

## Lymphography 1977. A Review of Some Technical Points

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Descriptions of the usual and well established methods of lymphography are readily available (1) and will not be repeated here. Instead some of the current refinements of technique and some new routes and approaches, chiefly those used in the practice of the author and his associates will be discussed.

### *Visual Lymphography*

Patent Blue Violet has held its place as the most generally efficient vital dye either for visual lymphography or a preliminary step before injection of a lymph vessel with radio-opaque contrast material. Its extreme efficiency depends on its ability to remain largely unlinked with tissue protein following injection. Only a small proportion combines so that the effective molecular size remains that of the dye itself (2). It is now listed under a formidable number of synonyms. They include Patent Blue Violet, Patent Blue V, Patent Blue, Disulphine Blue Violet, Alphazurine G., Erioglaucine, Acid Blue 1, "Food" blue 3, C.I. 42045 and others. They are marketed by a number of different firms and this probably accounts for some of the few reported cases of complications of its use as different batches from different manufacturers may contain varying amounts of impurity.

We have encountered only one complication in several thousand lymphographies. This was an anaphylactic episode in a girl under general anaesthesia. It occurred before any lipiodol was injected. The possibility of one of the multiple anaesthetic drugs which had been administered having been the cause was not entirely ruled out. The episode was brief and left no harmful sequelae.

The dye which we have used has usually been supplied by: *Geo T. Gurr* (Div. of Baird and Tatlock), Freshwater Road, Chadwell Heath,

Essex, England. or by Sigma London Chemical Co. Ltd., 12 Lettice Street, London, S.W. 6.

We continue to use a 10 per cent solution of patent blue for lymphography as this strength is necessary for the more difficult lymphographies where lymph vessels are severely hypoplastic and few and far between and difficult to find, also where the lymph system needs to be studied over a distance. Pelvic and inguinal lymphography following injection in the foot requires injection of concentrated dye, together of course with much massage and movement of the joints of the limb, particularly if small and scanty lymph pathways are to be found.

We have only rarely used the 2 per cent solution supplied by some manufactures largely because we know by experience the potentialities and what to expect from the conventional 10 per cent solution. The more dilute solution is, however, quite adequate for pedal lymphography in patients with normal foot lymph vessels in cases where, for example, abnormal nodes in the abdomen are under study. Its use may reduce the amount of general coloration of the patient.

### *Radio-opaque contrast material*

Ultra fluid lipiodol continues in use as our standard medium. Oil is however unsuitable when large and capacious vessels exist. They may occur in patients with the marked hyperplastic lymphatics of primary lymphoedema (megalympatics), in diffuse lymphangiomatosis as well as in the acunous lymphatomegaly of tropical filariasis. These may require rapid injection of large volumes of a water soluble contrast medium such as Conray 280 (*May & Baker*). In a recent case of filariasis (3) 60 cc of aqueous medium was injected into gigantic spermatic lymphatics to

outline similar huge serpentine vessels ascending through the trunk to the mediastinum where they replaced the normal thoracic passages. Aqueous solutions are almost invariably absorbed rapidly through the walls of the lymphatics and the injection and X-ray exposure must therefore be made in some 30 to 50 seconds. An appropriately wide bored needle must be employed.

There is an unfulfilled need for an oil contrast medium which might be more rapidly absorbed from the nodes than ultrafluid lipiodol, perhaps to clear in some two weeks. This would be useful in the unusual cases where lymphography needs to be repeated and it might be convenient to have the traces and remains of the first lymphogram cleared prior to the subsequent ones.

#### *Dealing with Small and Difficult Lymphatics*

Normal lymphatics found on the foot for lymphography of abdominal nodes present no difficulty but the smaller ones of children or the hypoplastic ones of lymphoedema often require every aid possible for success. A transverse incision is best as it allows search for further vessels if need be by extending it across the foot or ankle. Spasm of the exposed lymphatic is sometimes troublesome, particularly in infants. This seems to occur in the same way as in arteries through the mechanical trauma of handling it during dissection. It can be relieved in the same way as in arteries by dropping some, preferably warm, 4 per cent solution of procaine on to it and allowing it to remain in contact for a few minutes (4). An additional method of dealing with spasm is to inject procaine solution into the tissues where the patent blue was originally injected and along the course of the lymphatic between it and the exposed segment. This, for pedal lymphography, is usual interdigitally and at the base of the toes on the dorsum of the foot. The infiltrated area is then pressed and massaged so that a mixture of procaine and blue is forced up into the exposed spastic segment of lymphatic. The lymphatic meanwhile is occluded by gentle pressure just above the incision. This has the double effect of mechanical distension of the vessel and vaso-

dilating effect of the procaine and facilitates injection of what may at first sight look an impossibly small or spastic vessel. It is particularly efficacious in dealing with spastic vessels in a dry non-oedematous limb and where tissue fluid and lymph are scanty.

#### *The Diamond Knife*

The greatest advance in dealing with really difficult small or spasmophilic or irritable lymphatics has been the employment of the diamond knife. We have used the L273 Diamond Knife (Meyco, Switzerland) originally designed for ophthalmic surgery. The lightest strokes of this knife sever adherent tissues, particularly fat (that bugbear of microsurgery !) allowing them to separate from the lymphatic without disturbance which might cause contraction or spasm.

#### *Fine Needles*

The finest hollow steel needles that we have found commercially available are 30 SWG (external diameter 12/1000 inch = 0.3 mm). These are made up by Macarthy Surgical Ltd. (*Selinas Lane, Dagenham, Essex, Eng.*) on polyvinyl tubing as the St. Thomas's Hospital Lymphography sets. For very small lymphatics in clinical or experimental work a finer diameter needle is often of advantage.

Glass tubes can be used and drawn out to extremely fine diameters but there are difficulties in handling them without the use of micro-manipulators. Also the connection to flexible tubing for clinical use presents difficulties. A lymphogram set with a finer steel needle than 30 SWG has been successfully produced in our department at St. Thomas's by D.L. Rutt, Chief Research technician.

The needles are tapered and thinned on the outside by galvanic action by repeated dipping in an electrolyte solution. This results in a needle with unchanged lumen size but much smaller external diameter, particularly at the end. The tapered tip is very sharp but also fragile and usually only allows one injection. Should this fail the tip may blunt or buckle and a new needle be necessary.

### *Details of Electrolytic Tapering of Needle*

I am indebted to Mr. *R.L. Rutt* for the more detailed description of the process:

This is the method used at St. Thomas's to produce a needle which has a shaft size of 12/1000 of an inch and tapers to the point 6 to 7/1000 of an inch (36 SWG = 0.193 mm). The lumen remains unchanged in size at 4/1000 of an inch diameter, probably due to trapping of air during the dipping process.

These needles after processing are extremely sharp but can only be used once due to their fragile point.

Six normally ground and sharpened needles are fixed into a brass jig and via the jig to a positive terminal of a 6 amp hour, 12 volt battery. The jig is mechanically lowered and raised into a bath containing a mixture of glycolic 28.2 per cent, metaphosphoric 30.5 per cent and sulphuric acid 41.3 per cent.

Permanently fixed in the bath at one side is a heavy copper cathode which is connected to the negative terminal of the battery. With the current on, the jig is slowly lowered and raised in the bath, each immersion taking 4-5 seconds. Metal is removed from the needles by electrolytic decomposition (electrolysis) evenly and giving a taper to the point. Great care must be taken in timing the reaction to prevent the end of the needle being completely removed. It must be inspected periodically during the process. Following this process the needles are cleaned in an ultrasonic bath, dried, packed and gas sterilized.

### *Needle Holders*

The serrations inside the jaws must be fine, almost or non-existent. Coarse serrations act as furrows or grooves in which the needle becomes as it were embedded, taking up a set alignment. This prevents free and delicate adjustment and handling of the needle that is so desirable.

We use the long Kinmonth-MacCarthy needle holder (1) designed for the purpose\* or the "Micra" needle holder<sup>†</sup> which is shorter and

\* MacCarthy Surgical Ltd., Selinas Lane, Dagenham, Essex, Eng.

<sup>†</sup> Micra. Distributed by Ethicon Ltd. Edinburgh.

very suitable for superfine work. It has narrow, pointed jaws, little or no serrations and a cylindrical handle which allows it to be rotated in a most convenient fashion. Neither of these holders has a ratchet. It is found that the force needed to release a ratchet after the needle is inserted in a lymphatic may cause a jerk which dislodges the needle.

### *Magnification*

The Zeiss dissecting microscope continues in routine use. A minor but very useful advance is to have the entire working mechanisms of the head and outer part of the arm gas-sterilized so that the surgeon when scrubbed is much less dependent on assistants to help with adjustments. The appropriate parts of the instrument are kept in formaline vapour in a cotton hood which is removed when needed.

### *Some Newer Sites for Lymphographic Injections*

1) *The Groin.* There are sometimes no vessels suitable for injection on the dorsum of the foot. Injection of a vessel in the groin is a useful alternative. Colouring with patent blue should be attempted by a) deep injection into the sole of the foot b) intradermal and subcutaneous injections over the region of the great saphenous vein and accompanying lymphatics at the inner side of the knee c) some four or five intradermal wheals of patent blue injected about four inches below the planned site of incision in the groin. All injections are followed by local massage, centripetal massage and passive movements of the joints of the limb for 4 to 5 minutes. An incision is made about half an inch below a palpable inguinal node and deepened cautiously to search for coloured afferent lymph nodes. When a suitable vessel is found it is isolated and injected in the usual manner. Difficulty may be encountered through the vessel lying deep in the incision so that the needle has to point at an awkward, almost vertical angle, instead of nearly parallel with it. This may be overcome by inserting a suitable trocar and cannula through the skin from a point an inch or so below the incision so that its tip lies near the lymphatic. The trocar is removed and the needle and tubing passed through

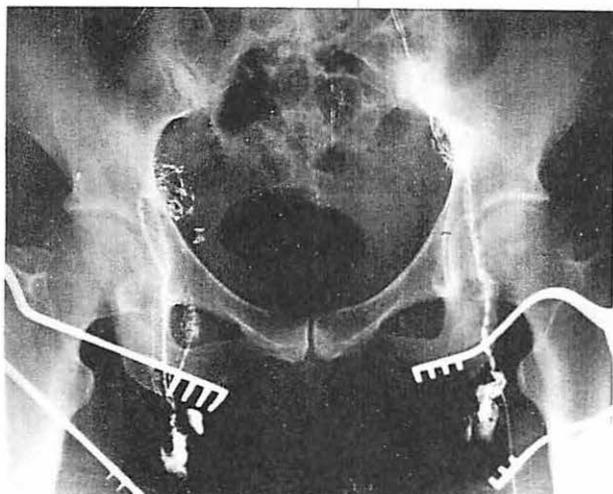


Fig. 1 Bilateral inguinal lymphography by injection into nodes. The patient Mrs F.S., aged 54, with 36 years history of lymphoedema of the feet and legs with erythrocyanosis. No injectable lymphatics on feet. The progress of the dye is more rapid on the patient's left where the needle was placed near the upper pole of the node.

the cannula and into the lymphatic at a suitably oblique angle.

Should no afferent lymphatic be found the skin at the upper side of the incision is dissected upwards to find a node. The injection is then made into the node itself, or should a suitable efferent vessel be apparent into that. Although there is often some extravasation, useful information may be obtained of the state of inguinal and iliac pathways.

The technique is often useful in long standing oedema where peripheral vessels have atrophied or disappeared. It may be applied in either secondary or primary lymphoedema, particularly of course in those with severe peripheral hypoplasia or aplasia.

It is interesting that the additional information obtained by modern improved techniques indicates that the nodes are far more often and severely affected in primary lymphoedema than was formerly thought. A recent review of patients with primary lymphoedema suggested that the nodes were the seat of the first changes far more often than were the vessels (5).

2) *Mesenteric Lymphography* has been informative and useful in certain cases. Its use in patients with protein loss from the gut ("proteinlosing enteropathy") in primary lymphoedema has been described and illustrated elsewhere (6, 7, 8). The procedure is of course carried out during the course of surgi-

cal abdominal exploration. Information can be obtained about areas of the lymph system which cannot be visualized at least under anything approaching normal circumstances, by injection by the pedal route.

Visual lymphography with patent blue often gives valuable information about abdominal lymphatics. It may or may not be necessary to use it as a preliminary to mesenteric lymphography. If so, some 0.1 ml of 10 per cent dye is injected into the muscles under the serous layer of the small gut and gentle pressure exerted. Very soon fine lymphatics will be seen coursing up the mesentery and in the gut wall near it. In other cases the lymphatics are already distended and visible, sometimes containing chyle, and no blue is necessary. Injection should be made by choice into a vessel on the gut wall itself. If such is not possible the second choice is injection into a vessel in the mesenteric. This is more difficult because the overlying peritoneum must often be incised and although thin it bleeds easily.

Mesenteric lymphatics of anything like normal size are very small and need a "paediatric" needle of the specially tapered type which has been described above. However, in many cases there is enlargement of the vessels and they may be readily injected using the routine 30 SWG Macarthy lymphogram set.

Respiratory movements of the abdomen present an obstacle. The solution is to arrange

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that the needle and lymphogram tubing move in unison with the gut or abdominal contents.

A loop of gut is steadied on the operative field, often just exteriorized on the abdominal wall at the edge of the wound, by placing two tissue forceps on it. The lymphogram needle is then brought to lie beside it and seen to move freely with it before the needle is inserted. Very small volumes of lipiodol are sufficient to give extensive filling and information. Injection of little more than 1cc into a jejunal lymphatic will outline the local mesenteric lymph vessels and rapidly reach the upper end of the thoracic duct. Films are placed in the cassette tunnel under the patient or small sterile wrapped films may be placed in the abdomen under the mesentery. The anaesthetist is requested to arrange a few seconds of apnoea while the X-ray film is exposed.

3) *Lymphography of the Thoracic Duct* may be improved by blockade of its upper end by injection of noradrenaline solution (9). During bipedal lymphography in most circumstances only the upper two or three inches of thoracic duct is visualized. Paying particular attention to movement and massage of the lower limbs and abdomen, together with timing of the radiograph, may allow greater lengths to be seen, but in only a small minority will the full length of the duct be visualized. The use of greater volumes of lipiodol increases the extent of the duct seen but this is unacceptable because of the increased oil embolism to the lungs. Slowing the emptying mechanism of the upper end of the duct by infiltration with adrenaline enhances the visualization. The full length of the duct was seen in 13 of 16 patients with this technique compared with 3 of 13 using the conventional method (9). Ten ccm of 1 in 200,000 noradrenaline solution is injected around the region of the termination of the duct by passing a needle down and back from a point just lateral to the sternal portion of the sternomastoid muscle above the clavicle. Aspiration is performed just before the noradrenaline is injected to ensure that the point of the needle

is not in the subclavian vein. The noradrenaline blockade injection is best made fifteen to twenty minutes before the end of the lipiodol injections in the feet are completed.

This can provide useful information on the duct but there is still a great need for a method that will delineate its condition in patients with bulky, diseased or otherwise obstructed abdominal pathways which hinder the free flow of dye into the cisterna chyli and thoracic duct.

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#### *References*

- 1 *Kinmonth, J.B.*: The lymphatics; disease, lymphography and surgery. Arnold, London (1972)
- 2 *Threefoot, S.A.*: Some chemical, physical and biological characteristics of dye used to visualize lymphatics. *J. Appl. Physiol.*, 15 (1960) 92
- 3 *Young, A.E. and Kinmonth, J.B.*: Filariasis. *Proc. Roy. Soc. Med.* 69 (1976) 708
- 4 *Kinmonth, J.B.*: Physiology and relief of traumatic arterial spasm. *Brit. Med. J.* 1 (1952) 59
- 5 *Kinmonth, J.B., P.W. Eustace*: Lymph nodes and vessels in primary lymphoedema. *Ann. Roy. Coll. Surg. Eng.* 58 (1976) 278
- 6 *Kinmonth, J.B., S.J. Cox*: Protein-losing enteropathy in lymphoedema. Surgical investigation and treatment. *J. cardiovasc. Surg. (Torino)* 16 (1975) 111
- 7 *Kinmonth, J.B., S.J. Cox*: Protein-losing enteropathy in primary lymphoedema mesenteric lymphography and gut resection. *Brit. J. Surg.* 61 (1975) 589
- 8 *Kinmonth, J.B., P.W. Eustace*: Gut protein loss in lymphoedema. *Proc. Roy. Soc. Med.* 68 (1975) 673
- 9 *Cox, S.J., J.B. Kinmonth*: Lymphography of the thoracic duct. A new technique for improving visualization. *J. cardiovasc. Surg., (Torino)* 16 (1975) 120

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