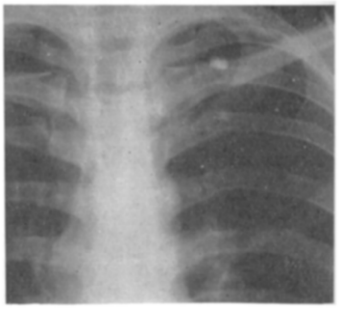

FIG. 2

FIG. 1—Normal para-aortic nodes. Good filling with contrast has been achieved up to the level of L.2. A—A.P. view. B—Lateral view.
FIG. 2—Normal supraclavicular node twenty-four hours after a lymphangiogram.

TABLE 1

INDICATIONS FOR LYMPHANGIOGRAPHY

1. Metastatic carcinoma. Demonstration of involved nodes is especially useful if block dissection, radiotherapy or chemotherapy of the involved nodes is contemplated.
2. Malignant reticuloses. Particularly with regard to diagnosis, extent of lymph node involvement and evaluation of the results of treatment.
3. Lesions of the thoracic duct including chylothorax.
4. Lymphoedema, both primary and secondary.
5. Prior to, and/or following therapeutic perfusion of the lymphatic system.
6. Pyrexia of uncertain origin.

Case 2.—A patient with a carcinoma of the rectum fixed to the sacrum complained of sciatic pain. Lymphangiography demonstrated an enlarged external iliac node. Following perfusion of the leg lymphatics with methotrexate he became free of pain. This case also demonstrates the use of lymphangiography prior to the introduction of therapeutic substances directly into the lymphatic system.

Lymph node involvement in the malignant reticuloses.—Involved nodes are enlarged and have a lace-like appearance with preservation of the margins. This last feature is an important differentiating point from metastatic disease involving lymph nodes.

Case 3.—A patient with Hodgkin's disease was found to have enlarged nodes in the pelvis (Fig. 4A). The typical ghost-like appearance is well shown in some of the nodes radiographed after post-mortem (Fig. 4B).

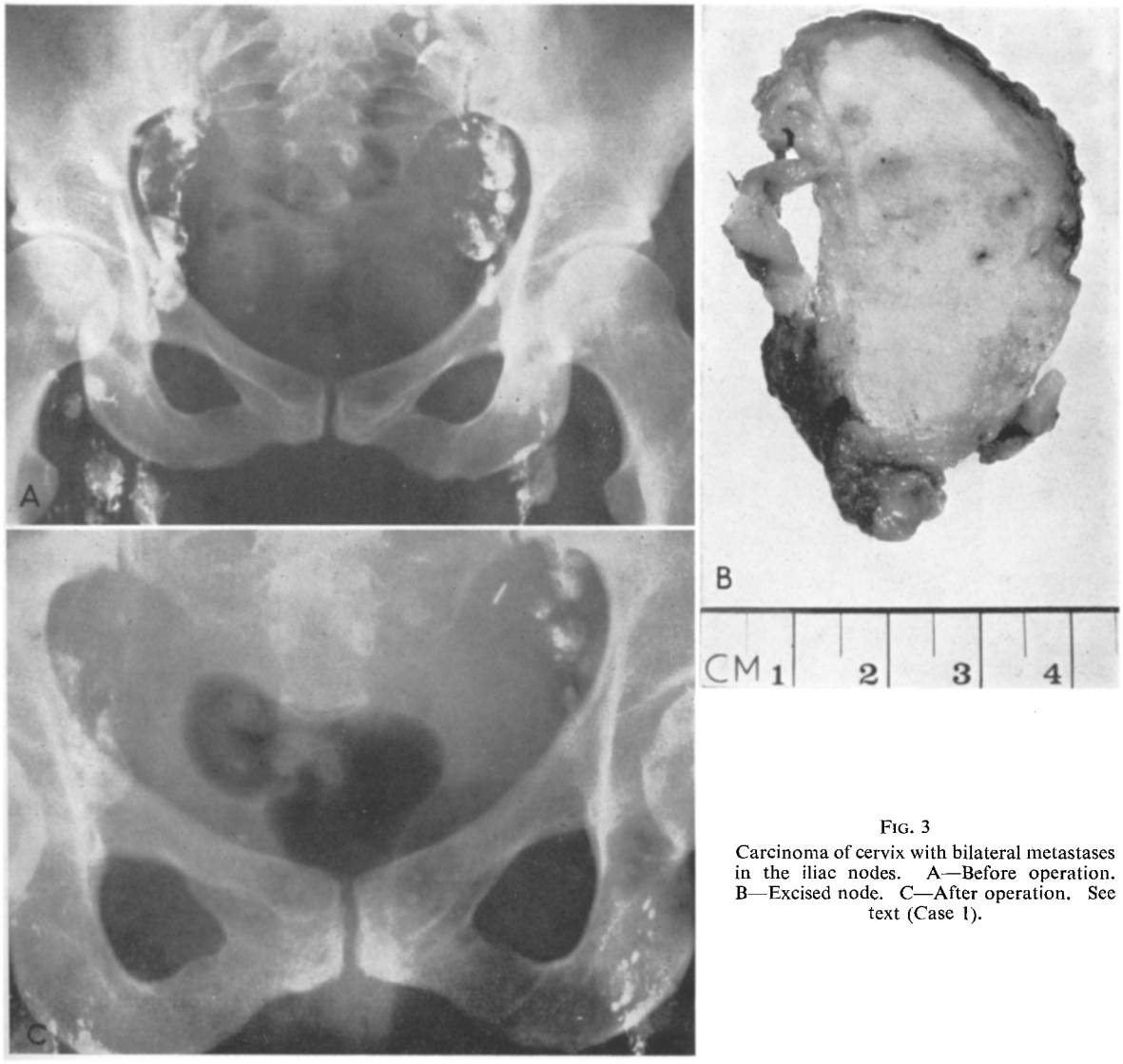

FIG. 3

Carcinoma of cervix with bilateral metastases in the iliac nodes. A—Before operation. B—Excised node. C—After operation. See text (Case 1).

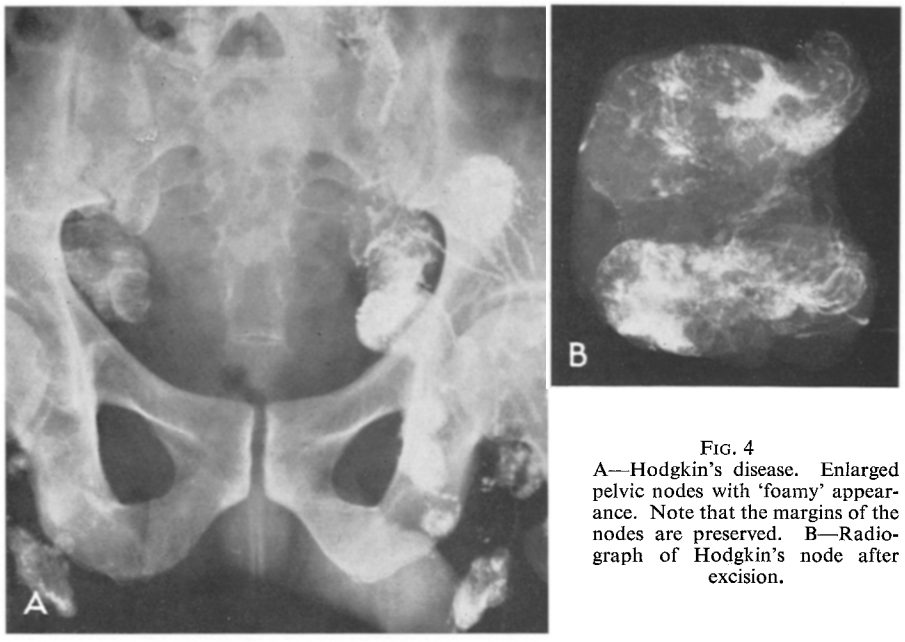

FIG. 4
A—Hodgkin's disease. Enlarged pelvic nodes with 'foamy' appearance. Note that the margins of the nodes are preserved. B—Radiograph of Hodgkin's node after excision.

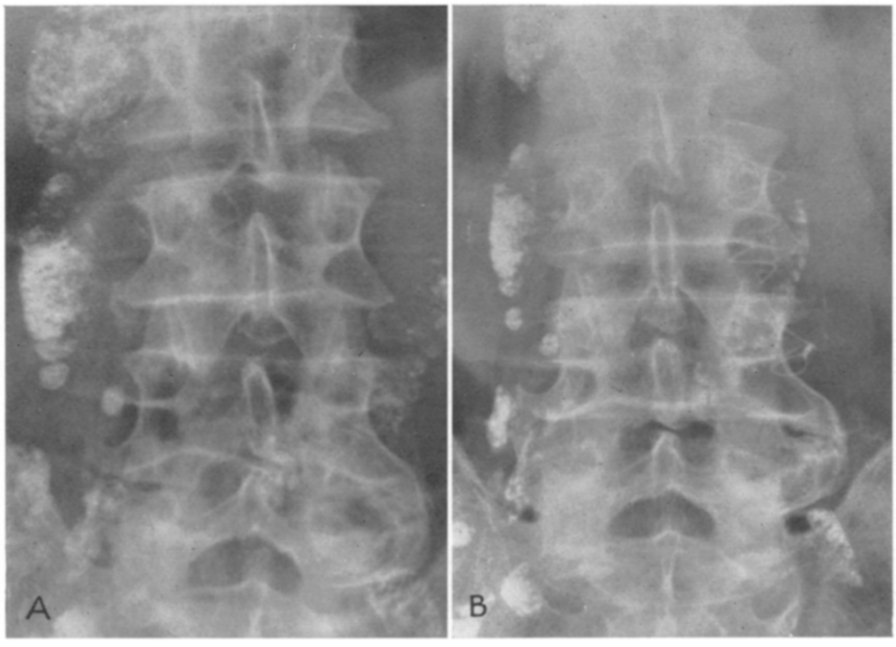

FIG. 5
Hodgkin's disease. Results of chemotherapy. A—A.P. radiograph before treatment. B—A.P. radiograph three months after treatment. The decrease in the size of the nodes can be seen.

Case 4.—A patient with Hodgkin's disease had marked enlargement of the para-aortic nodes (Fig. 5A). Following 'Endoxan', the patient improved markedly. The decrease in the size of the lymph nodes three months later is shown (Fig. 5B). Lymphangiography demonstrated the extent of the disease, and its response to treatment.

Lesions of the thoracic duct.—The thoracic duct can be demonstrated on lymphangiography if a lateral chest x-ray is taken at the end of injection of the contrast medium. This may be valuable in the investigation of chylothorax. A normal thoracic duct is shown in Figure 6.

Case 5.—A patient with a right chylothorax had a lymphangiogram which demonstrated collateral intercostal lymphatic vessels and escape of contrast into the thoracic cavity (Fig. 7). A film of the retroperitoneal nodes next

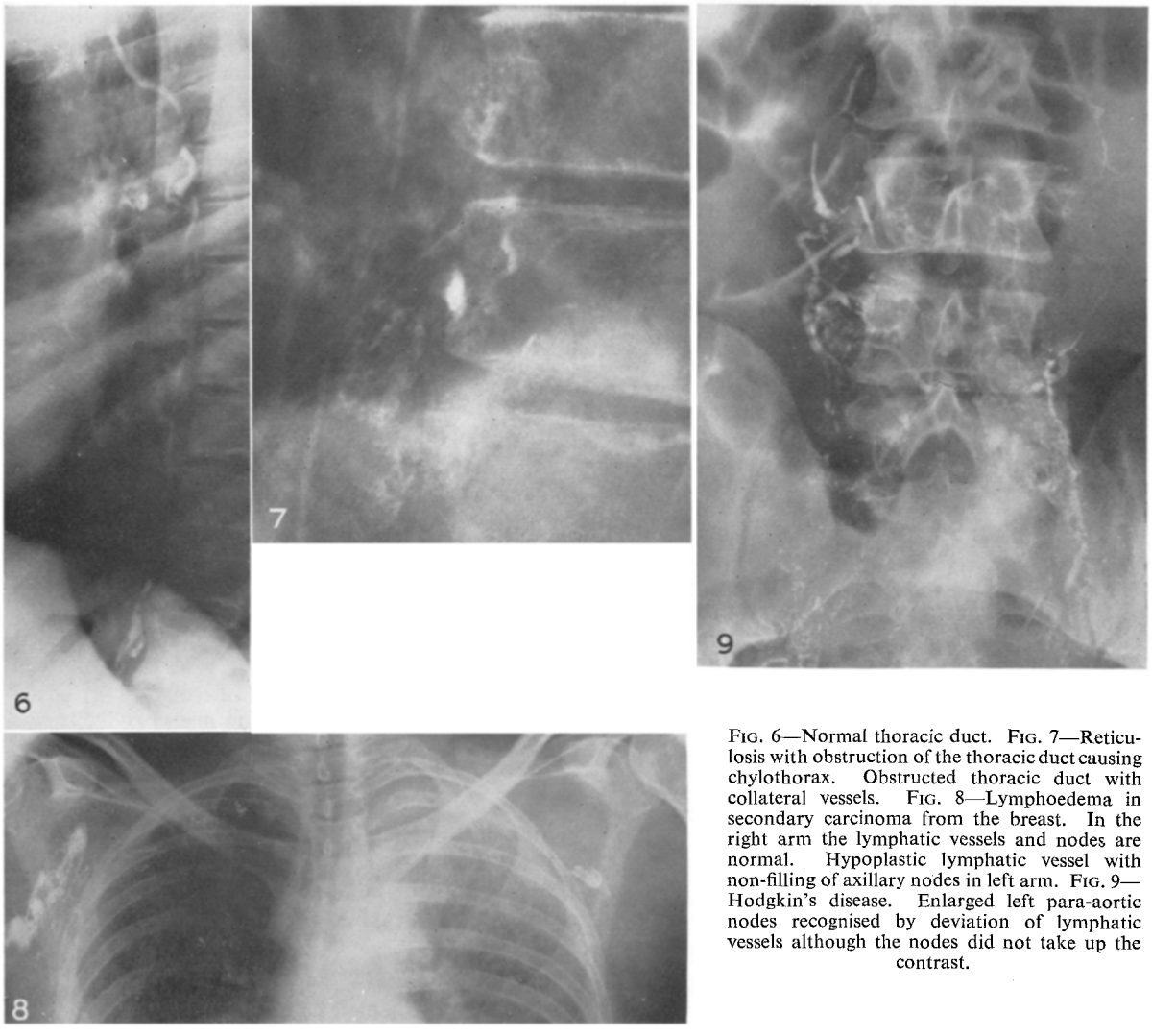

FIG. 6—Normal thoracic duct. FIG. 7—Reticulosis with obstruction of the thoracic duct causing chylothorax. Obstructed thoracic duct with collateral vessels. FIG. 8—Lymphoedema in secondary carcinoma from the breast. In the right arm the lymphatic vessels and nodes are normal. Hypoplastic lymphatic vessel with non-filling of axillary nodes in left arm. FIG. 9—Hodgkin's disease. Enlarged left para-aortic nodes recognised by deviation of lymphatic vessels although the nodes did not take up the contrast.

day showed that they were enlarged and were typical of a reticulosis.

Lymphoedema, both primary and secondary.

Case 6.—A woman with carcinoma of the breast, swelling of the left arm and a pleural effusion. On the left there was only one small hypoplastic lymphatic but the lymphatics in the right arm were of normal size and number (Fig. 8). The oedema of the left arm was due to a secondary carcinoma and radiation fibrosis.

Prior to therapeutic perfusion of the lymphatics.—Lymphangiography will demonstrate whether the involved lymph nodes can be filled with perfusion fluid. A theoretical objection is that the lymph nodes may be blocked by the contrast medium.

Pyrexia of uncertain origin.—We have investigated several patients with known Hodgkin's disease but no superficial nodes and a pyrexia of the Pel Ebstein type.

Case 7.—Patient with P.U.O. The left para-aortic nodes were presumed to be enlarged because of the deviation of the lymphatic trunks around them (Fig. 9). The enlarged nodes which did not fill with contrast could be recognised by the deviation of the lymphatic vessels around them.

SIDE EFFECTS OF LYMPHANGIOGRAPHY

The only serious complication of lymphangiography (Table 2) is that of pulmonary embolism from the oily contrast medium. It is usual to see miliary shadowing in the lung fields of patients following lymphangiography which clears spontaneously in a few days.

Fuchs (1961) reports a 20 per cent incidence of cardiovascular collapse and pulmonary oedema after lymphangiography with oily contrast. Our experience in over fifty patients is that 2 per cent

TABLE 2

SIDE EFFECTS OF LYMPHANGIOGRAPHY

1. Local—Wound infection. Lymphangitis. Thrombophlebitis.
2. Pain—During injection—distension of lymphatics. After injection—rupture of lymphatics.
3. Discolouration of patient due to aniline dye.
4. Allergic—Temperature. Skin rashes.
5. Pulmonary emboli and cardiovascular collapse.
6. Theoretical—spread of tumour emboli.

would be a more realistic figure. Three factors are related to the incidence of serious reactions:—

1. *The amount of oily contrast medium injected.*—This must not exceed 0·25 ml./kg. body weight especially in children. Animal experiments have shown that more than 1 ml./kg. body weight is likely to prove fatal. Under normal circumstances a dosage of 15 to 18 ml. of lipiodol is the maximum for an average adult. More can be injected if films at beginning of injection show that the patient has large retroperitoneal nodes. The enlarged nodes take up the contrast before it can enter the venous circulation.

2. *The rate of injection of the contrast medium.*—The injection should be spread over about one and a half hours. It has been suggested that the pulmonary emboli are due to agglutination of red cells and unrelated to the infusion rate, but all the serious reactions recorded in the literature have occurred when the amount of contrast and speed of injection have exceeded the limits already referred to above.

3. *Lymphatic obstruction.*—In the presence of obstruction of the lymphatics, contrast medium can be shunted directly into the venous system, by-passing the involved lymph nodes. Once an obstruction has been demonstrated, it is wise to limit the amount of injected medium.

We have encountered only one serious reaction during our series of fifty-five lymphangiograms. This was in a patient with a huge sarcomatous para-aortic mass. Lymphatic obstruction was probably responsible for excessive oil embolisation and an associated severe hypotension following lymphangiography. Complete recovery occurred following the use of pressor drugs and hydrocortisone.

The other complications listed in Table 2 are common to any minor surgical procedure which involves the introduction of a foreign substance into the body.

CONCLUSIONS

Lymphangiography is a simple and safe method of directly demonstrating involved nodes in metastatic carcinoma and the reticuloses. The information provided cannot be obtained by any other investigation at the present time. Cavography and retroperitoneal air insufflation give indirect information about the size of the retroperitoneal nodes, but they are much less accurate and the changes have to be much more extensive before they can be recognised.

SUMMARY

A brief description of the history, technique, indications for and complications of lymphangiography is presented. Its value in demonstrating enlarged nodes in the malignant reticuloses and metastatic carcinoma is illustrated. The safety of the technique is stressed, provided that the amount and rate of injection of contrast are strictly controlled.

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REFERENCES

BRUUN & ENGSET (1956). *Acta radiol.* **45,** 389.

DOLAN, P. A. & MOORE, E. B. (1962). *Amer. J. Roentgenol.* **88,** 110.

FUCHS, W. A. (1961). *Acta radiol.* **56,** 340.

FUNAOKA, S. (1930). *Arb. anat. Inst. Univ. Kyoto.* Ser. D. Hf. **1,** 10.

KINMONTH, J. B. (1952). *Clin. Sci.* **11,** 13.

KINMONTH, J. B., HARPER, R. A. K. & TAYLOR, G. W. (1955). *J. Fac. Radiol. (Lond.),* **6,** 217.

MALEK, P. (1959). Symposium IX International Congress of Radiology, Munich.