

## **Lymphatico-venous bypass surgery for lymphoedema**

Management of lymphoedema has traditionally centred around techniques focusing on compression bandaging, decongestive therapy and symptom control. These techniques involve a combination of elevation, compression and exercise, while avoiding injury and attempting to control infection. They are designed to manage the condition and minimise complications, rather than cure.

Historically the only surgical options for these patients were extremely mutilating operations. However, there have been a number of advances in the surgical management of lymphoedema over recent years. The most accepted of these are liposuction, lymph node transfer and lymphatico-venous bypass surgery.

**Liposuction**, while being effective in skilled hands, reduces the volume of the affected limb but does not address the cause of the disease. The vast majority of patients will still require the use of a compression garment.

**Lymph node transfer** is a technique whereby a lymph node is removed from an unaffected area of the body and inserted into the affected lymph node basin (often armpit or groin). The concept depends upon the new lymph node being incorporated into that area and stimulating improved drainage of the affected limb. Although this is clearly an exciting idea in principle, there remain some unresolved issues with the possibility of causing secondary lymphoedema at the donor site of the transplanted lymph node. Until these issues are resolved, this is a technique that we at the Royal Marsden Hospital are not performing.

**Lymphatico-venous bypass surgery** is a technique which involves re-routing the lymphatic fluid, by joining lymphatic vessels onto small veins positioned just under the surface of the skin. Thus in the case of secondary lymphoedema (after cancer surgery for example), the condition is treated by diverting the fluid that cannot leave the limb by the normal channels. These are tiny vessels (usually 0.5mm diameter or less) that are joined together with the use of a surgical microscope. It is a day-case operation, leaving only a few short scars in the skin of the affected arm or leg. This Lymphatico-Venous Anastomosis (LVA) surgery diverts lymphatic fluid into the venous blood system and has been proven to be advantageous to sufferers from post-surgical lymphoedema. It has been suggested that it has the possibility of curing the patient, with no further need for bandaging, elevation or any of the other techniques that would otherwise be employed lifelong.

Performing this LVA procedure on patients with lymphoedema has been reported to result in symptom improvement in 95% of patients and a quantitative (volume reduction) improvement of up to 66%. However, there is significant variation between patients with regards the amount of reduction in size of the limb that occurs. One suggested reason for this variation is because it has previously been difficult to assess which of the lymphatic channels are still functioning, and therefore suitable for re-routing.

The arrival of new imaging techniques may allow us to isolate which lymphatic channels are suitable for bypass. Near-infrared spectroscopy is one of these new

imaging systems and it allows real-time visualisation of lymphatic vessels with minimal invasiveness. It accurately shows the flow of lymphatic fluid without the use of expensive radioactive isotopes, which was the previously available technique. It employs the principal of fluorescence lymphography, which detects near-infrared light emitted by indocyanine green dye that has been injected into the affected limb. This not only demonstrates the exact position and path of superficial lymphatic vessels within a limb, but also shows which of those channels are functional. This information can show us which, if any, lymphatic channels can be diverted, with the aim of improving the outcomes of the procedure for the patient.

Fluorescence lymphography using indocyanine green dye in this manner has been used for many years in numerous medical situations such as liver function evaluation, assessment of intraocular neovascular formation, sentinel lymph node detection, cardiac output measurements and assessment of myocardial blood flow. The only factor for exclusion of patients from this technique is a history of allergic reactions to iodine and thyroid gland dysfunction.

Extensive studies of this imaging system combined with LVA in countries such as the USA, Japan and Spain have shown that its use during surgery enables real-time visualization of dynamic lymph flow and consequently makes the time required for detecting functional lymphatics shorter and the operation less invasive. Publications in the international literature and research presented at recent scientific meetings have shown that this is an exciting development in lymphoedema management, which can revolutionise our care for these patients.

As a world-leading cancer centre, the Royal Marsden Hospital is one of the very first centres in the United Kingdom to offer this surgery to sufferers of lymphoedema. In addition to carrying on the work that has been pioneered in Tokyo and Barcelona, we hope to more accurately image the patients pre-operatively, so that those patients who would benefit from this procedure the most can be identified. Previously it has been shown that timing of surgery from the onset of lymphoedema is crucial and this area also requires clarification.

Using near-infrared imaging for lymphatico-venous anastomosis surgery provides patients with lymphoedema at the Royal Marsden Hospital leading edge surgical technology aimed at enhancing their care well above current NHS standards.

Some key advantages of this technique are:

- 1) The system allows more accurate real-time visualization of dynamic lymph flow so that functional lymphatics can be identified prior to skin incision. These vessels can then be used for lymphatico-venous bypass, resulting in a faster, more physiological operation.
- 2) It is a simple technique, requiring only injection of a nontoxic tracer dye into the skin and using a non-invasive image sensor. Images can be easily interpreted and examinations can be repeated in the same patient
- 3) The imaging system is portable, enabling imaging in clinic or in the operating theatre. Furthermore, because indocyanine green and fluorescence are easy to handle, a special facility is not needed for use of the system.

Thus the combination of new dynamic imaging techniques as well as advancements in supermicrosurgery has led to significant developments. Imaging delineates which lymphatic channels are still functioning, and these are used for lymphaticovenous bypass procedures.

Results for this technique have shown optimistic results and we are presenting the first British experience combining these techniques at the British Plastic Surgery Meeting in June 2013.

Lymphoedema of all causes has been treated with this technique, but the majority of cases to date are those of secondary lymphoedema – usually after treatment for cancer. Patients suffering from breast cancer related lymphoedema in particular form a substantial proportion of those treated with this technique at the Royal Marsden Hospital, not least as a result of the prevalence of this disease.

After an initial consultation which involves extensive questioning and examination to assess suitability for treatment, the patient may be selected to proceed to near-infrared spectroscopy imaging. This imaging involves an injection of a very small volume of indocyanine green dye in between the fingers or toes of the affected limb. Although allergic reactions to iodine or thyroid gland dysfunction may preclude the patient from having this imaging, it is otherwise extremely well tolerated.

The results of the imaging are discussed with the patient and the proposed surgery, if appropriate, may then be discussed at length. The highly trained Royal Marsden lymphoedema therapy team separately assesses all patients and limb volumes are accurately measured, in order to quantify improvements.

The operation involves a day case, general anaesthetic procedure resulting in a small number of short scars on the affected limb. A small incision is used to open the skin and find the tiny lymphatic channels, as well as suitable small veins for the bypass procedure (Figure 1). The anastomosis is then performed (Figure 2) and repeated at different positions on the limb.

As with all surgery, there is the risk of infection and wound healing problems. Our series to date has had no such complications and extensive precautions are taken to minimise such risks. There is some blue and green discolouration around the scars which can take some time to fade. Near-infrared spectroscopy imaging is used to analyse the functioning lymphatics in the affected limb pre and post-operatively.

The post-operative regimen involves initial bandaging of the limb with a dressing change at one week. The stitches are removed after two weeks at which time the patient can mobilise as normal. At this stage the patient is fitted into the compression garment they were previously using and their progress is carefully monitored. Post-operative volumetric improvements of the affected limbs are measured at regular intervals with a perometer.

We recommend against flying or strenuous exercise for the first month. We also reinforce the importance of elevation of the limb whenever not mobilising to improve

swelling and give the wounds the best chance of healing.

Clearly the aim is to see a gradual reduction in the volume of the limb, resulting in the need for progressively smaller garments and ideally resolution of the condition.

Although this is a well documented and minimally invasive procedure it is not possible to guarantee that it will cure the lymphoedema. However the evidence that we have from the international literature as well as from our work show that many patients gain symptom improvement and more than 50% of patients get at least some volumetric improvement – i.e. the volume of the affected limb decreases. However the degree of this improvement is difficult to predict, and it is identification of those patients most likely to benefit that is the drive of our work.

Lymphaticovenous anastomoses compare favourably to other more traditional options and can be a useful adjunct in the management of this most debilitating condition. Patient selection, using imaging techniques, is crucial and there is a clear need for further investigation and research.

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