

Lymphofluoroscopy – a valuable tool to monitor decongestive treatment and enhance care

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There has been much discussion regarding the use of ICG fluoroscopy in the management and diagnosis of lymphoedema. This short paper will explain reasons for its use and application to clinical practice.

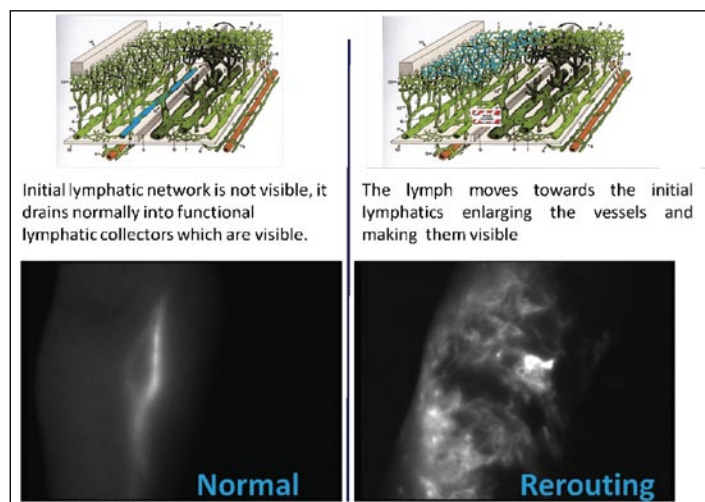
The quest for imaging of the superficial lymphatic network using contrasting products started over 200 years ago. However, due to the specific physiological structure, fragility and size of the lymphatic vessels, researchers have always had difficulty to find a specific tracer which could be sensitive and specific enough for lymphatics and was also minimally invasive, affordable and suitable for examinations in the clinic.

Indocyanine Green (ICG) is a well-known fluorescent dye which has been used in angiology, cardiology and liver studies for many years. More recently it has been applied to lymphology which complements the collection of lymphatic imaging tools to study lymphoedema and the superficial lymphatic system in humans.

ICG Fluoroscopy provides the ability for us to visualise lymphatics in real time for the first time. Through the use of a specific camera equipped with infrared diodes and adapted filters, the lymphatic architecture and propulsion of packets of ICG dye can be seen. In addition, the pathway of the drainage of the lymph or failings of the system can also be recognised.

This report draws on the conclusive experience of over 700 lymphofluoroscopies, carried out during the examination of primary and secondary lymphoedema and also on healthy subjects.

This minimally invasive examination consists of an intradermal injection of a small volume of highly diluted ICG (0.2ml). This is usually injected in places in the web spaces of the hand or foot depending on the area to be examined. The dye binds with the local lipoproteins (LP) that are localised in the interstitium (the place the oedema is situated) and reaches the lymphatic circulation.



During the examination, a camera is used which emits an infrared light, this excites the couple ICG-LP. In this condition, ICG-LP, diluted into the water of the lymph, starts to be fluorescent. At this point the lymphatic network is revealed to the camera. The signal is filtered and amplified and shows dynamic images of the lymphatics on a screen which can be recorded as necessary.

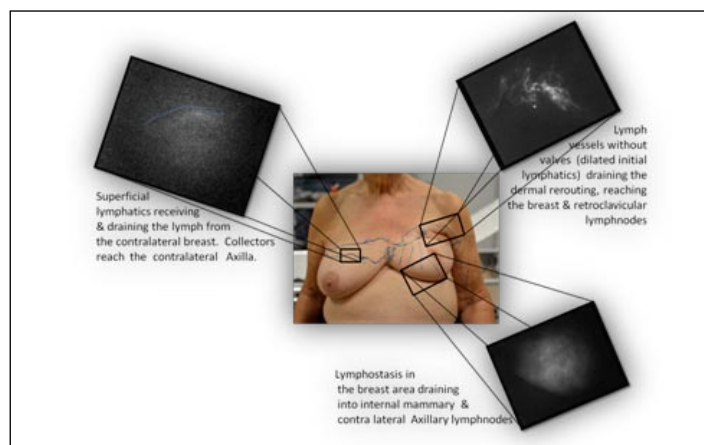
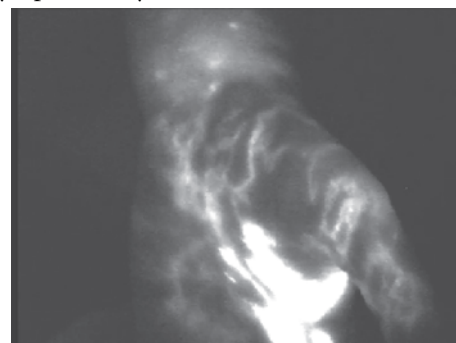
Immediately after the injection, the lymphatics at the injected area start to become visible, the lymphangion (pumping segments of lymphatic vessels) is seen pumping and progressively the entire superficial lymphatic network, connected with the injected area and their superficial lymph nodes becomes visible.

The map of the superficial lymphatic network is linked to the injected anatomical region, it appears like a dynamic route map that provides valuable information to understand the personal situation of each individual which can then be customised for the therapeutic choice.

The anatomical regions which are involved in an oedema and where the lymph collectors are not functioning are clearly highlighted: the rerouting of the lymph that flows through the initial lymphatics appears like a very dense, windy and small vessel network. On the contrary, functional vessels appear like straight lines and the efficiency of valves can be tested and the contractility of the lymphangion is perfectly visible. Dedicated software allows for the measurement of the mean speed of the lymph flow into the lymph collectors (how well the lymphatics are functioning/draining).

When the normal lymphatic ways do not work, the fluid and macromolecules are redirected to other functional areas to be drained. This is also visible during the exam. This provides information to the therapist to change the direction of the manual lymphatic drainage. The image (Examination of a Breast Cancer Related Lymphoedema – above) shows that fluid on the back of the hand reaches the palm, which is not the usual anatomical pathway.

In addition to the functional information, fluoroscopy shows substitution pathways. Substitution pathways are the drainage routes taken by the fluid if another area fails or is blocked. These pathways can be drawn on the patient's skin during the examination to provide details in order to customise the MLD treatment protocol for each individual patient and for each therapist (see below).



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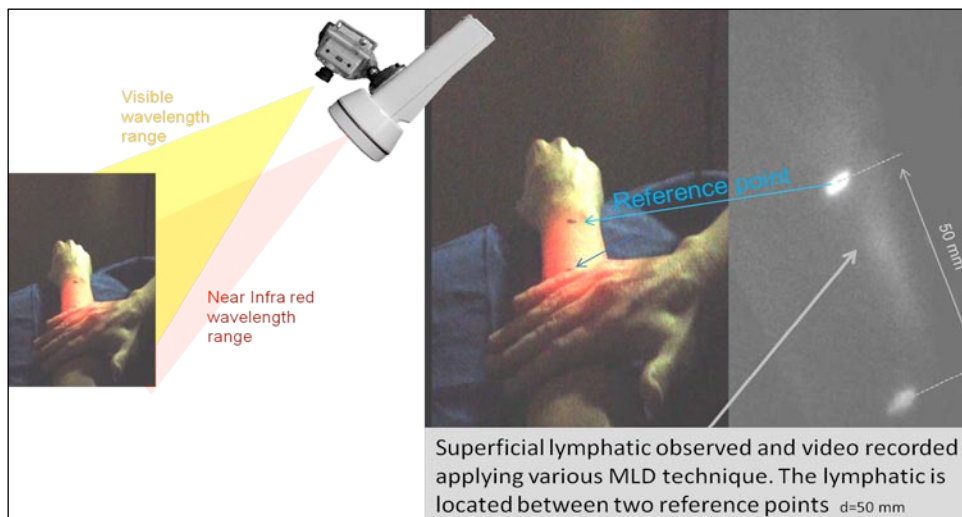
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NIR Fluoroscopy has helped us to optimise manual lymphatic drainage techniques: using a double camera (see right), one in the visible field and the second on the fluorescence, we can observe in real time the efficiency of each manoeuvre. The team has evaluated existing MLD techniques and following the feedback of fluoroscopy has developed a technique which is demonstrated to move more fluid faster and more effectively. This technique is now used in the University of Brussels physiotherapy training, is being rolled out globally and through the Lymphoedema Training Academy. The technique consists of 2 main manoeuvres of clearing the lymphatic with the 'flush' manoeuvre and filling the collectors with the 'fill' manoeuvre. This method of MLD will be known as the 'Fill and Flush' method or Fluoroscopy Guided Manual Lymphatic Drainage (FG-MLD) and has taken many years to refine following the mapping of the lymphatics.

Fluoroscopy has also been used to study intermittent compression therapy (see below) where we performed studies with customised transparent sleeves to allow for the visualisation of the flow.

The effects of multilayer bandages have been studied using lymphofluoroscopy.

The dye's progression is observed and recorded during the drainage from differing therapies. It is possible with this technique to observe the effects of diverse physical treatments such as different manual lymphatic drainage methods, intermittent compression therapy, multicomponent bandages or effect from wearing garments.



More recently, fluoroscopy helped us to define the occlusion pressure of superficial lymphatics, which is a slightly higher pressure than previously believed. It provides evidence that leads us to understand that we can use more pressure when carrying out MLD.

The use of fluoroscopy imaging is changing the focus of lymphoedema management and offering improved care pathways. In addition, it allows for the protecting of the lymphatic vessels and nodes during surgery but to remove those that need it. For therapists this is an emerging tool which has assisted with the improvements in the mapping of the lymphatics providing a map of the personal pathways used and therefore the improvements in MLD.

Editor's note: Some of the original text in this article has been changed in order to make it more patient friendly. ■

NIRF to improve the knowledge about Intermittent Compression Therapy related to lymphatic system and develop new concepts.

