IMAGING OF LYMPHATICS, LE AND LYMPHATIC FUNCTION

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Despite our best imaging techniques and technologies, many are still far from perfect. However, they can give us valuable information about the structural and functional status of the tissues and systems, and specifically about the lymphatic system and the diagnosis of lymphoedema.

Imaging of the lymphatics is not new; in fact it is a lot older than most of the treatments we have devised. It began with Erasistratus (circa 310 to 250 BC), but the most important imaging was devised by Asselli (1627) and presented in his dissertation, ‘locies venis’ of the mesenteric lymphatics, using long chain fats (which must be absorbed from the gut via the lymphatics). These techniques were followed and elaborated by Bartholinin (1674). While many others imaged the lymphatics between this time and the striking images of Sabin in the early part of the twentieth century, it was Sabin’s work which made us think more about the lymphatic function and structure and organisation, and, if not, their inter-relationships, and learn a little about if the system was normal in mesenteric lymphatics, using long chain fats and superficial vessels, and understand little about if the system was normal in the lymphatic system and what happened when they were dysfunctional.

However, it is Kinmonth (1950s) who is regarded as the doyen (father) of modern lymphatic imaging, lymphography (Kinmonth et al, 1955). He used isosulphan (blue) dyes and oily contrast media ethiodol (a concoction of the ethyl ester of the fatty acid of poppy seed oil mixed with iodine). This technique gave a ‘perfect and clear image’ of the lymphatics when it was injected properly, and helped us understand the major lymphatic pathways, their variants, and number and location. Kinmonth’s images clarified lymphatic hypo and hyperplasia, and what this meant for lymphatic drainage, allowing us to draw clear relationships between function and structure and to understand and visualise dermal backflow and areas of poor lymphatic clearance.

The next and almost parallel development came in the form of fluorescent microlymphangography. (Bollinger et al, 1981), which resulted in further understanding of the smaller lymphatic capillaries and their place in the blood tissue lymphatic system interfaces. Gashev (2010) explored indocyanine green and while giving beautiful images of the most superficial lymphatic capillaries, like microlymphangiograph, this technique was really only useful for superficial visualisation.

Thus far, we had the ability to look at most of the lymphatic system, the deeper and superficial vessels, and understand their inter-relationships, and learn a little about if the system was normal in structure and organisation, and, if not, where the issues lay. In other words, we had a picture of the pathways of the lymphatic system and what happened when they were dysfunctional.

However, when we talk of imaging we should think widely. We can now ‘image’ the fluids in the tissues, their location and volume using single and multifrequency bioimpedance spectroscopy, where we can discover whole limb or segmental fluids, and often detect their accumulation long before the patient is aware that there is a problem, or there is symptomatic presentation of their accumulation (VWard, 2009). We can detect fluids in a small area and at various depths using di-electric properties of the tissues (Mayrovitz et al, 2009). In terms of how fluid behaves and to get a feel of how its held, visco-elastic imaging techniques can be used.

Fluid accumulation is a sign of a failing lymphatic system, and to assess that failure we also have imaging in the form of lymphoscintigraphy. In this technique, a sulpha colloid is combined with radio tracers (the most common being tc99), and, when used with Gamma Cameras, can image both the deep and superficial lymphatic systems, areas of poor clearance, and backflow. This is a much safer version from that used by Kinmonth to image the lymphatics. The tracer is meant to mimic what happens to a protein (or other high molecular substance) when it has left the vascular system. In the world of images, it is not a perfect one. If the ‘brev’ is not good, some tracer may detach and behave like a small molecule and leave via the venous system, or the tissues might not be active enough (not a particularly high lymph load) and the lymphatic system is not in failure, or some may be accidentally injected into the lymphatics rather than the intra dermal spaces. To get a clear lymphoscintigraphic image, accurate injection, a number of injection sites (to cover all major lymphatic drainage pathways), and a lymphatic system which is put under stress (relatively high lymph load) to show its areas of failure are needed. Lymphoscintigraphy can be viewed from two perspectives:

- Quantitative: this looks at how quickly counts at the depot reduce and how quickly they rise through the limb and then decline again, as well as how and when they present at specific regions of interest
- Qualitative: where the image is examined more from the densitometry point of view, looking for regions of tracer presence in the image and to what tissues/areas these relate.
Another favourite and commonly used form of imaging is that of ultrasound. It is not without issues if used in assessing lymphoedema and a good outcome depends on placement of the head, gentle pressure (so as not to push out any accumulated fluids out of the area), and a great deal of gel. Ultrasound can tell us about the underlying fibrosis of the tissues, the depths and thicknesses of the deep and superficial fascias and help in differential diagnosis between lymphoedema and lipoedema. Not everyone has access to ultrasound, but a surrogate measure of fibre can be gained from the use of various forms of tonometry and indurometry. It is not an image as such, but can provide a picture of the fibre in the tissues by means of its resistance to compression.

Beyond ultrasound there is X-ray imaging and magnetic resonance imaging (MRI). The latter, in particular, can be accurate in terms of locating pools of fluid, lymph nodes, lymphoceleles and showing the structure of the epifascial tissues. As with ultrasound, this can be useful in differential diagnosis between lipoedema and lymphoedema.

The benefits of imaging the vascular system, both venous and arterial, using laser Doppler techniques should also be considered. These images can help to show if there are issues with these systems which may be hyperloading the lymphatics, and if we might use these systems to help overcome a dysfunctional lymphatic system (Piller, 2009).

Thus, imaging can help us in early and differential diagnosis of lymphoedema, and the assessment of structural and functional changes in the lymph capillaries, and collectors and tissues in which they are immersed. It can tell us what and where the problems are and, importantly (if the right images are collected), can show what to treat, suggest treatment sequence, and crucially, if treatment is working according to best practice expectations.

Whatever technique is used, imaging can help to gain better outcomes. However, we need to understand what each technique can offer, its limitations and benefits, and to base our actions on the evidence that images can go some way to provide. That said, imaging is but a small part of the important holistic assessment of any patient at risk of or with any lymphoedema. For those interested in more detail regarding the discovery and exploration of the lymphatic system and associated structures, we recommend you read a good summary by Chikly (1997).

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References