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Lymph/Lipoedema Treatment
in its Different Approaches

1st JOBST Scientific Symposium
2008

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Lymph/lipoedema treatment in its different approaches

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Foreword

Professor Christine Moffatt

The challenges of providing effective treatment for patients with lymphoedema-related disorders have never been more prominent. Conservative management of lymphoedema remains of central importance, however, there is increasing evidence that other therapies, such as surgical approaches, may have an important part to play in the arena of treatment.

The findings from these proceedings highlight the potential role that surgical approaches, including liposuction, can have in transforming the lives of patients. Conservative approaches, while effective in many patients, do not provide a solution for some of the complex issues patients face, nor do they always provide sustained results even after periods of expensive, intensive treatment.

Relatively little attention has been placed on the impact that lymphatic conditions have on the lives of patients and their families. However, research is beginning to show that patients' health-related quality of life is significantly affected and that previously dismissed symptoms, such as pain, are a feature of the condition. Lymphoedema and lipoedema are both likely to have a deleterious effect on the body image of patients who live day-to-day with distorted limbs. Treatments such as liposuction have the potential to reverse some of the crippling effects of these disorders on the psychosocial health of patients.

The indications from these proceedings are that this is an important and encouraging area of practice that must be considered as part of the armoury of treatment. Liposuction has often been viewed negatively by the lymphoedema community, who have been sceptical about its value and concerned for its safety. This document shows that when it is used appropriately, by well trained surgeons, it can be very effective. In fact, the area of liposuction now has a growing evidence base that rivals many of the other conservative areas of lymphoedema management. Management of lymphatic conditions demands that the professional groups begin to work together in a more collaborative way in order to develop treatments that really address the growing number of patients with these types of conditions.

Christine Moffatt
Honorary Professor, Glasgow Medical School
March, 2009

Introduction

Thomas Terwey, David Gray

On behalf of BSN-Jobst® I would like to welcome you to the first Jobst scientific symposium. Over the years, since its foundation in 1953, Jobst has organised a number of scientific symposiums. These have never been on a regular basis, but driven by special occasions.

This first scientific symposium is the start of a series of annual symposia in the areas of phlebology and lymphology, which will provide a platform for scientific discussion and exchange. The fact that more than 70 participants from the UK, Netherlands, Sweden, Italy and Germany have registered for this symposium shows the great interest in this subject of lympology and lymphoedema treatment in its different approaches.

The first Jobst scientific symposium is taking place in the Pan Museum. Until the early 1960s, this building was used as a chocolate factory in Emmerich am Rhein, called Lohmann.

After its closure, the building was abandoned for almost 40 years. Back in 2003, the former chocolate factory was brought back to life as the home for a museum of contemporary poster art. The basic stock collection consists of more than 90,000 posters.

Thomas Terwey,
Manager/Director Marketing & Sales
BSN-Jobst GmbH

HealthComm UK Limited are the publishers of *Wounds UK*, and more recently have become the publishers of the *Journal of Lymphoedema*. As a clinician in the wound field, one thing that has become increasingly obvious to me over the years is that people will refer individuals with significant skin problems for treatment of an ulcer, with complete failure to recognise the underlying complications associated with lymphoedema and/or lipoedema. This meeting is an opportunity to share information and different strategies that are employed to facilitate a better quality of life for the patient. It is all too easy to lose ourselves in our own internal clinical professional debate but, ultimately, there is a patient who is looking for good treatment to move on with their life.

I have noticed in the literature about the poster museum that it describes the poster as having the ability to bring people together — thus, a perfect venue to come together to listen to world-leading speakers and to engage in professional discussion.

For someone who looks into the lymphoedema world from a wound background and recognises the link between the two, I am excited to come and participate in this event. This is an area that we need to explore, and it is an area in which BSN-Jobst have been innovative for many years. We also need to remember the key point, that, at the end of treatment, there lies a patient, a patient who places their trust in the professionals from whom they seek advice.

David Gray
Clinical Director
HealthComm UK Ltd

Liposuction as a treatment for lipoedema

Professor Dr Wilfried Schmeller

Lipoedema is a disease characterised by an abnormal, circumscribed accumulation of subcutaneous fat, mainly in the lower extremities, in combination with oedema. This results in an obvious disproportion between the upper and lower half of the body, as well as pain (*Figure 1*).

Figure 1: Disproportion of the body is typical of lipoedema

Figures 2a and b: Girl (left) aged eight, and later in life (right), aged 30, after the onset of lipoedema

Although lipoedema was first described in 1940 by Allen and Hines in the United States of America, the discussion still continues today as to whether this disease really is an entity, with some clinicians even doubting that it exists. In the 1940s it was described as a symmetrical subcutaneous deposition of fat in the buttocks and lower legs, together with an accumulation of fluid that begins almost imperceptibly, progressing gradually. Lipoedema was often associated with weight gain and accentuated by orthostatic activity.

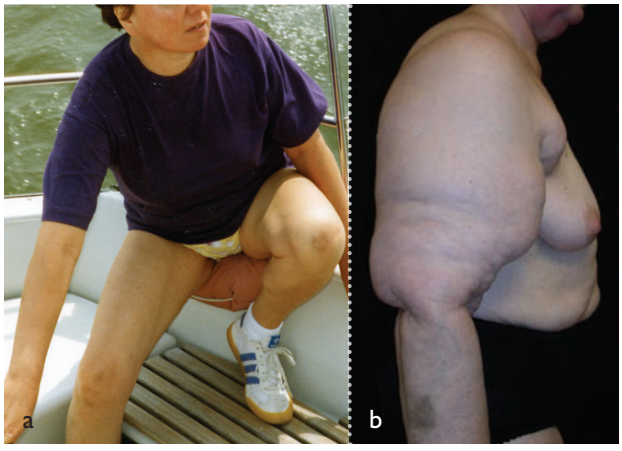
There are still aspects of lipoedema that are poorly understood. However, what we do know is that lipocytes, capillaries and venules are involved. An increased number and/or size of lipocytes results in increased fat volume, increased permeability of the capillaries causes oedema, and increased fragility of venules leads to haematoma (*Table 1*). Oedema is the main and most obvious cause of pain in people with lipoedema, so conservative therapy which reduces oedema can lessen the pain suffered. There are probably other factors causing pain, but oedema seems to be the most obvious.

Lipoedema only develops in adult females. *Figures 2a* and *2b* show the same patient at different ages. In most cases, lipoedema starts after puberty, a time when women want to look slim and beautiful. *Figures 3a and 3b* show the legs of a girl at the age of 17 and then 10 years later. The increase in volume can be seen mainly in the thighs. For some people lipoedema continues to progress until the end of life and is accentuated by pregnancy, birth and other hormonal changes, such as the menopause. In others, it remains at a steady level without progressing. The disease can also develop later in life. *Figures 4a* and *4b* show a patient's arm at the age of 51 and 10 years later. The forearms have stayed the same, while the upper arms have dramatically increased. It is not known why only the upper part of the arm is affected and the lower part remains unchanged.

Table 1: Pathophysiology of lipoedema

Lipocytes	Capillaries	Venules
hypertrophy	increased permeability	increased fragility
hyperplasia		
Increased fat volume	**Oedema**	**Haematoma**

Figures 3a, b: Young girl aged 17 (left), and ten years later (right), showing the progression of lipoedema



Figures 4a, b: Lady aged 51 (left), and ten years later (right), showing an increase in fat volume in the upper arm

Figure 5: Legs affected by an increase in fat volume

Figure 6: Thighs affected by an increase in fat volume

Fat volume can increase in different body areas. For instance, the entire leg can be affected (*Figure 5*), or just the thighs (*Figure 6*). An increase in fat volume covering the thighs and upper parts of the calves is sometimes referred to as 'Turkish legs', as the shape of the legs resembles traditional Turkish trousers which are gathered or pleated around the waist and gathered into a band below the knee, giving a full blooming effect from the knee up. Alternatively, an increase in fat volume may only be found in the lower legs. However, in all cases, the disproportion is obvious.

Progressive lipoedema can be classified into a number of different stages:

- **Stage I:** skin surface remains normal, but with palpation the small nodular fatty tissue structure can be felt (*Figure 7*)
- **Stage II:** skin surface is uneven with a nodular fat structure (*Figure 8*)
- **Stage III:** there is a lobular deformation due to increased fatty tissue, often with tissue 'sacks' on the inner side of the legs (*Figure 9*).

Oedema tends to increase as fat volume increases. However, in cases where there is a great deal of fatty tissue but little oedema, the patient will not suffer as much. Conversely, if there is little fat but a great deal of oedema, pain and tension will be worse. By pressing the lower legs with a finger, pitting oedema can be found. This tends to be worse in the evening than in the morning, and more in the summer than winter months.

In the 1940 study by Allen and Hines, the majority of the patients suffering from lipoedema were also overweight. These initial findings are also supported by the author's experience. From 150 patients treated in the author's clinic over the last few years, 19% had grades 2–4 obesity with a body mass index (BMI) of over 35 kg/m^2. In the general population, about 8% of the population fall into this category. It remains unclear whether this increased prevalence of high BMI is part of the disease process, or, is it because the patients are frustrated that despite their diets they cannot reduce the size of their legs, and so they eat even more and gain weight on the trunk as well?

Surgical history

The dream to remove fat is an old one. It was reported that the Duke of the Ostmark (1130–1190) — Dedo 'the fat one' — tried surgically to get rid of his body fat but died during the operation. At that time surgical procedures were very dangerous.

Figure 7: Stage I lipoedema

Figure 8: Stage II lipoedema

Figure 9: Stage III lipoedema

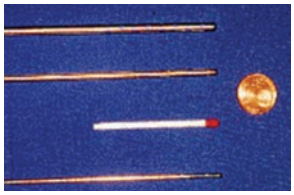


Figure 10: Micro cannulas

Figure 11: Infiltration of tumescent local anaesthesia (TLA)

Figure 12: Powered liposuction

In 1929, the French Dujarrier removed fat from the calves of a dancer with a curette. Unfortunately, the patient lost his legs as a result of a complication. In the 1960s, Wilkinson in the USA and Schrudde in Germany had more success trying to remove fat under general anaesthesia with a curettage and aspiration. In Italy in the 1970s, Georgio and Arpad Fisher invented a cellu-suctiotome (a special curette with a blade and suction pump). They were quite successful in removing fat but there were many complications and the cosmetic results were poor.

In the 1980s, Yves-Gerard Illouz and Pierre Fournier started to work with blunt cannulas. They put a saline solution into the subcutaneous space to dilute the fat and tried different techniques, including the so-called criss-cross technique, to achieve better cosmetic results. This was the beginning of modern liposuction. In the1990s, tumescent local anaesthesia (TLA) was invented in the USA. This involved putting a highly diluted anaesthetic solution (0.04% of lidocaine, or a lidocaine/prilocaine mixture) into the subcutaneous space. Liposuction could now be performed as an outpatient procedure with good cosmetic results. This revolutionary technique came to Europe in the 1990s, mainly supported by Jeffrey Klein, who used it first and did a great deal of teaching worldwide. In Germany, Gerhard Sattler propagated this method with great success.

Today, in addition to TLA, we use blunt vibrating cannulas (*Figure 10*) with a diameter of 3 or 4 millimetres. This technique results in minimal damage to the tissue. The procedure takes some time as the TLA-fluid has to be infiltrated into the fat (*Figure 11*). This takes up to one hour, followed by an intermission of half an hour for the anaesthetic to take effect before the operation can start (*Figure 12*). Between 4 and 8 litres of TLA-fluid are needed.

Although conservative therapy in the form of manual lymphatic drainage (MLD) helps to reduce oedema in the limb/tissue, it has no effect on fat volume. While most patients will improve according to plan, their body shape will

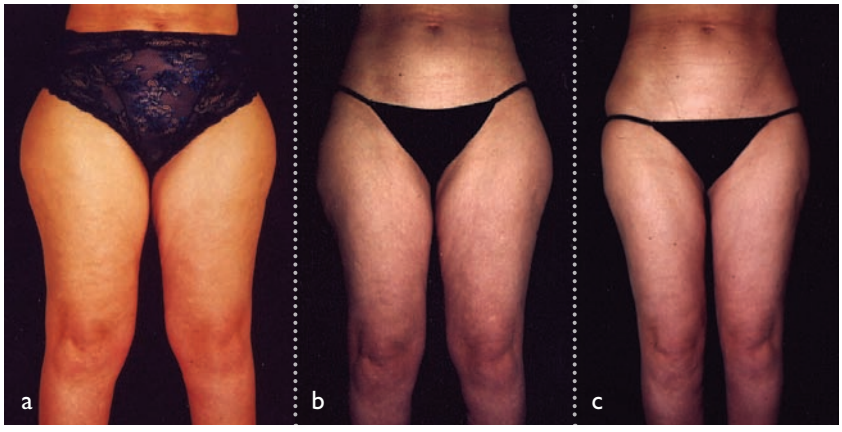


Figure 13a: Prior to conservative therapy. Figure 13b: After three and a half weeks' conservative therapy, 2.8 litres of oedema was removed. Figure 13c: After the removal of 3.3 litres of fat

Figure 14: Fluid coming out from the lower incision points

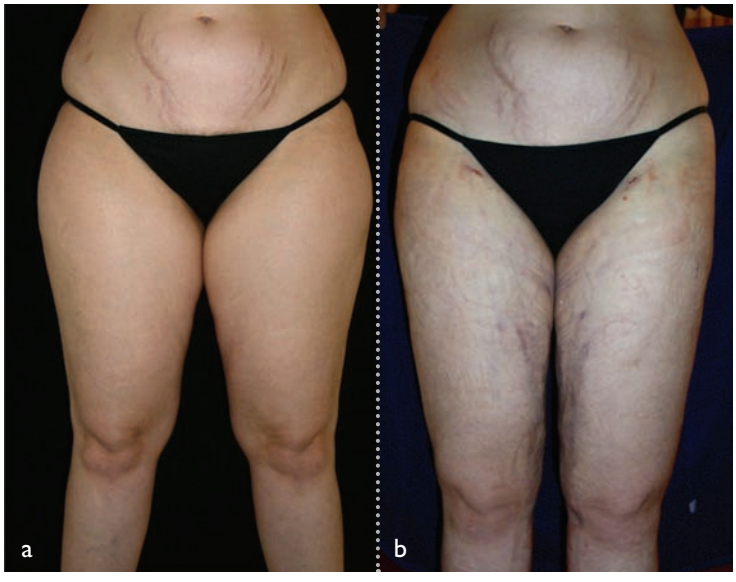


Figure 15a: Before surgery. Figure 15b: One day after surgery, 4.0 litres of fat have been removed from the outer and inner thighs

Figure 16a: Before surgery. Figure 16b: One day after surgery and the removal of 6.0 litres of fat

basically stay the same. *Figure 13a* shows a typical example. This patient with lipoedema had been in a lymph clinic for three and a half weeks, where 2.8 litres of fluid had been removed from her legs (*Figure 13b*). Although the patient no longer suffered from pain due to oedema, the fat volume of the limb remained the same. She subsequently presented at the author's clinic, where the fat on the outer and inner sides of her thighs was removed. In two hours, 3.3 litres of fat were removed. The patient's figure returned to being in proportion (*Figure 13c*). Three and a half weeks of fluid removal reduced the oedema, but a relatively quick surgical procedure had the dramatic effect of greatly reducing the volume of the limb.

In the immediate postoperative period, a great deal of TLA-fluid will leak from the lower incision points (*Figure 14*). Some of the fluid that is infiltrated will be removed during liposuction, the rest remains in the tissue producing an anaesthetic effect for a further 24 hours. This fluid will slowly leave the body through the incisions, as well as being absorbed in and excreted through urine.

Figure 15a shows a patient before surgery and *Figure 15b* the following morning after 4 litres of fat have been removed. The upper incision sites are visible in the groin, as well as the beginning of haematoma formation on the inner side of the thighs. The new body proportions can already be seen.

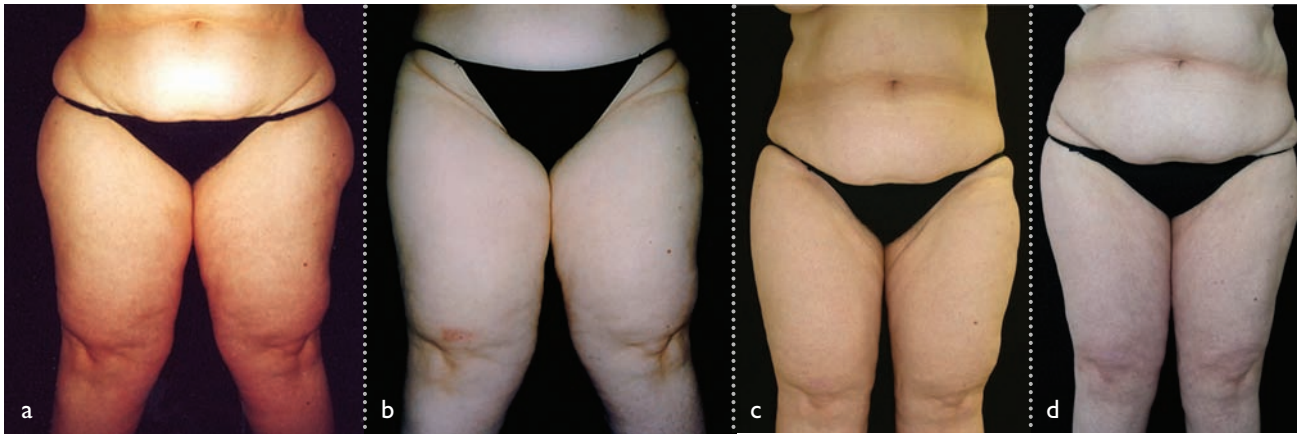


Figure 17a: Lipoedema. Figure 17b: After liposuction on the hips and outer thighs. Figure 17c: After liposuction on the inner thighs and knees. Figure 17d: After liposuction on the front of the thighs

Figure 17e: Before liposuction of the calves. Figure 17f: After liposuction of the calves

The patient in *Figure 16a* had previously visited many lymph clinics, but conservative therapy had been ineffective. She came to the author's clinic because she was still concerned about her figure and suffered considerable pain. *Figure16b* shows the patient the morning after her first liposuction treatment which removed 6.4 litres of fat from the outer side of the hips and thighs. A dramatic improvement can be seen after just one day.

Liposuction can be performed, step by step, on all areas of the body, normally starting with the hips and outer thighs. An interval of 4–6 weeks is needed between treatments. *Figure 17a* shows a patient before surgery. In the first step, 3.7 litres of fat were removed from the outer hips and thighs (*Figure 17b*). After four weeks, a second operation was performed on the inner side of the leg, in which 3 litres of fat were removed (*Figure 17c*). The next step treated the front of the thighs and 2.8 litres of fat were removed (*Figure 17d*). Thus, in three operations under local anaesthetic, the body's shape markedly changed.

The lower legs are usually the last area to be operated on (*Figure 17e*). *Figure 17f* shows the result after the removal of 3050ml of fat. Altogether, this patient had 12.6 litres of fat removed (it is usual for 10–20 litres of fat to be removed).

Lipoedema can affect several generations of a family. *Figures 18a* and *18b* show a mother with her first and second daughter pre- (*Figure 18a*) and post-operatively (*Figure 18b*).

The morphological changes as a result of liposuction are obvious. However, patients' grievances should also be addressed. Liposuction is not a cosmetic operation but a treatment that improves quality of life. Three months after the author's first 77 patients had completed all their operations (between two and five episodes of liposuction), they were asked how their quality of life and pain from the pressure felt as a result of oedema had improved. Patients were asked using a scale to provide their views on pain, oedema and haematoma, and how they varied pre- and post-operatively. Two patients had the same pain as before. Seventy-five patients reported that their pain had improved considerably, and some patients, including those who had had significant problems, reported being pain-free (*Figure 19*).

Figure 18a: Preoperative. Mother (left), 55 years; daughter (centre), 33 years; daughter (right), 31 years

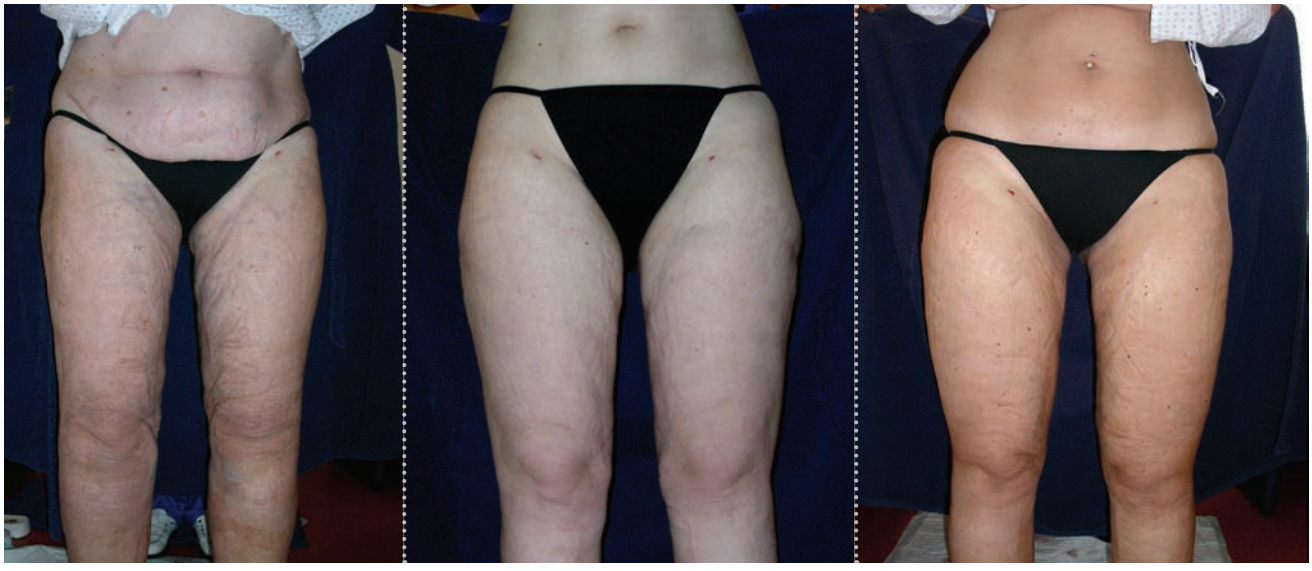


Figure 18b: The same people as above the morning after liposuction

Similarly, patients were asked if their oedema had reduced following surgery. Seventy-five patients reported that their oedema had reduced, and some patients, including those who had had a great deal, reported that it had disappeared (*Figure 20*). Oedema was not measured directly but the patients were asked if the swelling had improved. They completed forms, classifying themselves with a score, i.e. a subjective rating. Again, two patients saw no improvement in their oedema, but they had only had a small amount at the outset. For the other patients, their oedema had decreased and, in some cases, it had disappeared. The permeability of the capillaries cannot be changed by liposuction and, in the author's opinion, this is a result of the reduced space in the subcutaneous area after the removal of fat (*Figure 21*).

Are there changes regarding the effect of surgery on the occurrence of lipoedema-associated haematoma? About half of the patients at the author's clinic stated that this condition had remained the same. Others claimed that it had improved, and many said that their inclination to haematomas had disappeared completely after liposuction (*Figure 22*). As we cannot change the fragility of the venules by liposuction, to date we have no explanation for this improvement.

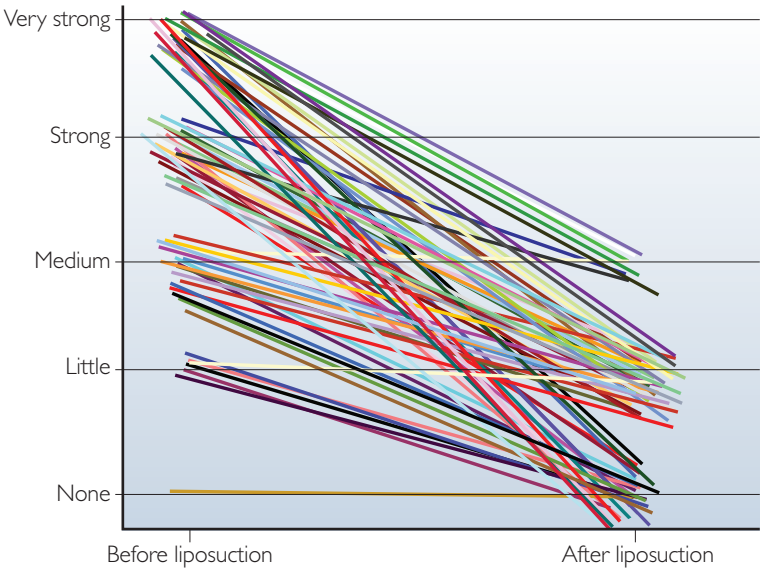


Figure 19: Pain due to pressure

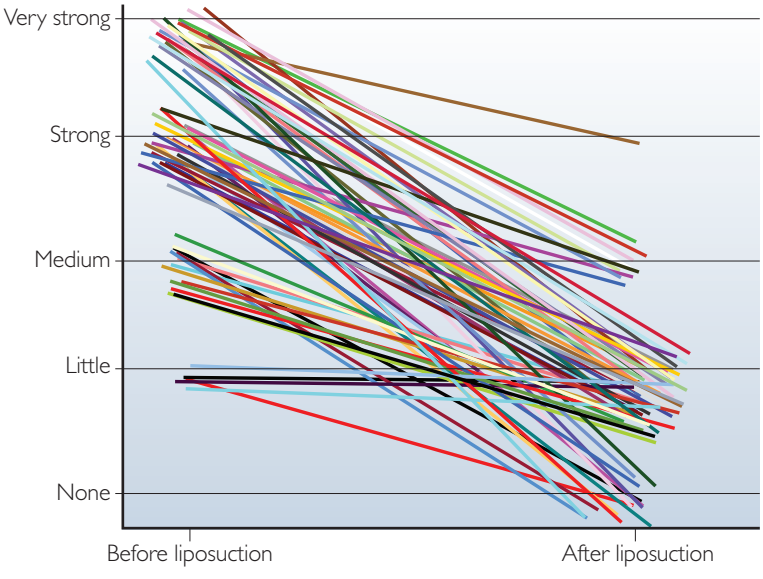


Figure 20: Pain due to oedema

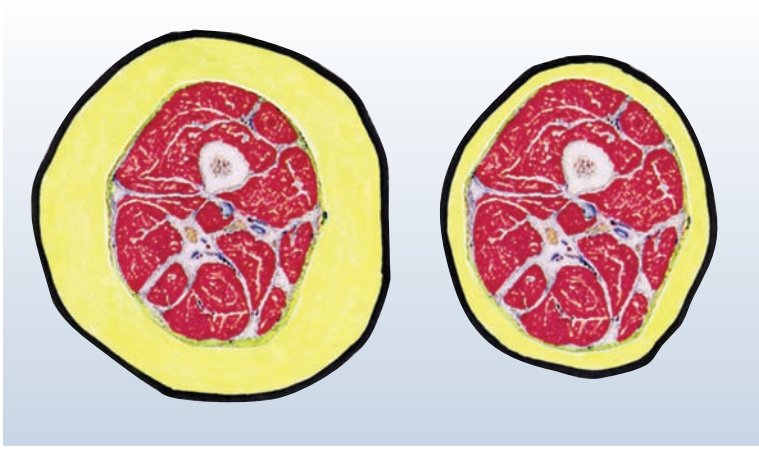


Figure 21: Cross-section through a thigh, showing reduction of subcutaneous fat on the right side following lipoedema

Figure 23a shows the legs of a patient before treatment. There were two choices open to this patient: to continue conservative treatment with an inevitable increase in fat and oedema over time, or, to undergo liposuction. The patient took the latter course. *Figure 23b* shows the dramatic improvement that can be achieved, as this lady no longer has 'classical' lipoedema. Any oedema that she might develop later in life would be orthostatic oedema, which can easily be treated by conservative therapy. One might even consider if liposuction is a sort of causative treatment?

Most patients have some degree of oedema following surgery. Is further conservative therapy therefore needed after liposuction? Twenty-five percent of patients from the author's clinic said that they did not need to wear stockings or to continue seeing physiotherapists after liposuction (*Figure 24*). Forty-one percent said that they still underwent conservative therapy, but less frequently and the results had improved. Twenty-three percent maintained their preoperative regimen, including hosiery, but felt that they needed therapy less and that their hosiery fitted better. Eleven percent confessed that they had not even known that they should be seeing a physiotherapist before they came to the author's clinic, but now they were going and it was helping them.

Many of the author's patients commented that a revolution had taken place for them by their liposuction treatment for lipoedema. Although liposuction does not address underlying pathology completely in patients with lipoedema, the removal of fat means that the disease is no longer visible, improving patients' quality of life.

The question of relapse after liposuction has been discussed — what do we mean by relapse? The effects of MLD may last a few days before oedema recurs. With compression hosiery one tries to delay relapse, to prolong the effects of MLD. However, after a week or so oedema

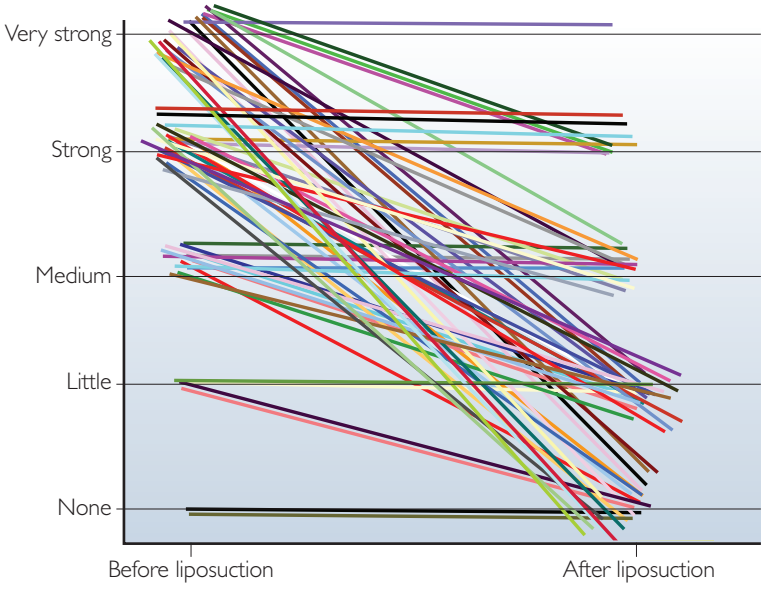


Figure 22: Lipoedema-associated haematoma before/after liposuction

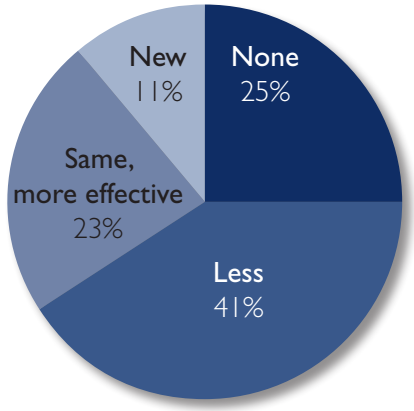
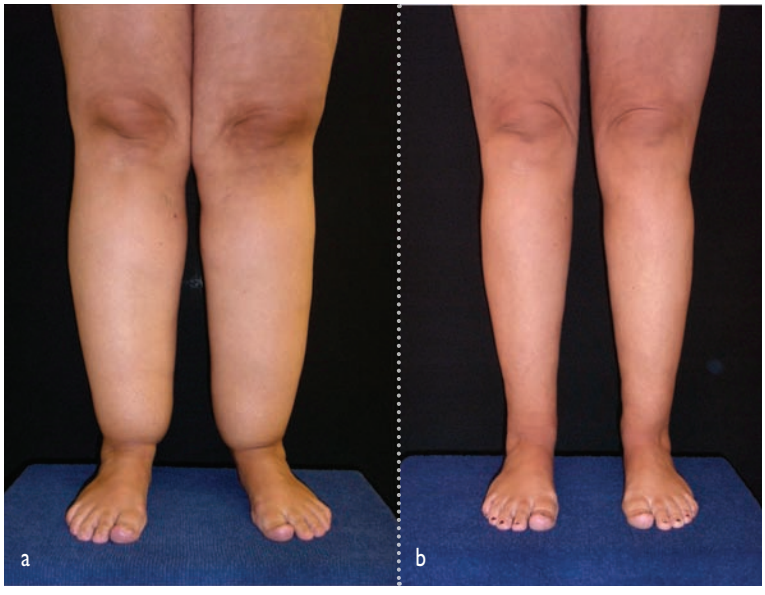


Figure 24: Conservative therapy following liposuction



Figures 23a and b: Lower legs. 4.5 litres of fat have been removed

comes back again. Thus, the effects of conservative therapy are shortlived; it has to be performed every week, every month, every year, lifelong.

However, following the initial series of operations, the effects of liposuction can last for years. It might take decades before a patient's fat volume increases again. This raises the question of whether this is a real prophylaxis for oedema and the disease as a whole.

As said, lipoedema starts during puberty with an increase of fat volume. Throughout life this fat volume will grow. Lymphatic drainage alone has no effect on this continuous increase. Conservative therapy follows the disease — the disease progresses and one tries to remove a bit more oedema. You are always 'running behind' the disease, unable to catch up because you only have a symptomatic treatment of a short duration.

What does surgical therapy do? It removes the fat volume, returning patients to a normal figure with a normal amount of fat — a figure that they had 10 or even 20 years ago.

It is entirely possible that the patient may suffer from a relapse since the pathology responsible for the development of lipoedema remains following surgery. However, the condition can be turned back. After 20 years the fat volume may have increased and you are back to the point where you started the surgical treatment. Is this a relapse? Studies following lipoedema patients after liposuction for 10 years show that the long-term results are good. The author's clinic have followed more than 150 of their patients for up to five years and have seen only two patients with a 'so-called' relapse. One patient gained 20 kilos of body weight, something over which you can have no control. The other patient had a slight increase in the area of the outer thighs again.

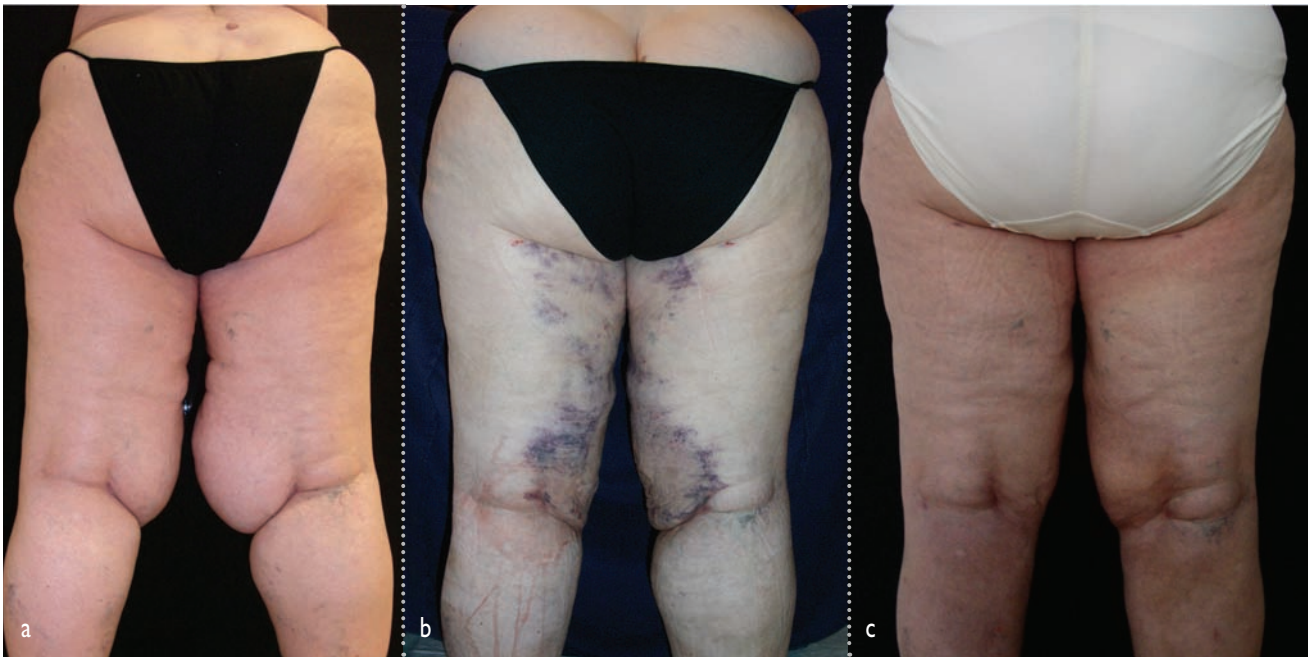


Figure 25a: Lipoedema before liposuction at the inner thighs and knees; Figure 25b: Haematomas on the first day after surgery; Figure 25c: Result after three months

Turning briefly to the damage that can occur as a result of surgery; *Figure 25a* shows a patient who had had no benefit from conservative therapy. *Figure 25b* demonstrates the new shape of the legs just one day after surgery, and *Figure 25c* shows the result after three months. 2.5 litres of fat were removed on the right-hand side and 1.9 litres of fat on the left. After one day some 'damage' was noticeable. There were haematomas due to disruption of the capillaries and maybe also disruption of tiny initial lymph vessels or precollectors that run through the subcutaneous fat. However, there is no obvious damage to the lymph collectors of the main vessels. These big collectors run deep in the subcutaneous fat on top of the fascia and are the important ones that should not be cut, damaged or squeezed. By doing modern surgery, these structures are not destroyed. As long as there is no damage to the great lymph collectors, there will be no secondary lymphoedema. This has been affirmed by the author's studies.

In the last century, lipoedema therapy consisted of lifelong MLD to address the oedema component of the condition, with clinicians unable to do anything to change fat volume and thus prevent the disease from progressing.

In the 21st century, treatment of lipoedema should be different. Conservative therapy is a crucial first step, but should be followed by liposuction. This is important and will remain important, but, on another level than before. Conservative therapy should be followed by liposuction, which can be performed several times until all areas have been treated. After this, most patients will still need MLD, but far less and with a better effect than before.

If performed properly, liposuction achieves excellent results: patients have less fat, less oedema, less pain, resulting in an improved body image and quality of life. Modern therapy should be a combination of surgical and conservative methods, performed by experts in specialised centres. Postoperatively, it would seem that conservative treatment is more successful, with hosiery fitting more comfortably.

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Liposuction as a treatment for lymphoedema

Dr Håkan Brorson, Dr Carolin Freccero

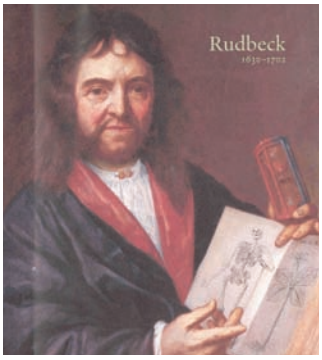


Figure 1: Olof Rudbeck, 1630–1702

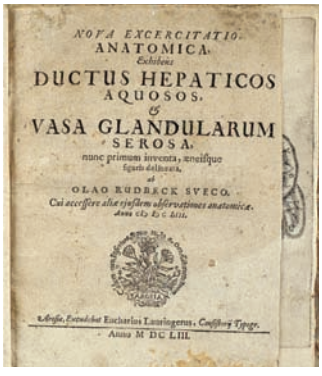


Figure 2: Rudbeck thesis — Novo exercitatio anatomica, exhibens ductus hepaticos aquosus et vasa glandularum serosa

In the 1700s, Olof Rudbeck from Uppsala, Sweden (*Figure 1*) outlined the function of the lymphatics. In 1653 he wrote a thesis about the lymphatic system (*Figure 2*). *Figure 3* shows a diagram of the liver and the lymph vessels entering the cisterna chyli and finally, via the thoracic duct, emptying into the venous junctions in the neck. In the 1700s scientists thought that the lymph vessels drained to the liver. In 1652, Olof Rudbeck performed an autopsy to show that the lymphatic vessels instead drained the liver and bowels as well as the legs (*Figure 3*). Thomas Bartholin from Denmark (*Figure 4*) was told about these findings and was fascinated by this procedure and likewise started to do dissections. In 1653, Bartholin presented his thesis four weeks before Rudbeck's, resulting in one of the great academic disputes of the 1700s.

Figure 5 shows a patient in the 1960s after surgery for breast cancer, suffering the effects of heavy irradiation. She had disturbances of both the lymph and blood circulation and had to undergo amputation. Fortunately today, patients do not undergo such high levels of radiation, but rather more frequent, low-level radiation that causes less damage.

Figures 6 and *7* show typical patients who have presented at the authors' clinic in Malmö, Sweden. The literature shows that there have been a number of surgical techniques for lymphoedema (*Figure 8*). *Figure 9* shows two patients with bilateral lymphoedema who were operated on in the 1960s. They were treated by excision of the skin and subcutaneous tissue down to the muscle fascia, which was covered with split skin grafts (Charles' procedure). In contrast to liposuction, this technique resulted in poor cosmetic outcomes and patients often had problems with subsequent scarring, eczema, lymph fistulas, etc. The authors have not performed this procedure for the last 15 years.

Figure 3: Novo exercitatio anatomica

Figure 4: Thomas Bartholin, 1616–1680

In 1998, the first author wrote a thesis entitled *Liposuction and controlled compression therapy in the treatment of arm lymphoedema following breast cancer* (Brorson, 1998), which further increased the interest and knowledge in liposuction as a treatment for lymphoedema. This thesis included five different papers on how to treat lymphoedema with liposuction. The first paper explored how complete reduction of lymphoedema could be gained (Brorson and Svensson, 1997a), and another described a randomised trial where liposuction and compression were used, versus compression alone (Brorson and Svensson, 1998). The compression-only group achieved a 47% reduction of excess volume in the lymphoedema, but the group with surgery as well showed complete reduction (100% reduction). In those early days, the pitting test was not performed as rigorously as it is done today, thus explaining the effect of compression, which mobilises fluid but not fat.

In one paper, the author showed that liposuction did not further reduce an already decreased lymph transport system. This was important because some clinicians thought that the lymphatics were destroyed by the procedure (Brorson et al, 1998).

Another paper found that skin blood flow increased after surgery, which possibly explained why patients had fewer attacks of erysipelas after surgery (Brorson and Svensson, 1997b). The last paper dealt with the improvement of quality of life found after surgery (Brorson et al, 2006a).

Figure 5: Patient suffering the effects of heavy irradiation in the 1960s who had to undergo amputation

Figure 6: Patient with excess volume of 2.1 litres

Figure 7: Patient with excess of volume 12.3 litres

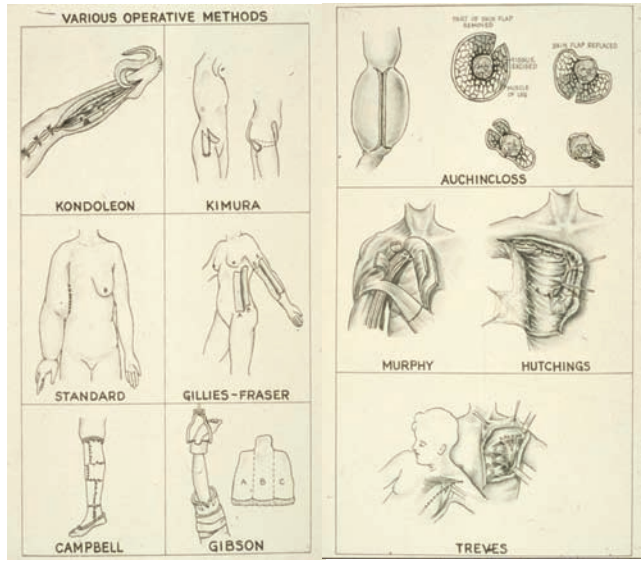


Figure 8: Examples of various operative techniques

Pitting test

The pitting test is a quick and easy method of deciding which patients are suitable for surgery. 'Pitting' refers to the depression formed after pressure is applied to the oedematous tissue. The thumb presses as hard as possible on the extremity to be investigated for 60 seconds, the amount of depression being estimated in millimetres (*Figure 10a*). Oedema that is mainly hypertrophied adipose tissue and/or fibrosis shows little or no pitting (*Figure 10b*).

In 1993, a magnetic resonance imaging scan (MRI) was taken of the first patient to undergo liposuction. On analysis, excess adipose tissue could be seen (*Figure 13*). *Figure 11* shows a picture of excess fat volume in the lymphoedematous arm taken in the 1960s. The authors had often been told that the excess volume was dominated by fibrosis. Fat was never spoken of. Thus, the liposuction aspirate in patients was analysed and 90–100% fat was found. If it had simply been fluid, it would have been 90% fluid and maybe 10% fat. *Figure 12* shows the aspirate, from a typical patient, in a 2-litre canister. The adipose tissue separates into an upper adipose fraction (90%) and a lower fluid (lymph) fraction (10%).

Figure 9: Typical results after excision of skin and subcutaneous tissue followed by split skin grafting

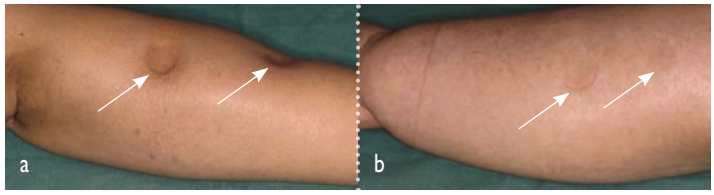


Figure 10a. Marked lymphoedema of the arm after breast cancer treatment, showing pitting several centimetres in depth. The arm swelling is dominated by the presence of fluid, i.e. the accumulation of lymph. Figure 10b. Pronounced arm lymphoedema after breast cancer treatment. There is no pitting in spite of hard pressure by the thumb for one minute. A slight reddening is seen at the two spots where pressure has been exerted. The 'oedema' is completely dominated by adipose tissue. The term 'oedema' is improper at this stage since the swelling is dominated by hypertrophied adipose tissue and not by lymph. At this stage, the aspirate contains either no, or a minimal amount of lymph

Figure 11: Cross-sections of a lymphoedematous (right) and a normal arm (left) showing abundance of excess adipose tissue in the affected arm

Figure 12: The aspirate contains 90–100% adipose tissue in general

Evidence of adipose tissue in lymphoedema

Indications for adipose tissue hypertrophy include:

- Consecutive analyses of the content of the aspirate removed under bloodless conditions using a tourniquet showed that a high content of adipose tissue in 44 women with postmastectomy arm lymphoedema (mean 90%, range 58–100) was found (Brorson et al, 2004)
- Analyses with dual X-ray absorptiometry (DXA) in 18 women with arm lymphoedema following breast cancer treatment showed a 73% increase in volume of adipose tissue in the non-pitting swollen arm before surgery (Brorson et al, 2009)
- Preoperative investigation with volume rendered computer tomography (VR-CT) images in eight patients, following breast cancer treatment, showed a significant preoperative increase of adipose tissue in the swollen arm, the excess volume consisting of 81% fat (Brorson et al, 2006a)
- Tonometry findings in 20 women with postmastectomy arm lymphoedema showed postoperative changes in the upper arm, but not in the forearm, which also showed significantly higher absolute values than in the upper arm. This is probably caused by the high adipose tissue content with little or no free fluid, just like the situation in the normal arm. The thinner subcutaneous tissue in the forearm may also play a part. Tonometry can

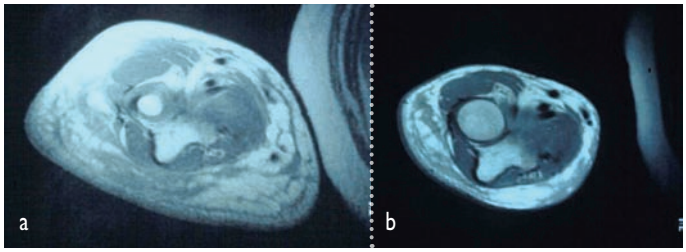


Figure 13a: Preoperative. Figure 13b: One year postoperatively

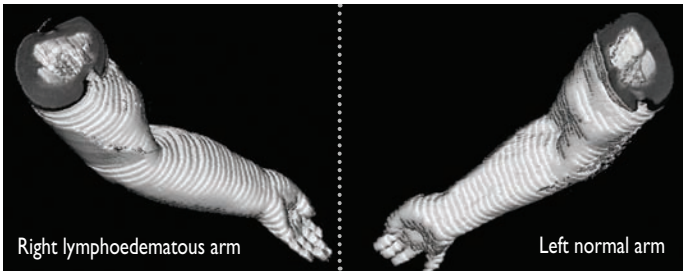


Figure 14: Volume rendering computer tomography (VR-CT) images showing 1.3 litres of excess fat in the right arm

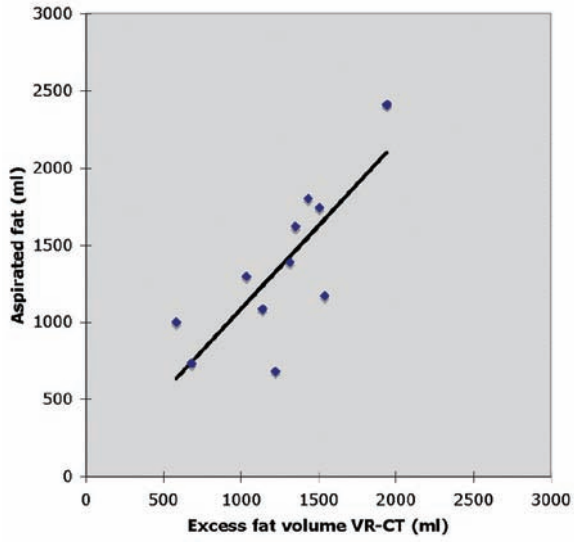


Figure 15: Aspirated fat versus VR-CT excess fat volume. Reproduced by kind permission of Lymphatic Research and Biology (Brorson et al, 2006b)

distinguish if a lymphoedematous arm is harder or softer than the normal one. If a lower tissue tonicity value is recorded in the oedematous arm, it indicates that there is accumulated lymph fluid in the tissue, and these patients are candidates for conservative treatment. In contrast, patients with a harder arm compared with the healthy one, have an adipose tissue excess that can successfully be removed by liposuction (Bagheri et al, 2005)

- The findings of increased adipose tissue in intestinal segments in patients with Crohn's disease, known as 'fat wrapping', have clearly shown that inflammation plays an important role (Jones et al, 1986; Sheehan et al, 1992; Borley et al, 2000)
- In Graves' ophthalmopathy, a major problem is an increase in the intraorbital adipose tissue volume leading to exopthalmus. Adipocyte related immediate early genes (IEGs) are overexpressed in active ophthalmopathy and cysteine-rich, angiogenic inducer 61 (CYR61) may have a role in both orbital inflammation and adipogenesis and serve as a marker of disease activity (Lantz et al, 2005).

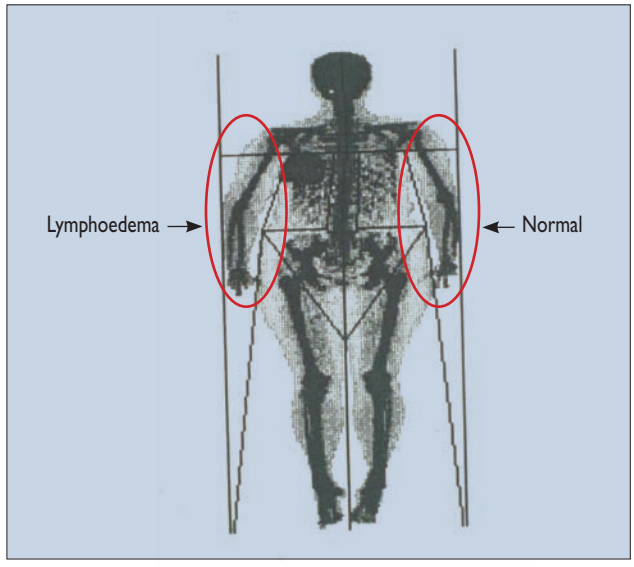


Figure 16: Dual energy X-ray absorptiometry (DXA)

Measurement techniques

In the authors' opinion, the problem with non-pitting lymphoedema is fat, not lymph. Looking at an MRI scan before and after surgery, there is a considerable reduction of the excess volume (*Figures 13a, b*). However, to achieve objective measurements further analysis with VR-CT can be performed. This involves tomography of both arms with the computer being programmed only to show pixels for fat. Fat volume can be calculated by measuring the fat pixels.

Figure 14 shows a patient with an excess fat volume of 1.3 litres. This is an objective sign of excess adipose tissue. The amount of aspirated fat can also be correlated to the excess fat volume measured with computer tomography (*Figure 15*).

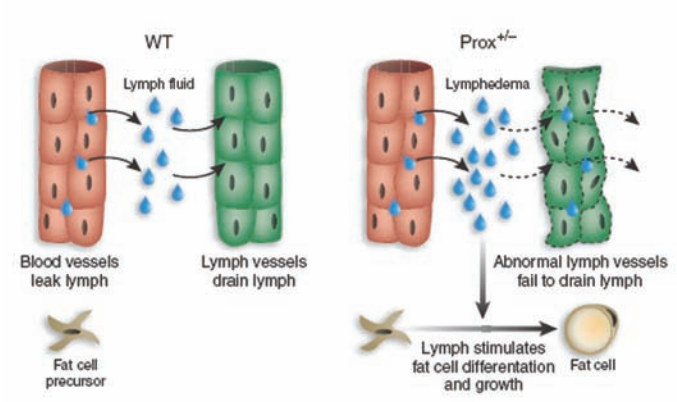


Figure 17 Lymph makes you fat. Reprinted by permission from Nature Genetics, October, 2005 (Schneider et al, 2005)

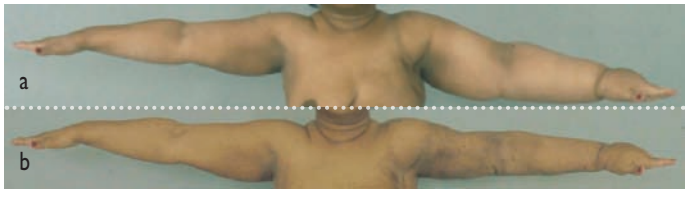


Figure 18a: Preoperatively, 2.315 ml; Figure 18b: four weeks postoperatively

Figure 19a: A 74-year-old woman with a non-pitting arm lymphoedema for 15 years. Preoperative excess volume was 3.1 litres. Figure 19b: One year postoperatively

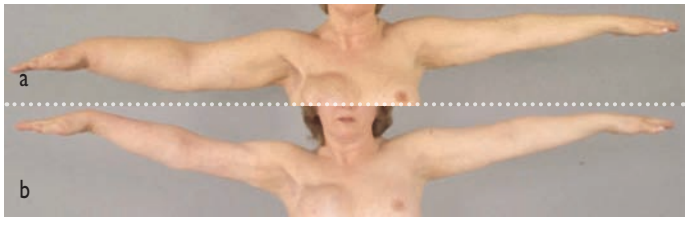


Figure 20a: Preoperatively, 1.335 ml; Figure 20b: One year postoperatively

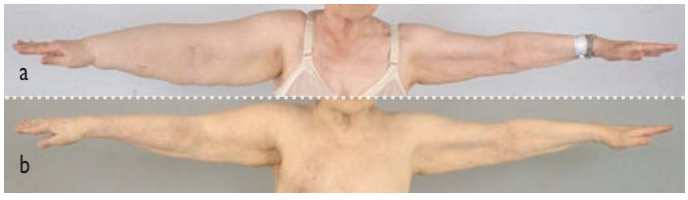


Figure 21a: Preoperatively, 2.480 ml; Figure 21b: Five years postoperatively

Figure 22a: Preoperatively, 2.200 ml; Figure 22b: 14 years postoperatively

Another measurement technique is DXA, where fat, muscle and bone are measured in grams and transferred to volumes by density. *Figure 16* shows a typical patient where DXA shows an excess of 510 grams in the lymphoedematous arm. The same relationship with aspirated fat and excess fat volume measured with VR-CT was found. The amount of excess adipose tissue in the lymphoedematous arm showed a mean excess amount of fat of 73% using DXA (Brorson *et al*, 2009), and of 81% using VR-CT (Brorson *et al*, 2006b).

Both VT-CT and DXA are methods to objectively show excess adipose tissue merely for research purposes. This is not necessary in the clinical situation where the pitting test is sufficient.

In 2005, Harvey *et al* cited in *Nature Genetics* one of the authors' earlier works regarding findings of excess adipose tissue (Harvey *et al*, 2005). *Figure 17* shows that in the wild type (WT) mouse fluid leaks from blood capillaries and is collected by the lymph vessels and is transported back to the blood circulation (left-hand image). In the Prox $1^{+/-}$ mice, impaired lymph drainage caused accumulation of lymph fluid in the tissues, where it induced excess differentiation of fat cell precursors and fat cell hypertrophy (right-hand image). The factors determining the adipogenic potency of lymph are not known (Schneider et al, 2005).

Inflammation is probably one of the causes of excess fat deposition. The goal of liposuction should be to remove excess fat and achieve complete reduction. *Figures 18–22* show some typical results.

Initially, liposuction was done as a 'dry' technique, no dilute adrenaline or anaesthetics being injected into the adipose tissue beforehand (Clayton et al, 1989). A disadvantage of the 'dry' technique was the large amount of blood lost (Courtiss et al, 1992). Most surgeons recommended that no more than 1500ml of fat should be removed to avoid the need for blood transfusions.

Illouz was the first to infiltrate the subcutaneous fatty tissue when doing liposuction (Illouz, 1983). In the early 1980s most surgeons used the 'wet' technique (Goodpasture and Bunkis, 1986), which involves infiltration of 200–300ml of

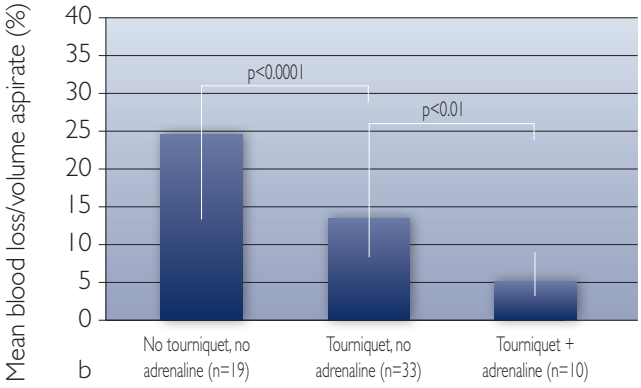


Figure 23: Mean blood loss (ml) in the groups with lymphoedema. Reproduced by kind permission of the Scandinavian Journal of Plastic Reconstructive Surgery and Hand Surgery (Wojnikow et al, 2007). Available online at: www.informaworld.com/sjplastic

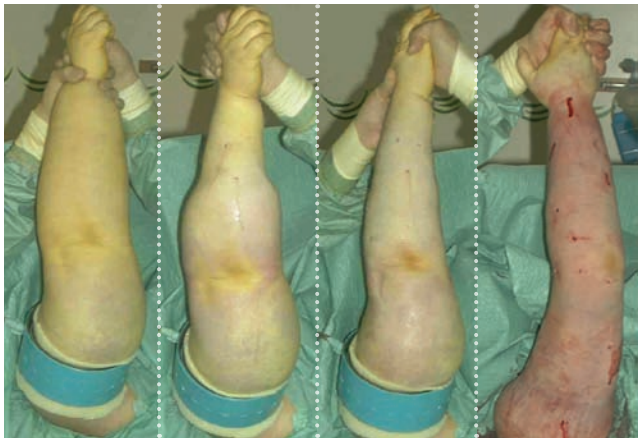


Figure 24: Liposuction of arm lymphoedema. The procedure takes about two hours. From preoperative to postoperative state (left to right). Note the tourniquet, which has been removed at the right, and the concomitant reactive hyperaemia

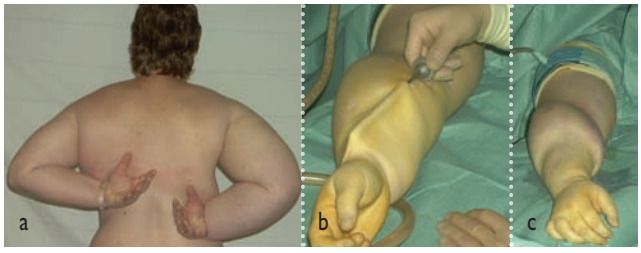


Figure 25a: Preoperative picture showing a patient with a large lymphoedema (2.900 ml) and decreased mobility of the right arm. Figure 25b: The cannula lifts the loose skin of the treated forearm. Figure 25c: The distal half of the forearm has been treated. Note the sharp border between treated (distal forearm) and untreated (proximal arm) area

normal saline with or without lignocaine, adrenaline, or a combination, into the surgical area before liposuction.

In 1986 the 'superwet' technique was introduced, which involves infiltration of a solution of normal saline containing adrenaline and lignocaine in an amount equal to that of the fat that is to be removed (Rohrich and Mathes, 1990).

The following year, Klein described the 'tumescent' technique, which involves somewhat larger amounts of saline containing both low-dose adrenaline and lignocaine in a ratio of 2–3:1ml (infiltrate:aspirate) being injected (Klein, 1987).

These techniques enabled surgeons to remove large quantities of adipose tissue. By infiltrating dilute adrenaline and lignocaine into subcutaneous fat, both the excessive loss of blood and the need for general anaesthesia with its associated risks are reduced (Wojnikow et al, 2007).

According to other authors, more than 3000ml of fat can be removed during liposuction under local anaesthesia without sedation (Klein, 1987; Klein, 1993). Samdal et al (1995) reported the amount of whole blood contained in the aspirate is roughly 2% (volume/volume) when superwet or tumescent techniques are used, whereas in the 'dry' technique it is 25% (Goodpasture and Bunkis, 1986), and in the wet technique 15% (Clayton et al, 1989).

When the authors' team started to treat arm lymphoedema following breast cancer treatment, they used the 'dry technique'. Later, to minimise blood loss, a tourniquet was used in combination with tumescence. Liposuction was performed up to the distal edge of the tourniquet. A sterile compression garment was put on and the tourniquet released. The area covered by the tournique was infiltrated with dilute adrenaline before liposuction was completed (tumescence) (*Figure 23;* Wojnikow *et al,* 2007). This technique keeps blood loss to a minimum, thus removing the need for transfusions.

How to perform liposuction for lymphoedema — surgical technique

Liposuction for both leg and arm lymphoedema is similar, removing excess hypertrophied adipose tissue under bloodless conditions (*Figure 24*). General

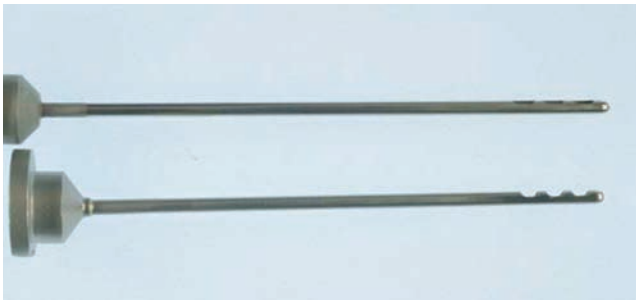


Figure 26: Cannulas: The upper cannula is used for aesthetic procedures, whereas the lower is used for liposuction for lymphoedema. Note the larger openings at the tip

Figure 27: After liposuction on the proximal part of the upper arm the garment is pulled up and secured with the bands of the garments that are fastened with velcro

Figure 28: Glove with fingertips cut off

anaesthesia is used in most cases but some patients with arm lymphoedema prefer nerve blockade with a plexus and scalenus block. Neither local anaesthetic nor epinephrine is injected distal to the tourniquet; hence, the 'dry technique' is used. Through around 15–20, 3mm long incisions, the shoulder and arm are treated (*Figures 24* and *25*).

Cannulas are connected to a vacuum pump giving a negative atmospheric pressure of 0.9. The cannulas are 15 cm long with an outer diameter of 3 and 4 mm, with three openings at the tip (*Figure 26*). The finer cannula is used mainly for the distal part of the forearm, and also when irregularities are remedied. The openings differ from normal liposuction cannulas in that they take up almost half of the circumference to facilitate the liposuction, especially in lymphoedemas with excess fibrosis. Liposuction of an arm can be done manually using ordinary cannulas (*Figure 26*) or by power assisted liposuction, which uses a vibrating cannula to facilitate and speed up surgery. This is especially important in the leg.

Made-to-measure compression garments (two sleeves and two gloves) are ordered two weeks before surgery. The size of the garments is measured according to the size of the healthy arm and hand. Liposuction is executed circumferentially, step-by-step, from hand to shoulder, and the hypertrophied fat is removed as completely as possible (*Figure 24*).

When the arm distal to the tourniquet has been treated, a sterilised made-to-measure compression sleeve is applied (Jobst® Elvarex BSN medical, compression class 2) on the arm to stem bleeding and postoperative oedema (*Figure 27*). An Elasto-Gel (Southwest Technologies, USA), 10×10 cm, is put on the ventral aspect of the elbow joint (for the first two weeks), and between the thumb and index finger to ease off the pressure from the new garment and glove. A sterilised Easy-Slide (Credenhill, England) facilitates putting on the garment and is later always used for this procedure. A sterilised, standard interim glove (Cicatrex interim, Thuasne®, France), where the tips of the fingers have been cut to facilitate gripping, is put on the hand (*Figure 28*). The tourniquet is removed and the most proximal part of the upper arm is treated using the tumescent technique. Finally, the proximal part of the compression sleeve is pulled up to compress the proximal part of the upper arm. The incisions are left open to drain through the sleeve. The arm is lightly wrapped with a large absorbent compress covering the

Figure 29: Standard gauntlet without a thumb (Jobst® Elvarex BSN medical, compression class 2), is combined with standard interim glove (Cicatrex interim, Thuasne(R), France)

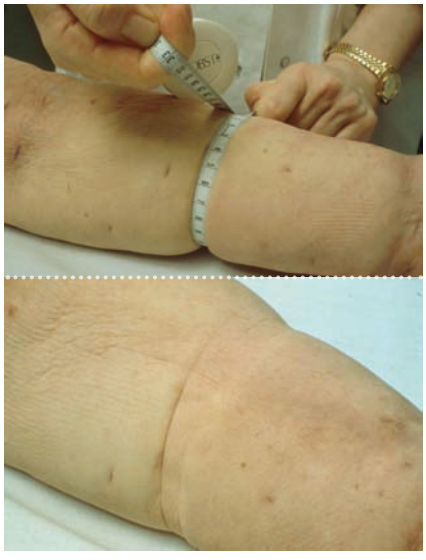


Figure 30: Measurements being taken at postoperative follow-up. Arm is still swollen at this stage. Firm measurements are taken to overcome the normal postoperative oedema. Note the indentation by the tape measure

whole arm (60 x 60cm, Cover-Dri, www.attends.co.uk). The arm is kept at heart level on a large pillow. The compress is changed when needed.

The following day, a standard gauntlet (a glove without fingers with a thumb), where the thumb has been cut off (Jobst® Elvarex BSN medical, compression class 2) is put over the interim glove (*Figure 29*). If the gauntlet is put on straight after surgery, it can exert too much pressure on the hand when the patient is still unable to move the fingers after the anaesthesia. Operating time is, on average, two hours. An isoxazolyl penicillin or a cephalosporin is given intravenously for the first 24 hours, and then in tablet form until incisions have healed, about 10–14 days after surgery.

Postoperative care

The arm is held raised by the patient herself during hospital stay. Garments are removed two days postoperatively so that the patient can take a shower and measurements are compared with the normal arm (*Figure 30*). There is no bruising because the compression is put on before releasing the tourniquet. The tumescence solution and any blood leak out through the small incisions. Water-soluble ointment that does not destroy the garment is applied. Then a new Elasto-Gel (Southwest Technologies, USA) is put on the elbow. The other set of garments is put on and the used set is washed and dried. This is repeated by the patient herself after another two days before discharge. The standard glove and gauntlet is usually changed to the made-to-measure glove at the end of the stay.

The patient alternates between the two sets of garments (two sleeves and two gloves) during the first two postoperative weeks, changing them daily or every other day so that a clean set is always put on after showering and lubricating the arm. After the two-week control, the garments are changed every day after being washed. Washing 'activates' the garment by increasing the compression due to shrinkage (*Figure 31*). It also removes perspirated salt that can cause dry and irritated skin. During the subsequent course, this rigorous compression regime, referred to as controlled compression therapy (CCT), is maintained exactly as described below.

Controlled compression therapy (CCT)

A prerequisite to maintaining the effect of liposuction, and, for that matter, conservative treatment, is the continuous use of a compression garment (Brorson and Svensson, 1998). Compression therapy is crucial, and its application is therefore thoroughly described and discussed at the first clinical evaluation. If the patient has any doubts about continued CCT, she is not accepted for treatment. After initiating compression therapy, the custom-made garment is taken in at each visit using a sewing machine, to compensate for reduced elasticity and reduced arm volume. This is important during the first three months when the most notable changes in volume occur. At the one- and three-month visits the arm is measured for new custom-made garments. *Figure 32* shows an online order form for the different garments. This form is useful as it has all the values, enabling you to see what you are aiming for and what you have ordered before. Measurements are pulled tightly since it is the postoperative oedema that you want to reduce (*Figure 30*). This procedure is repeated at six, (nine) and 12 months. If complete reduction has been achieved at six months, the nine-month control may be omitted. If this is the case, remember to prescribe

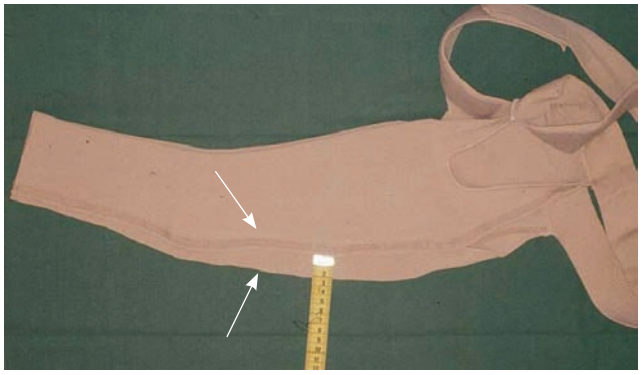
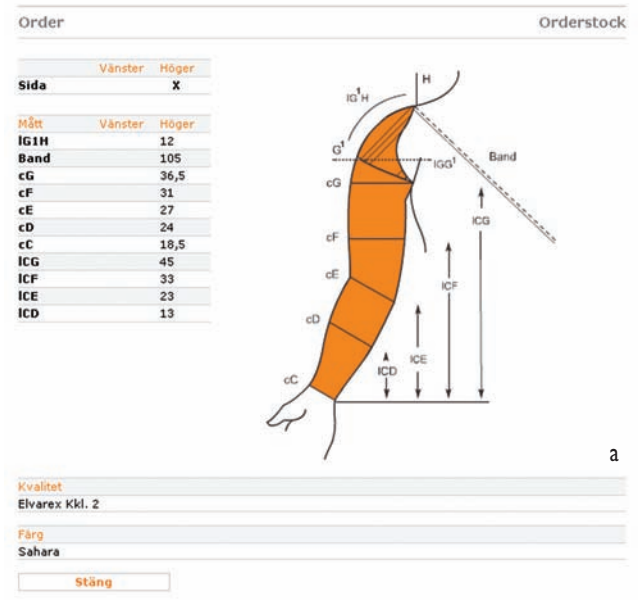
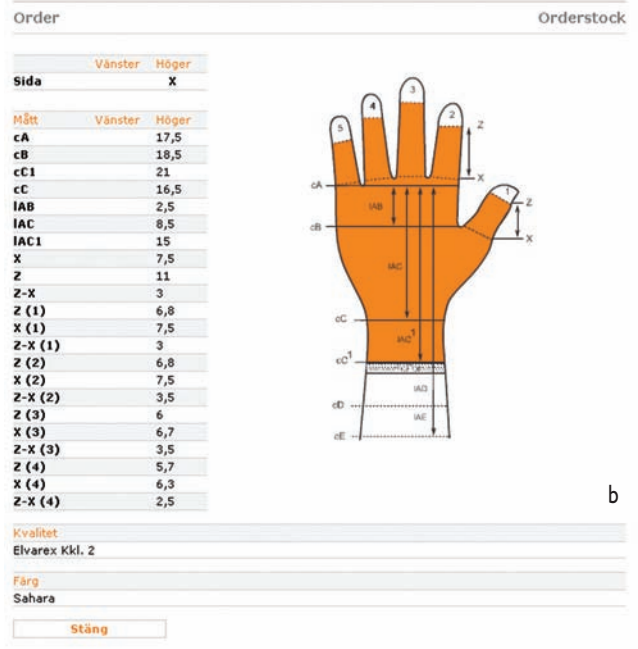


Figure 31: Two identical compression garments on top of each other, showing the effect of washing on the garment. Note that the circumference has decreased 4 cm after washing





Figures 32a and b: Online ordering forms for compression garments

garments for six months, which normally means double the amount that would be needed for three months. It is important, however, to take in the garment repeatedly to compensate for wear and tear. This may require additional visits in some instances, although the patient can often make such adjustments herself. When the excess volume has decreased as much as possible, i.e. no pitting is seen, and a steady state has been achieved, new garments can be prescribed using the latest measurements. In this way, the garments are renewed three or four times during the first year. A checkup should be done at one and a half years for compliance and volume measurements. If everything is stable at two years, a once-yearly visit is enough Two sets of sleeve and glove garments are always at the patient's disposal; one being worn while the other is washed. Thus, a garment is worn permanently, and treatment is interrupted only briefly when showering and, possibly, for formal social occasions. The patient is informed about the importance of hygiene and skin care, as all patients with lymphoedema are susceptible to infections and keeping the skin clean and soft is a prophylactic measure (Brorson and Svensson 1997a, 1998).

The life span of two garments worn alternately is usually four to six months. After complete reduction has been achieved, the patient is seen once a year when new garments are prescribed for the coming year, usually four garments and four gloves (or four gauntlets). In active patients, six to eight garments and the same amount of gauntlets/gloves a year are needed. Patients without preoperative swelling of the hand can usually stop using the glove/gauntlet after 6–12 months postoperatively.

For legs, the authors' team often uses up to two to three compression garments on top of each other, depending on what is needed to keep pitting away. A typical example is Jobst Bellavar® compression class 2, Elvarex® compression class 3, Forte and Elvarex® compression class 2 (BSN medical). The latter can be a leg-length or a below-the-knee garment. Thus, such a patient needs two sets of 2–3 garments. One set is worn while the other is washed. Depending on the age and activity of the patient, two sets can last for 2–4 months. Thus, patients should be prescribed garments 3–6 times during the first year. After complete reduction has been achieved, the patient is seen once a year when all new garments are prescribed for the coming year.

Controlled compression therapy can also be used to effectively treat a pitting oedema as an alternative to complete decongestive therapy (CDT), which, in

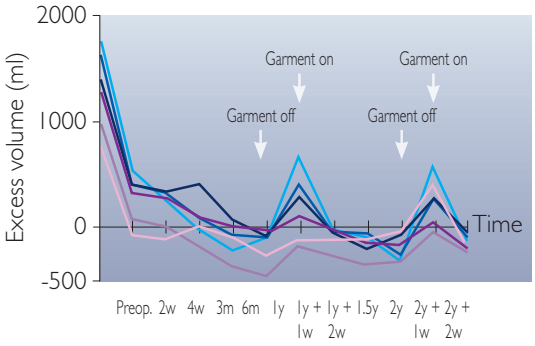


Figure 33: Removing the compression garment leads to accumulation of lymph. Putting it on again, reverses the situation (Brorson and Svensson, 1998)

Figure 34: Ineffective and poorly-fitting compression garment

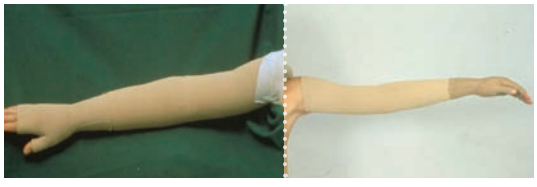


Figure 35: Effective, tailor-made compression garment that fits perfectly

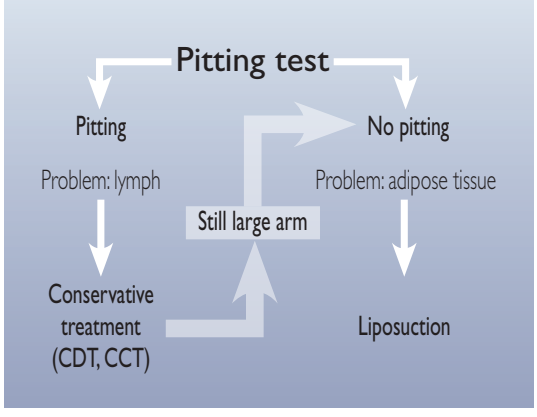


Figure 36: The pitting test decides if conservative therapy or liposuction is indicated to reduce excess volume

contrast to CCT, comprises daily interventions (Brorson and Svensson, 1998). Controlled compression therapy is simple, economic and efficient.

Every chain has its weakest link and the weakest link in oedema treatment is the compression garment. If oedema increases after the operation, it is due to the compression garment being ineffective or decreased patient compliance. Compression is crucial to maintain the effect of liposuction.

Increasing compression

Compression can be increased when pitting is still present. Increased compression can be achieved by:

- decreasing the circumferential measurements when ordering compression garments
- increasing the compression class
- using several compression garments (multilayer)
- increasing the amount of garments prescribed at the same time, or
- taking in existing garments.

Class 2 is often used, but some patients need class 3. With legs, class 3 or 4 can be used. Alternatively, several layers can be placed on top of each other.

Removal of compression garments

Figure 33 shows the pre- and postoperative excess volumes in six patients. To see what would happen if compression garments were not worn, the authors removed them from six patients and after one week the excess volume had increased in all the patients. The garments were put back on and, after another week, the excess volume had again lessened. A year later the experiment was repeated because the authors thought that a possible postoperative scar formation within the tissue might stabilise the situation. Again, the excess volume returned on removal of the garments and disappeared when the garments were put back on (Brorson and Svensson, 1998).

Thus, the way to control oedema is compression, compression, compression….

Correct compression must also be worn. *Figure 34* (right) shows a garment that is too large and has slithered down, strangulating the wrist. *Figure 34* (left) shows a compression garment that is thought to be for the lower leg, but the patient has been using it herself on the arm by cutting off the foot. This will have no effect whatsoever. *Figure 35* is an example of how a compression garment should fit: custom-made and fitting perfectly.

Figure 37: Lymphoscintigrapy. Typical dermal backflow in the right leg, while the left leg shows normal lymph transport

Figure 38a: A man with congenital lymphoedema that worsened after surgical removal of a seminoma and postoperative radiotherapy. Preoperative excess volume was 14.300 ml. Figure 38b: After six months, 10 litres of fluid had been removed. Figure 38c: Eight years after CCT and liposuction no recurrence can be seen

Liposuction is not the first choice of treatment and should not be performed without training. It is a lifetime commitment both for the surgeon, who should be well trained, and for the patient. Liposuction *per se* is not the solution — it is the start and should then be continued with compression garments for life, just like after CDT.

The key to success is the information provided to the patients. A mental contract with them facilitates compliance. Equally, if a patient cannot be supplied with a sufficient number of garments, liposuction should not be performed.

As said, the pitting test acts as a simple means of classification (*Figure 36*). Where there is pitting, there is still oedema; if there is no pitting, lymphoedema has turned into adipose tissue (*Box 1*). If there is still pitting, the patient should be treated with conservative therapy until no, or minimal pitting is seen. Then the decision can be made as to whether it is sufficient for the patient. If the patient wants further reduction, liposuction is an option.

Many lymph therapists regard it as normal for patients to come back regularly for maintenance therapy. Patients are pleased with their initial treatment, but then return to the therapist because their arm has swollen again, about six months later. The whole process with CDT is repeated. After another six months the arm is swollen again, new treatment with CDT, and so on.... This begs the question as to why the therapist did not analyse why and when the arm had become swollen again. If a therapist had seen the patient every two months during the first year after treatment, measuring both arms and seeing when the swelling started to come back, new garments could have been ordered. Thus, after one year you would know exactly how many garments the patient needed, and the correct number could be ordered for the following year. A check-up should be done at one and a half years for compliance and volume measurements. If everything is stable at two years, a once-yearly visit is enough. In the long run this will save time, money and unnecessary visits.

Box 1: Inclusion criteria for liposuction

- No pitting
- Continuous compression with garments
- Arm swelling around 1000 ml, can be as low as 500 ml but also the patient's BMI should be considered
- No active breast cancer
- No effect of conservative therapy
- No wounds

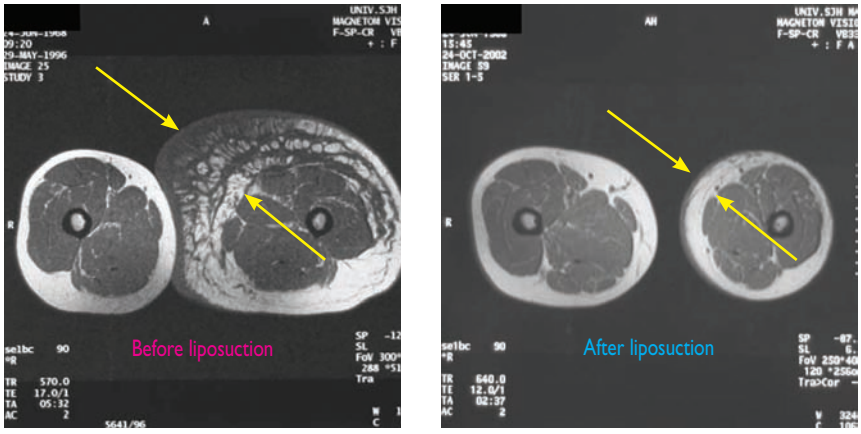


Figure 39: MRI a) Shows the swollen left leg before treatment. b) Result after CCT and liposuction

Figure 40: Typical example of primary lymphoedema. Left-hand figure shows preoperative limb with an excess volume of 4.490 ml; right-hand figure two years postoperatively

Figure 42: 73-year-old woman who has had a primary lymphoedema since she was 50 years old. Preoperative excess volume was 5.790 ml (left-hand figure), and six months after surgery where there is a slight overcorrection (right-hand figure)

Figure 41: Typical example of secondary lymphoedema. Left-hand figure shows preoperative limb with an excess volume of 4.565 ml; right-hand figure one year postoperatively

Figure 43. Preoperative excess volume 6630 ml (left-hand figure). Postoperative result after two years where excess volume is 30 ml (right-hand figure)

Leg lymphoedema

Most patients with lymphoedema show a positive Stemmer's sign, but a negative Stemmer's sign does not exclude lymphoedema.

Figure 37 shows a typical lymphoscintigraphy of a lower leg lymphoedema. The injection can be seen on the feet and the uptake in the liver. After four hours there was a dermal backflow in the right leg and no uptake in the lymph glands in the groin. The left leg shows normal lymphatics and lymph nodal uptake in the groin.

Figure 38a shows a man with congenital lymphoedema that worsened after surgical removal of a seminoma and postoperative radiotherapy. Preoperative excess volume was 14.310ml. A garment was applied to this patient, which was taken in after the size reduced as a result of CCT. In six months, 10 litres of fluid had been removed (*Figure 38b*). Eight years after CCT and liposuction, no recurrence could be seen (*Figure 38c*). Where there is no pitting but still excess volume, it is adipose tissue. The MRI scan in *Figure 39* shows the thickness of subcutaneous space before and after liposuction and CCT in this patient (Brorson et al, 2008).

Figures 40–43 show examples of primary and secondary lymphoedemas before and after surgery.

Figure 44 shows a male patient with class III leg-long flat-knit compression, and another round-knit class II compression garment and below-the-knee class II flat-knit compression garment on the right leg. He later developed lymphoedema in the left leg, where he wore class III leg-long flat-knit compression and another leg-long round-knit class 2. For one year the authors ordered six garments of each at the same time. The patient numbered the garments from one to six, so that, for example, he wore those with number three for 24 hours. These were then removed when he took a shower and lubricated the skin with a water soluble ointment. He would then put on the next set of garments marked with number four, and so on. The used set was washed. By doing this, he always knew which set of garments should be put on. In total he needed 30 garments a year, demonstrating the importance of being able to afford garments so that the lymphoedema does not recur.

Figures 45 and *46* show how a patient found that she could use bandages for hernias to treat a localised oedema in the genital region. The bandage was modified with a piece of an elastic roll that was secured in the front with velcro.

Conclusion

Liposuction is an effective treatment on chronic large lymphoedema not responding to conservative regimens.

Figure 44: This patient needs the following compression: Right leg: Elvarex 3 Forte (leg-long), Bellevar 2 (leg-long), Elvarex 2 (below-the-knee). Left leg: Elvarex 3 Forte (leg-long), Bellevar 2 (below-the-knee). For one year he needs six of each. All garments for one year are ordered at the same time, in total 30 garments

Figure 45: This patient has obtained excellent compression by the use of a hernia garment supplemented with a piece of elastic roll (Dauer) that has been sewn together at the back and fastened by velcro in the front

Figure 46: Hernia garment

Providing that the compression garments are used all the time, even after 14 years there is no recurrence. Excess adipose tissue can be removed by liposuction, but not by CDT, compression pumping or microsurgery.

In Sweden the costs for treating lymphoedema are:

- 8,300 euros for an arm; 11,000 euros for a leg
- garments cost 120 euros a pair
- gauntlets cost 180 euros a pair
- patient pays 30 euros for each outpatient visit.

The patient pays nothing for hospitalisation (4–7 days), surgery or compression garments, as it is done within the Swedish health care system. Since 1998 the authors' clinic has been approved as a clinic for the treatment of post-mastectomy and lymphoedema with liposuction by the Swedish National Board of Health and Welfare.

To conclude, it is important to be open-minded with regard to liposuction. In the authors' opinion, if they had read all the 'dos and donts' before starting this novel treatment, they would never have obtained the results that they have achieved.

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Multidisciplinary operative options

Dr Harry Voesten

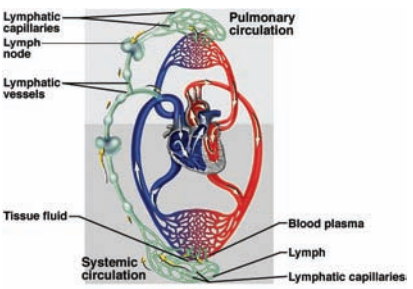


Figure 1: Lymphatic system

Lymphoedema is a debilitating, progressive and incurable pathological condition caused by a chronic imbalance between the production and transport of lymph within the lymphatic system. There are many reasons for this damage or disruption to the lymphatic system. Lymphoedema results in significant physical and psychological morbidity. Approximately 140–250 million people worldwide are affected by this condition, mostly in developing countries as a result of lymphatic filariasis, a parasitic infection transmitted by mosquitoes. In the majority of cases, treatment is non-curative, complex and requires a multidisciplinary clinical approach. Surgery takes place as a last resort when conservative treatment has proven ineffective to restore function, reduce comorbidity or the frequency of erysipelas attacks.

Anatomy

The lymphatic transport structures within the human body can be anatomically subdivided into three compartments; the superficial, deep and organ-bound lymphatic systems. The superficial lymphatic system has a cutaneous layer where multiple lymph capillaries are surrounded by blood capillaries just below the skin's surface, which drain into the pre-collectors. These pre-collectors are small vessels of endothelium, an accessory membrane, a few muscle cells and valves. These vessels provide drainage of a circular patch of skin with a diameter of 1–4 cm. The collected lymph is transported via the sub-dermal collectors (large lymphatic vessels) containing lymphangions, which propel lymph towards the draining lymph nodes by means of smooth muscle cell contractions aided by one-way valves. The deep lymphatic system is located beneath the deep fascia and has vessels which follow the main arteries and veins. Lymph collected in this deep system is transported either directly towards the draining lymph nodes (20%), or towards the superficial drainage system via perforating lymphatic vessels (80%). The lymph nodes are drained by larger lymphatic vessels ending up in the ductus thoraticus, which drains into the central venous system near the heart. All lymphatics start with blind loops in the interstitium (*Figure 1*).

Physiology

Within the capillary network a constant exchange of fluids and metabolic products takes place between arterial and venous capillaries via the interstitial space. In non-affected tissues, 90% of the arterial capillary filtrated fluid is resorbed into the venous capillaries, according to the Starling equilibrium in microvascular fluid exchange. The remaining 10% of the filtrated plasma is transported from the interstitial compartment via lymphatic drainage. The lymphatic system has three main functions. Besides playing a major role in maintaining the amount of interstitial fluid, it also clears cellular debris, toxins, fluid and filtrated macromolecules such as plasma proteins and lipids from the interstitial compartment. Thirdly, the lymphatic system has a major role in the afferent and efferent immunological response. Lymphatic fluid transport is partly initiated by intrinsic propulsion and largely stimulated by external pressure changes from muscular activity and compression by guiding arteries. Negative pressure in the thorax stimulates lymph flow towards the vena cava.

Aetiology

Lymphoedema exists in two distinguishable forms, primary and secondary lymphoedema. Primary lymphoedema develops as a result of rare congenital conditions with either an hereditary or non-hereditary basis, which can result in an anatomical deformity or functional deficiency of the lymphatic transport capacity in various regions of the lymphatic system. Secondary lymphoedema develops due to sustained damage to a previously fully functional lymphatic system. In the industrialised world, it is generally associated with surgery and/or radiation therapy to parts of the body where there are many embedded lymph nodes (i.e. the axillary fossa and inguinal region). Lymphoedema may develop in 8–38% of women treated for breast cancer (breast cancer-related lymphoedema, BCRL) who have undergone surgical mastectomy with axillary lymph node dissection (ALND) and/or radiation therapy, depending on the treatment combination. The risk of lymphoedema following breast surgery without ambulant ALND or radiation is approximately 0%. The incidence of secondary lower limb lymphoedema (LLL) ranges from 26–50% in patients who undergo radical inguinal or parailiacal dissection followed by radiation therapy. In third world countries, chronic lymphoedema (elephantiasis) is commonly caused by filariasis, a mosquito-borne parasitic infection, afflicting over 120 million (2% of the world's population) people worldwide.

Pathogenesis

Impaired lymphatic transport causes fluids, proteins and other tissue elements to accumulate within the interstitial space. Chronic stasis of high levels of protein and toxins that are found in lymph causes a local inflammatory reaction, adipose tissue hypertrophy and fibrosis which result in swelling, loss of function, disfigurement and recurrent skin infections. The subcutaneous hypertrophic adipose and fibrotic tissue cannot be mobilised by conventional means (non-pitting oedema). Lymphoedema can be considered as a continuum, starting initially with pitting oedema in the first stages and ending up with irreversible, end-stage lymphoedema.

Figure 2: Lymphoedema unit, Drachten

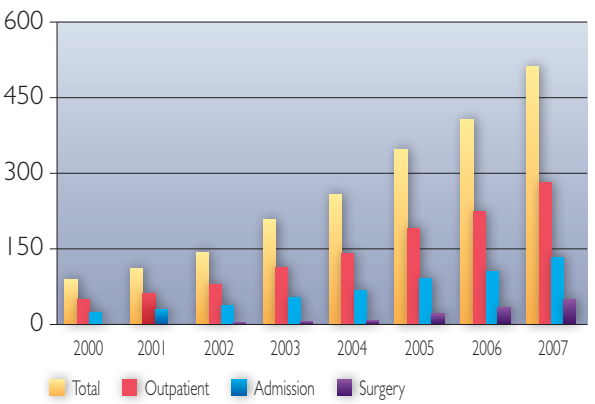


Figure 3: Lymphoedema referrals to the author's clinic

The author and his colleagues first started to see patients at their lymphoedema clinic (*Figure 2*) at Nijsmellinghe Hospital, Drachten, Netherlands in 1996, and a good working relationship has been established between dermatologists and surgeons. Through multidisciplinary collaboration, successful results have been achieved in patients with varicose veins, trauma patients with oedema and those with oedema of the arms.

Figure 3 shows the lymphoedema referrals to the author's clinic. About 450 new cases are seen every year, 40% referred by university hospitals. Women who come with lymphoedema in the arms are mostly breast cancer patients. Those with lymphoedema in the legs, often present with other complications.

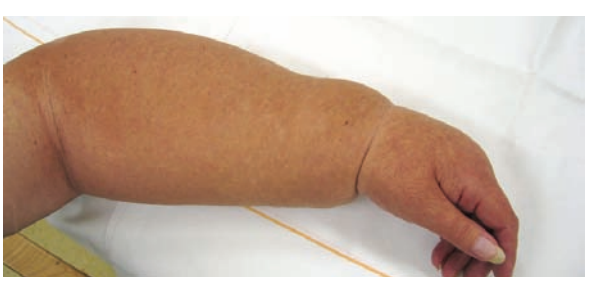


Figure 4a: Fracture to the wrist

Every Friday afternoon six referred patients are seen by the whole team. Individual cases are discussed and a diagnosis is reached, which is then explained to the patient.

There are two main issues with surgery for lymphoedema. Firstly, what happens if you have a patient with lymphoedema who has another condition that needs treatment —

Figure 4b: Fracture to the wrist with external fixation

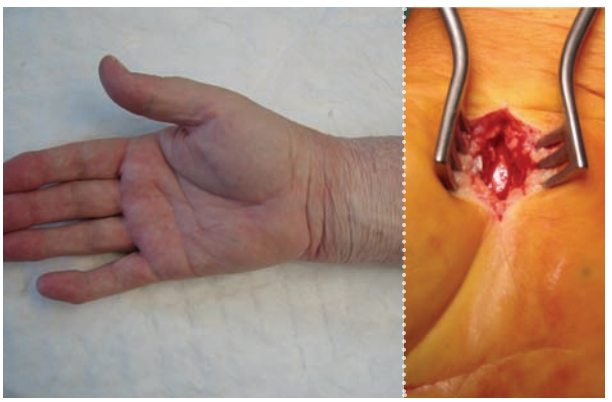


Figure 5: Carpal tunnel syndrome

Figure 6: Late radiation damage to the axilla. 6a: An overview; 6b: Details of scars; 6c: After surgical division of scar tissue; 6d: End result

can you get away with treatment in the extremity with lymphoedema? The other issue is whether there are surgical solutions for lymphoedema patients not responding to conservative treatment.

Other clinical conditions and lymphoedema

Surgical treatment for patients with lymphoedema involves using scar tissue that is already present. Patients with arm lymphoedema may have other complications such as a fracture, carpal tunnel syndrome, triggerfinger or even a contracture, which need to be considered before treatment of the lymphoedema can begin. *Figure 4a* shows a patient who has lymphoedema and a fractured wrist: the former cannot as yet be treated with reduction, or the latter with plaster of Paris. Other solutions need to be found. However, after six weeks when the external fixation has been removed (*Figure 4b*), the lymphoedema can be treated as well.

Carpal tunnel syndrome is an interesting condition. Most of the time the nerve afflicted in the arm is the ulnar nerve, but, in lymphoedema of the arm, the median nerve is the one most afflicted. A carpal tunnel release can be performed, provided that the patient is treated before and after with conservative therapy (*Figure 5*).

Figure 6 shows late radiation damage to the axilla, which often results in scar tissue causing contracture. If the range of motion in the shoulder is limited, the lymph transport capacity is reduced by 90%. If scar tissue is removed successfully, thereby allowing the shoulder unrestricted movement, the lymph transport capacity rises dramatically.

Problems can occur in the legs as a result of, for example, varicose veins (*Figure 8*), fractures, an urgent need for joint replacement, malignancy, ingrown toenails or (hyper) papillomatosis. At the author's clinic, again working with dermatologists, after duplex mapping a crossectomy or stripping is carried out in a clinical setting where the patient is treated with compression both before and after surgery. *Figure 8* shows the greater saphenous vein

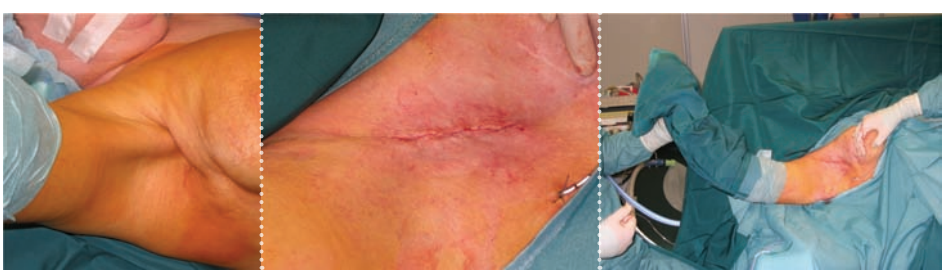


Figure 7: Contracture in the breast that can impair shoulder mobility

Figure 8: Varicose veins. Greater saphenous vein crossectomy localised by duplex

Figure 9: Oedematous leg one week after cryostripping

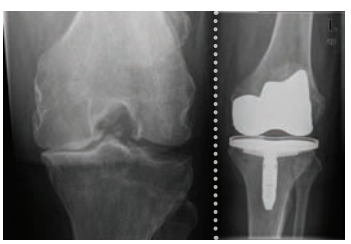


Figure 10: Joint replacement in lymphoedematous legs

Figure 11: Joint replacement

Figure 12: Ingrown toenail

Figure 13: Compression applied after treatment for ingrown toenail (left) and final result (right)

Figure 14: Recurrent groin hernia that was treated by the laparascopic route to avoid further damage to the lymphatics

crossectomy localised by duplex. Surgical incision can be adapted to the circumstances.

Figure 9 shows how a leg looks one week after cryostripping of the greater saphenous vein.

Joint replacements can be difficult. The patient may be unable to use his leg because of arthrosis and thus gains weight, becoming obese. However, joint replacements can still be successful provided that they are performed in a clinical setting with, again, the application of compression before and after surgery (*Figures 10* and *11*).

Ingrown toenails (*Figure 12*) are a frequent cause of infection, erysipelas (an acute streptococcus bacterial infection of the dermis, resulting in inflammation and characteristically extending into underlying fat tissue), which needs to be treated. Compression is essential afterwards (*Figure 13*).

A patient with lymphoedema of the leg may present with an urgent inguinal problem, such as a groin hernia or scrotal problems. *Figure 14* shows a patient who came

Figure 15: Compression garment applied after laparascopic hernia repair

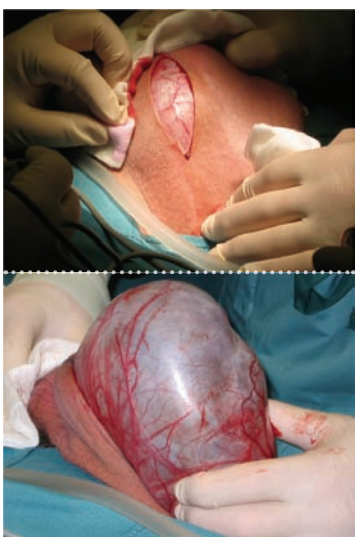


Figure 16: Hydrocele

Figure 17: Compression applied after hydrocele surgery

in with a recurrent groin hernia for which a laparascopic hernia repair was performed, without compromising the lymphoedema transport capacity further. Compression was, of course, necessary afterwards (*Figure 15*).

Hydroceles are usually only treated when they cause discomfort or embarrassment, or if they are large enough to threaten the testicle's blood supply. *Figure 16* shows a young man with lymphoedema of the right leg and a hydrocele. Surgeons usually use the inguinal route to do surgery on the hydrocele and, in this particular case, there was a small region right between the scrotum and the perineum where an incision was made to treat the hydrocele surgically. Not only does surgery sometimes have to be performed through a different route, but compression is needed afterwards (*Figure 17*).

If you have a patient with scarring in the lower abdomen, a double-sided hernia repair should be performed, staying away from the region just above the pubic area (*Figure 18*).

Surgical options for patients with lymphoedema

Lymphovenous shunt therapy was initially tried at the author's clinic. A prospective study in lymphoedema and shunt procedures was undertaken and presented in a paper in Freiburg in 2003, but no lasting success was found with shunts. Shunt surgery was subsequently stopped at the author's clinic and, for seven years, conservative therapy was used before other surgical techniques were tried. Damstra et al (2009) carried out an extensive literature search into the treatment for lymphoedema with shunts, which concluded that there were no lasting results.

There are several types of reduction surgery, such as incision or shaving. *Box 1* shows the different types of surgery. A longitudinal incision can be performed (*Figure 19*), after which you need compression. The upper part is the flap that has been removed and the lower part shows how thick the skin is. *Figure 20* shows the result after one week. However, this type of procedure is no longer carried out at the author's clinic because it does not effectively reduce the volume.

Sometimes the cases that present are so desperate that drastic surgery is the only way forward. *Figure 21* shows the legs of a 35-year-old patient with spina bifida, who was oxygen-dependent and was admitted four times a year for erysipelas. *Figure 22* shows the protruding second toe. As she could no longer use her legs there was no point in doing reduction surgery other than amputation. For such a case, the best form of compression is a plaster

Box 1: Reduction surgery

- Complete removal of all soft tissues (Charles)
- Excision primary closure
- Amputation
- Shaving
- Electric coagulation
- Circumferential suction-assisted lipectomy (Brorson)

Figure 18: Incision in double-sided hernia repair. Note the 'no-go' pubic area

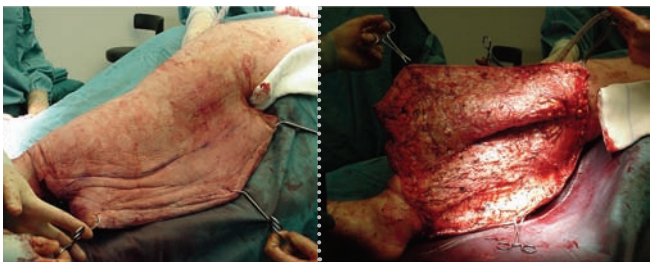


Figure 19: Left-hand figure showing the flap that has been removed. Right-hand figure shows skin's thickness

Figure 20: Result one week after surgery

Figure 21: Legs of a 35-year-old patient with spina bifida

Figure 22: Same patient as Figure 21 showing protruding second toe

Figure 23: Patient after double-sided amputation

Figure 24: Four months later

of Paris cast. The patient went for a double-sided amputation (*Figures 23* and *24*). This was a desperate case, not a routine procedure.

Papillomatosis is a condition that the author often sees in advanced cases of lymphoedema (*Figure 25*). Shaving is a form of treatment where the excess tissue is used until it is bleeding. *Figure 26* shows how it looks after about four weeks and *Figure 27* shows the result after about seven weeks.

Patients are always treated with toecaps after surgery (*Figure 28*). The lesson from this case was that the opportunity to use toecaps earlier was missed. If toecaps are used at the outset, there is less chance of developing papillomatosis.

Severe cases of papillomatosis may present (*Figure 29*), where far more patience is needed to achieve a good end result.

Midline scrotum lymphoedema (*Figure 30*) is difficult to treat because patients can no longer pass urine in a normal way, and sexual intercourse is not possible. In such cases,

Figure 25: Papillomatosis

Figure 26: Four weeks postoperatively

Figure 27: Seven weeks post-operatively

Figure 28: Toecaps

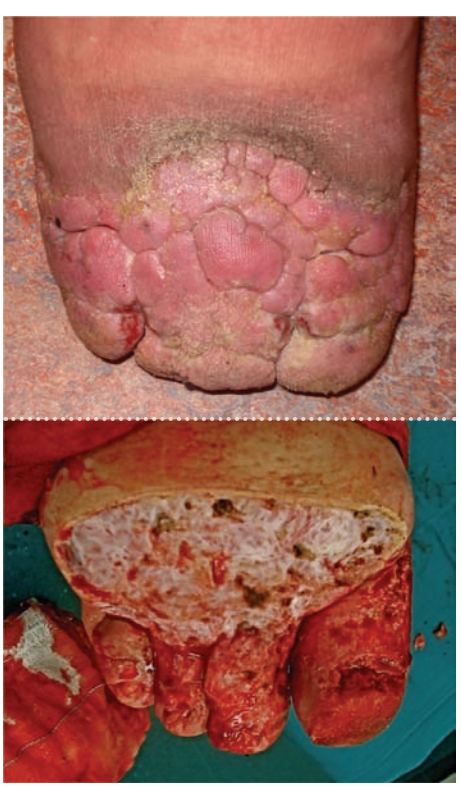


Figure 29: Severe case of papillomatosis

surgical treatment is necessary: the testicles are identified, the urethra is catheterised and the reduction of the excess tissue is carried out (*Figure 31*). *Figure 32* shows the end result.

At the author's clinic the focus is on lymphoedema. Surgery in lipoedema is not performed unless the lipoedema is causing lymphoedematous complications.

Figure 33 shows a patient who weighed 240 kilograms and was unable to walk. She had lymphoedema complications of lipoedema. Treating such a patient required a great deal of organisation, e.g. special surgical tables had to be ordered because normal ones would only guarantee a weight of 180 kilograms.

The first step in this case was to apply compression therapy (*Figure 34*). Solid, old-fashioned compression can remove all the fluid and then the fat can be removed surgically — lumpectomy (*Figure 35*).

Many patients with complications from Wertheim Meigs procedure, such as lymphangioma, present at the author's clinic (*Figure 36*). This surgical procedure for the treatment of cervical cancer, removes the uterus, ovaries and lymphatics (a radical hysterectomy). Coagulation treatment is used for weeping from lymphangioma after a Wertheim Meigs procedure. The author's clinic have treated about 10 patients in this way and the end results have been successful (*Figure 37*).

From the literature you can see that there are many types of conservative treatment for lymphoedema. However, such therapies are unable to reduce the difference by more than 40%. If you have a difference of more than 1 litre, surgery is sometimes inevitable.

Not only young women but also older women can benefit from surgical treatment. Suction on the back of the hand is not routine, however, *Figure 38* shows a spin-off from compression treatment after surgery. *Figures 39* and *40* show some examples of patients who have been followed-up at the author's clinic.

Lymophoedema of the arms is almost always secondary. However, in the last five years, the author has seen two cases of primary

Figure 30: Midline scrotum

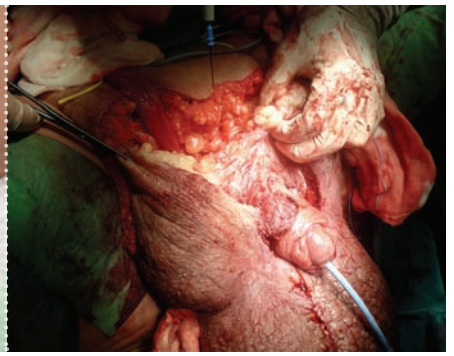


Figure 31: Surgery for midline scrotum

Figure 32: Before (left) and after (right) surgery for midline scrotum

Figure 33: Patient with lipoedema, weighs 240 kilograms

Figure 34: Compression therapy prior to surgery

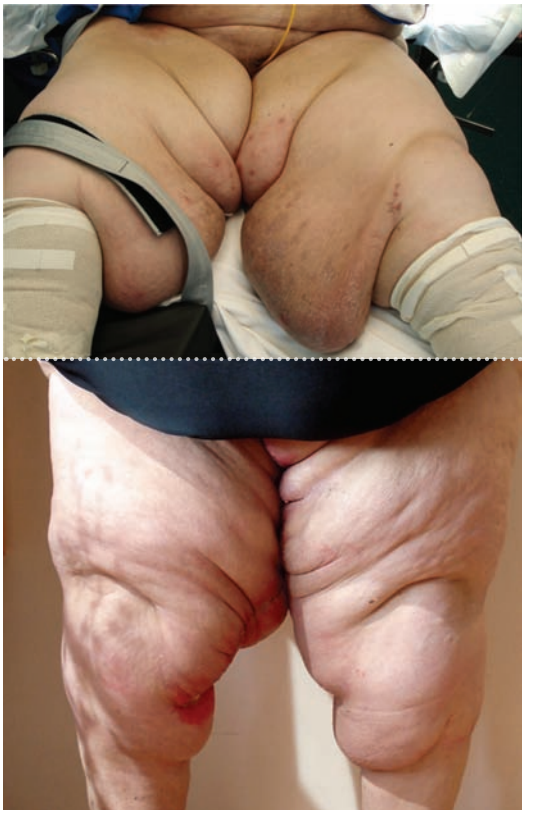


Figure 35: Before surgery (lumpectomy), 240 kilograms (top); after surgery, 190 kilograms (bottom)

Figure 36: Weeping lymphangiomata after a Wertheim Meigs procedure

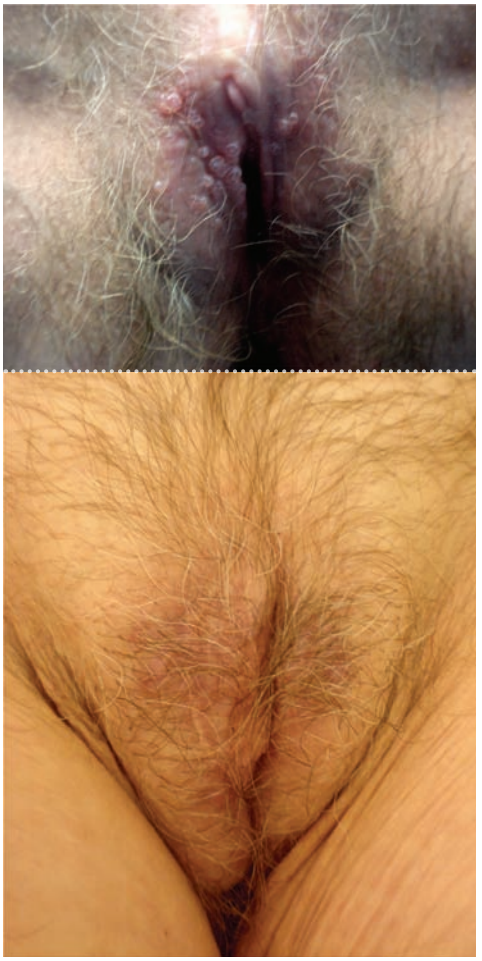


Figure 37: Late result after coagulation

Figure 39: Lymphoedema of the arms pre- and postoperatively

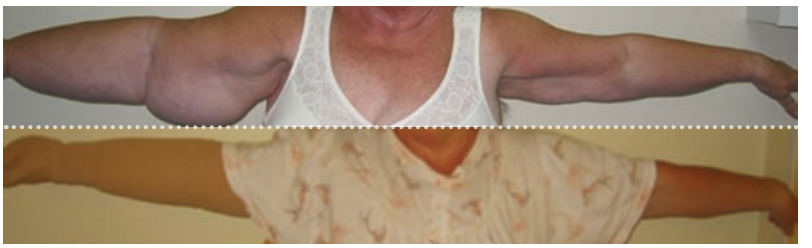
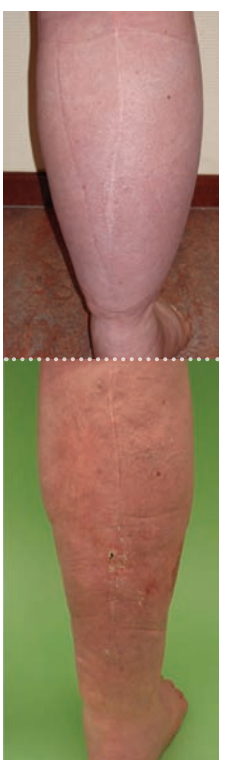


Figure 40: Lymphoedema of the arms pre- and postoperatively

Figure 41: Primary lymphoedema of the leg

Figure 38: Lymphoedema of the hand (top). Result after compression (bottom)



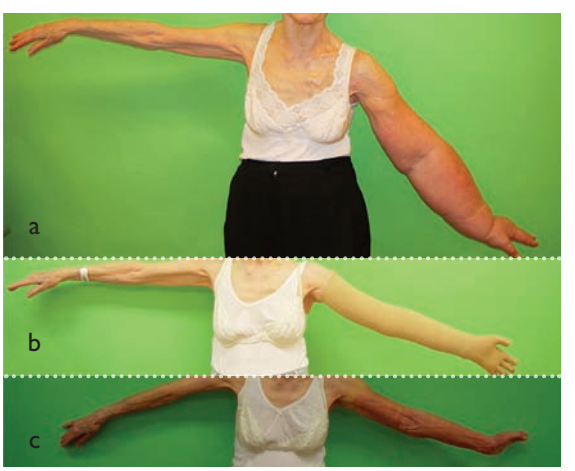


Figure 43a: On admission. Figure 43b: On discharge; Figure 43c: Six months after conservative treatment

Figure 42: Results of surgical procedure to the leg. Scar tissue from an earlier operation is present

lymphoedema of the arm. In the legs, there are more cases of primary lymphoedema (*Figure 41*). Surgery on the legs is also undertaken.

Figure 42 shows a patient who has already been operated on before, demonstrating that you can succeed with surgery when some scar tissue from earlier surgical procedures is present.

The author's clinic have now treated 29 patients with leg problems. It is important to convey to the patient that time is needed to achieve the desired end result.

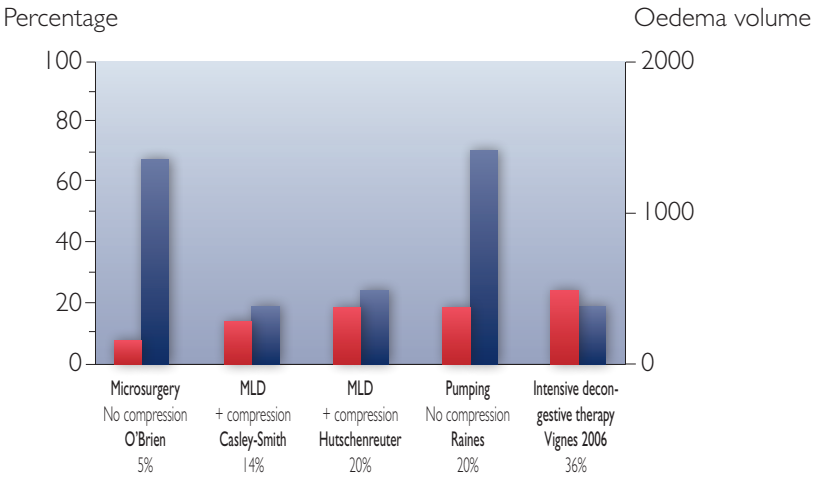


Figure 44: Results achieved from conservative treatment

To conclude, you should always try conservative therapy first. *Figure 43* shows a lady who was not operated on but received conservative treatment. Surgery in lymphoedema should only be done for restricted indications, and is only effective if you do pre- and postoperative conservative treatment. Lifelong commitment for the patient is crucial, as longstanding follow-up and guidance are mandatory.

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Facts about lipoedema and lymph/lipoedema

Professor Dr Etelka Földi

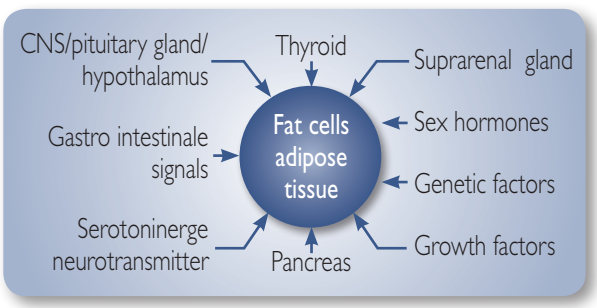

Figure 1: Lipolyse/lipogenese

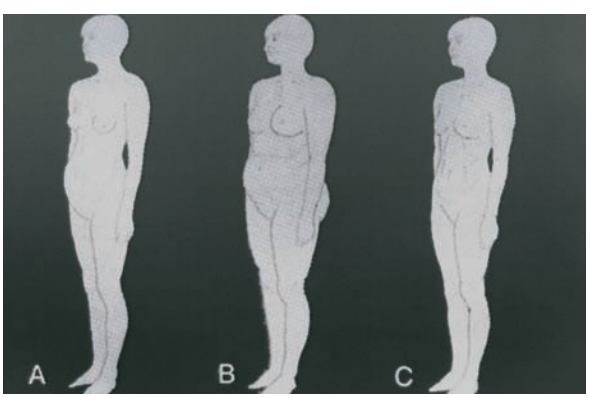

Figure 2: A = Gothic-like; B = Rubens-obese; C = Wonderwoman (Taken from: Ryan and Curri, 1989, Clinics in Dermatology 7(4))

Figure 3: Simple nutrition-related obesity (grades I–II) with no lymphological aspects

Knowledge of both the morphology/pathomorphology and physiology/pathophysiology of adipose tissue is limited and the behaviour of fat tissue has not been widely researched. Changes in adipose tissue (hyperplasia, hypertrophy and atrophy) are defined differently and, as a consequence, diagnostic failures frequently occur. *Figure 1* shows the complicated regulatory mechanisms which are responsible for lipolysis and lipogenesis.

Even if body weight is normal, appearance depends on the distribution of subcutaneous adipose tissue (*Figure 2*). The amount of fat we carry and how we look are, in part, subject to fashion. What was still sexy several decades ago, a bigger waist and more on the hips, no longer corresponds to how we see perfection today. *Figure 2* shows the different ideals of beauty — 'Wonderwoman', for example, where you can detect as little fat as possible. Recently, there has been a mania for slimness. In order to comply with the current trend in fashion, young girls starve or undergo surgical procedures to have the typical female fatty tissue removed.

Generalised increase of adipose tissue

Ninety percent of generalised increase of adipose tissue (simple obesity) (*Figure 3*) is nutritionally-related. This kind of disturbance in fat distribution or the nature of the fat distribution is also dependent on sex — the increase and distribution of fat cells being different between men and women. There are **no** lymphological aspects. In grades I–II obesity, for example, arteries and organs remain healthy.

However, various endocrine disorders can also trigger a generalised increase of adipose tissue, for example:

- Cushing syndrome
- hyperthyreosis
- gonadal hypofunction
- hyperinsulinisim
- Stein-Löwenthal syndrome

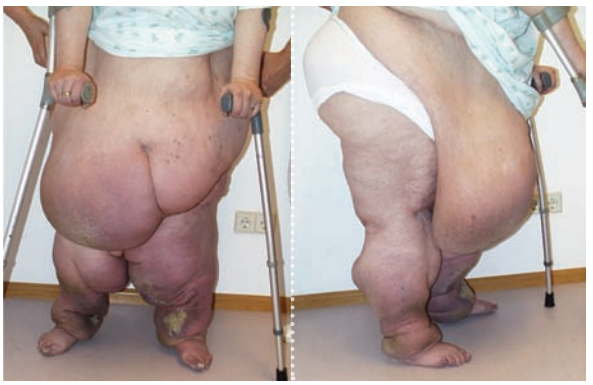

Figure 4: Obesity-related multimorbidity in combination with lymphoedema

Figure 5: Lipohypertrophy with oedema — Launois-Bensaude syndrome

Figure 6: Lipoedema of the legs

Hypothalamic obesity occurs due to lesions of the hypothalamus, e.g. in cases of brain tumours or after brain injury.

Grade III obesity is often associated with lymphoedema, venous congestion, cardiac insufficiency, arthrosis, metabolic diseases and hormonal dysfunctions. In these cases, general medical care is indicated, e.g. the treatment of cardiac insufficiency, metabolic disease combined with psychotherapy and, finally, of the lymphoedema itself (*Figure 4*).

Localised increase of adipose tissue

This involves an increase of adipose tissue in some regions of the body, e.g. Dercum's disease (diffuse lipomatosis), Madelung's disease (symmetric lipomatosis, Launois-Bensaude syndrome [*Figure 5*]), and lipoedema.

This paper deals with the clinical picture of lipoedema, its differential diagnosis, and its therapeutic consequences.

Allen and Hines (1940) were the first to define lipoedema as a syndrome characterised by a symmetrical increase in adipose tissue on the lower extremities, in combination with orthostatic oedema (*Figure 6*). In 1981, Schmitz spoke about the 'obese legs of the healthy woman', based on genetic factors. Genetic increases in fat can occur in families which are not connected with diet, and do not have any oedema component, lymphatic or microcirculatory aspects.

Lipedoema is characterised by oedema of increased adipose tissue triggered by a disturbance of blood capillary permeability. Both the clinical and the histological picture distinguish lipoedema from other localised increases of adipose tissue. Cases of combination lipoedema and obesity often occur.

The clinical picture of lipoedema is well known: a symmetrical, progressive increase of adipose tissue, mostly on the lower extremities of women, which is resistant to diet. It develops in stages which can be distinguished from each other both by their clinical picture and their histological characteristics (*Figure 7*).

- **In stage I** there is an increase of subcutaneous adipose tissue, the skin is smooth. Due to orthostatic oedema, tenseness and heaviness periodically occur.

- **In stage II** subcutaneous tissue is thickened. By palpation, coarse knots are found and the skin becomes uneven. Patients complain of pain at the slightest touch or pressure, and haematomas caused by minor trauma. Orthostatic oedema is permanent, with legs swelling from morning to evening.

- **In stage III** the skin has become flabby with huge, hard knots. The limbs are disfigured by folds of fat. Patients' grievances become worse. Quite often the swelling of the legs does not disappear during bed rest. Histological

Figure 7: Clinical stages of lipoedema syndrome

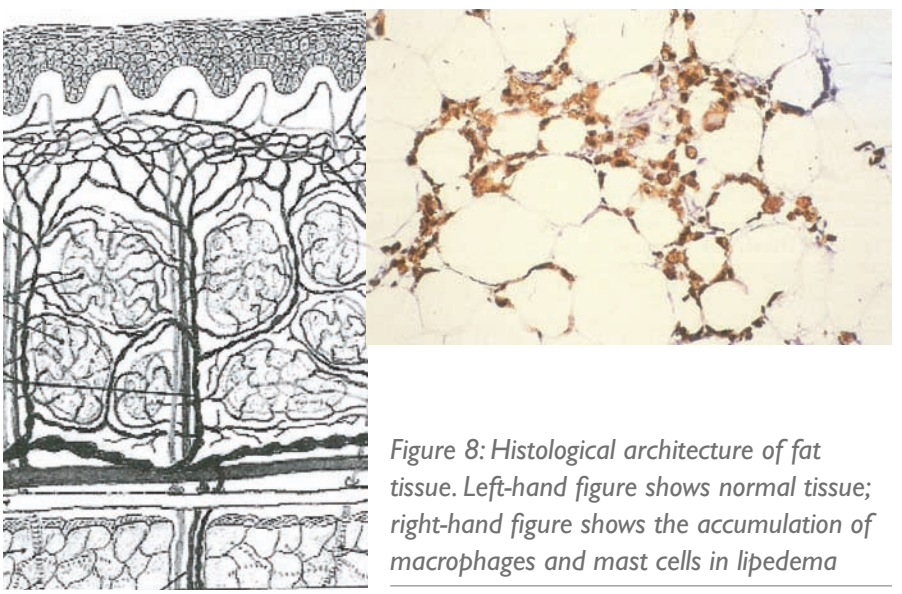

Figure 8: Histological architecture of fat tissue. Left-hand figure shows normal tissue; right-hand figure shows the accumulation of macrophages and mast cells in lipedema

changes depend on the stage of lipoedema (*Figure 8*).

The morphological changes in lipoedema can also be divided into stages:

- **Stage I:** the interstitium of the adipose tissue, its septa, is oedematous. As a consequence, adipocytes are dislocated.
- **Stage II:** there is a proliferation of argyrophil and collagen fibres in the septa. As a consequence, micro-nodules appear.
- **Stage III:** fibrosis of the interstitium has increased. There is an increased number of macro-phages and mast cells. Micronodules have turned into macronodules. The number of blood capillaries is increased. Signs of a mild inflammatory process, focal necrosis of adipocytes and oil cysts are present.

Thus, hyperplasia of the adipose tissue is characterised by univacular, partly hypertrophic adipocytes containing an increased amount of fat. There is an increase in the number of blood capillaries. In later stages, diffuse fibrosis of the interstitium arises. A large number of macrophages and mast cells are present. Calcified elastic fibres, foreign-body granulomas, even granulomatous inflammatory processes may be found.

Established pathophysiology of lipodema is based on the following points:

- **Blood capillaropathy:** the permeability and fragility of the blood capillaries is increased. Microaneurysms can be seen.
- **Lymph capillaropathy:** increased permeability and aneurysm-like structures. The lymphatic formation is disturbed.
- **Disturbance of lymphangiomotoric activity:** impaired lymph formation
- **Increased compliance of the skin:** the effectiveness of muscle and joint pump function is decreased
- **The veno-arteriolar reflex is missing:** the effectiveness of the calf pump is decreased.

Tiedjen (1991) has shown that lymphoscintigraphic findings vary with the different stages of lipoedema. In stage I the transport of the tracer is accelerated, in stages II and III it is slowed down, corresponding to lymphoedema. Based on the clinical, histological and lymphoscintigraphic data from the point of view of lymphology we are able to describe lipoedema as follows:

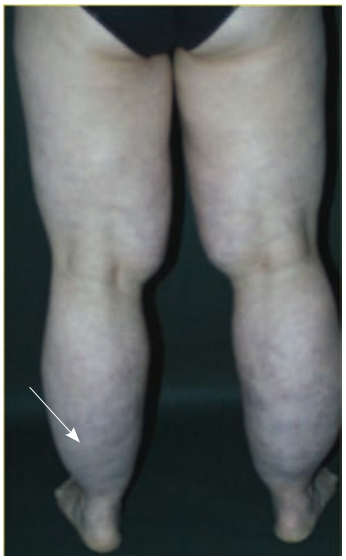

Figure 9: Lypohypertrophy

Figure 10: Lipoedema

In stage I the component oedema of the disease is compensated. In stage II periods of compensation and decompensation alternate. In stage III decompensation prevails; we designate this stage as lipo-lymphoedema.

It is important to differentiate between lipoedema and fat legs of healthy women (*Figures 9* and *10*). This can be done either by blood capillary scintigraphy performed by Behar in France or by the water-loading test of Streeten.

Streeten test

Before starting the test, heart and venous diseases as well as renal insufficiency should be excluded. The patient drinks 20ml water/per kilogram of body weight and remains in an upright position for four hours. During this time urine is collected. The leg volume is measured before and after the examination. Normal healthy people excrete more than 60% of the ingested water and the volume of the legs does not increase more than 350 ml/leg. A simple pathological test, therefore, will show that the volume of excreted urine is less than 60% of the ingested water, and the increase of leg volume in four hours is higher than 250ml per leg. A pathological Streeten test speaks in favour of an increased permeability of the blood capillaries (*Table 1* shows the results of the Streeten test in a clinical study).

Based on the literature and clinical experience concerning the effect of hormonal disturbances on microcirculation and lipogenesis, the author's clinic has analysed the frequency of diseases of the thyroid gland, polycystic ovary syndrome (PCOS) and of type II diabetes in lipoedema. Two percent of the population in Germany suffer from thyroid disorders; 43% of those with stage II lipoedema have thyroid diseases. The frequency of PCOS is 4–10% in the general population, while 15% of those with stage I lipoedema suffer from PCOS. Diabetes is prevalent in 4–5% of the population, 28% of those with stage II lipoedema suffer from either type I or type II diabetes. Based on these findings, the author concluded that a positive correlation between the frequency of endocrinological diseases and lipoedema is present (*Table 2*).

Table 1: Streeten test — results of a clinical study

	Volume legs	Urine %
Control group, n = 10	252 ± 30	76%
Lipoedema stage I and II, n = 65	1098 ± 480	52%
Lipoedema stage II and III, n = 91	1260 ± 650	42%

Table 2: Frequency of endocrinological diseases and lipoedema

	Thyroid diseases (2%)	PCOS (4–10%)	Diabetes type I and II (4–5%)	Liposuction
Control group, n = 10	–	–	–	–
Group I, n = 65	38%	15%	3%	26%
Group II, n = 96	43%	8%	28%	11%

Treatment

Based on the pathophysiological and pathomorphological alterations described above, the author's treatment of choice for lipoedema is combined physical decongestion (CDP).

In stage I lipoedema the author recommends that the GP prescribes 12 lymphatic drainage sessions over a period of a year. Compression hosiery should be applied only in cases of lengthy immobilisation. The patient should take exercise and be given advice on watching weight gain.

In stage II lipoedema, where orthostatic oedema is evident,

Table 3: Dosage of therapeutic measures			
	ML	Compression	Sports
Stage I	series 12x/year	if indicated	yes
Stage II	series 30–50x/year	nearly daily	yes
Stage III	1–2x/week	continuously	yes and remedial exercises

the author's clinic offer lymphatic drainage and compression is recommended. If the patient is going out socially it may be left off but should otherwise be worn continuously, even at work.

In stage III lipoedema, where lipolymphoedema is present, all the laws of lymphology apply (*Table 3*).

Box 1: Summary

- Diagnosis of lipoedema has to be distinguished from other forms of increased fat tissue.
- Therapeutic measures should be conservative.
- Further research into the pathophysiology of lipoedema is necessary.

If diagnosis is established according to strict criteria, in the author's opinion liposuction should not be performed because it does not remove the pathophysiological alterations. According to observations at the author's clinic, without continuous compression treatment, relapse occurs 18–24 months after liposuction. However, healthy women with fat legs are happy with the outcome of liposuction.

In a clinical long-term study, performed on patients suffering from lipoedema, the author's clinic have found that although phase 1 of CPD has been effective, after four years there was significant relapse (*Figure 10*).

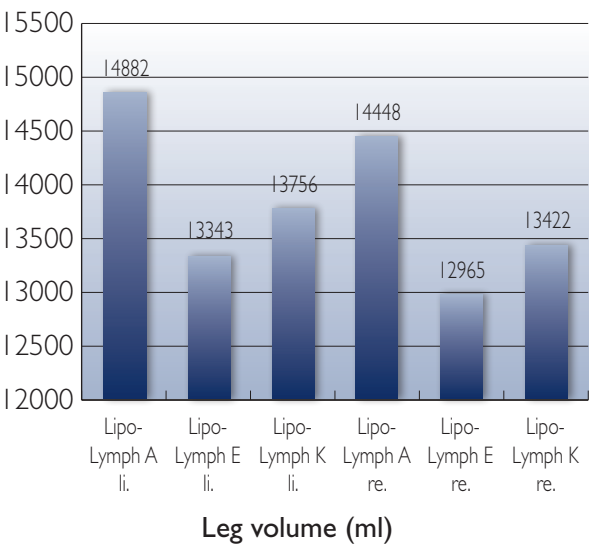

Figure 10: Long-term therapy results (n = 122). Follow-up four years

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Appendix: questions and answers

Question: A question for Professor Schmeller. Directly after operations, do your patients have to wear stockings?

Professor Schmeller: Compression garments are put on directly after surgery and the patients wear them for four weeks. For the first week they wear them day and night, the second, third and fourth weeks they wear them during the day. Compression is a very important part of liposuction.

Question: What is the timescale and frequency of any relapses that you have witnessed following liposuction?

Professor Schmeller: The question is, what do you understand by relapse? We have followed our patients for nearly five years. With the exception of two cases, we have not seen any relapses. One case was a woman who gained 20kg over a two-year period. So, the effect of liposuction could no longer be seen. The other was a lady who was also heavy and she gained volume on the outer side of her thighs. We are always concerned when women become pregnant. We had two women who became pregnant several years after liposuction and they were both afraid of gaining weight.

One of these women has lost weight, in fact, she was slimmer after the delivery than before, the other one maintained the same weight. If there is a relapse, I think it is due to enormous weight gain. One needs to question why they have gained weight. Basically, the fat that is removed — this fat cannot come back. Only the fat that is left there might increase in volume. However, this seems to be the exception.

Question: What is the youngest age at which you are prepared to perform liposuction?

Professor Schmeller: Usually after 18. We had one patient who was 16. She had widespread fat cells on the legs. She came to our clinic with her mother and was clearly suffering and so we asked ourselves, why wait another two years to remove the fat? But, usually it is from 18.

Question: Do you sometimes do skin resection after a significant liposuction procedure?

Professor Schmeller: Usually never. There are people who have large upper arms. In these instances, it is not easy to estimate how the skin is going to contract when the volume and the weight have been reduced. We often treat very large conditions, but we let the patient know beforehand that we do not know what the cosmetic outcome will be. It is extremely rare that they are not be satisfied with it. They will lose the sensation of pressure on the arm and they won't be carrying around such a huge weight that they can't put a blouse on, but it might be that the skin will be looser and that a skin excision is necessary. This happens in a very few isolated cases.

Question: We know from traumatology that, as a result of trauma, the function of the lymphatic

motor system is reduced. Would it make sense, postoperatively after liposuction, to perform drainage therapy similar to phase I of lymphatic drainage or to use bandages?

Professor Schmeller: Most of our patients have had manual lymphatic drainage before the procedure. This should be continued postoperatively. We have the impression that when we operate on arms or upper legs, the healing process is problem-free. There is hardly any tendency for oedema. When we operate on lower limbs, in addition to compression garments and bandaging the legs, we also ensure that women have appointments in place to see a lymph therapist after the procedure. This therapy should be carried out intensively for two, possibly three months. This also applies to other areas.

Question: How do you determine which stocking or garment the patient needs to have postoperatively? Do you use a laser or how do you do this?

Professor Schmeller: I'm a little bit embarrassed to say, but the nurses do it by looking. We have all sizes to hand. The nurses look at the patients (even I've become quite good at judging if it is a S or M) and in 99% of cases they are right. You have to remember that the fabric is a long-stretch material, not the usual hosiery style with a short-stretch. These are post-liposuction garments which are elastic and, therefore, have a great deal of stretch. After a while it becomes fairly easy to judge what is needed.

Question: I can't quite figure out the costs. If you wanted to remove 3 litres of fat volume, what would the cost be? Perhaps our colleagues from Sweden and Holland could comment.

Professor Schmeller: I would like to comment first for Germany. In a very few cases, the social security system pays — I would guess 5% of all patients. This is a huge privilege. Otherwise, patients have to pay privately. We reckon that if two areas are treated, it is around 4,500 euros per operation. In addition, there are the costs of garments at around 200 euros and an overnight stay in hospital at 150 euros. That is the total cost including VAT. I'm not sure what the costs are like in other countries.

Dr Voesten: In the Netherlands, if you want to have liposuction on a leg, my colleagues would require five treatments and for each treatment they would receive 5,500 euros — this is all paid in cash by the patient. Now that treatment is being carried out in hospitals, there is the possibility that social security might be prepared to pay in future, but this would only be in extreme cases of lipoedema where there are complications from being overweight. Another interesting point is that BMI is now less of a consideration, what we are interested in is waist measurements. BMI can give a false impression.

Dr Brorson: With regard to costs in Sweden, a leg costs about 11,000 euros and an arm around 8,300 euros. But the patient pays only 30 euros at each outpatient visit. They pay nothing for the surgery or the stay in hospital because this is covered by social security. We have no insurance companies in Sweden — the government is the one big insurance company. As a Swedish citizen you are entitled to any treatment free, apart from the outpatient cost and costs for medicines, which are maximised to 90 euros per year. Patients pay nothing for garments after surgery. If surgeons get paid for each treatment, there tends to be unnecessary procedures. When medicine in Sweden was nationalised in 1970, overnight the number of tonsillectomies and the removal of adenoids was reduced by 70%. This cannot mean that Swedish children were 70% healthier overnight, it was because the 'carrot' of money was taken away, and surgery was only done on those who really needed it.

Question: Dr Freccero, when you say compression garments should be used on the arms continuously,

do you mean 24 hours, in bed, out of bed? What has led you to use different types of garments together?

Dr Freccero: We start with two garments at the time of the operation. This is followed by a check-up after two weeks to see whether the wounds are healing as they should. After another two weeks we measure the reduction of the excess volume, and this is the first time that we adjust the measurements and order new garments for the patients. When we see the patients after three months, we can see whether the compression therapy is sufficient. We, so to say, estimate with each individual patient, what that particular patient needs or does not need. We cannot say in advance that this patient will need two stockings on top of each other or four stockings, but we have to try them out, increasing the level of compression or increasing the layers on top of each other. This is the process for the first six months to a year, until we achieve the desired volume reduction.

Dr Brorson: I can add a little more. With arms, we use just one garment. On legs, we start with one leg-long garment and also prescribe a below-the-knee garment to put on the day after surgery. Thus, the patient uses two leg-long and two below-the-knee garments initially. Each set (leg-long and below-the-knee) is worn for 24 hours while the other set is being washed and dried to be used the following day, and so on. During the first year we find out how many garments each individual patient needs. We have patients who are very active who need two leg-long garments and two below-the-knee garments a month — up to two garments every six months. It's like diabetes — you have to find out how many units of garment you need for that particular patient. If you can only provide one or two garments for a year, you will have a relapse. We still see patients who have been treated conservatively and go back time and time again to the therapists who regard it as normal that the arms should swell, instead of analysing why the arm has become swollen again. If, instead, the therapist sees the patient at one-month after the initial treatment, she or he will see when the excess volume increases and it is time for new garments. This is how we do it and we have never had any relapse.

Question: I have a question regarding compression therapy in lipoedema. Professor Schmeller has just said that after liposuction pressure pains reduce. In my experience this is one of the main problems — patients with lipoedema experience extreme pressure pain and so compression therapy becomes difficult. Many of these patients cannot bear the pressure of wearing compression stockings. I wanted to ask if other colleagues have had similar experiences of pressure pain reducing after liposuction and, therefore, compression therapy becoming easier.

Dr Voesten: I can talk about the Dutch experience. Many lipoedema patients experience pain when you touch them and so it is difficult to get the leg garments right. There is manual lymphatic drainage — hand movements which the patient can practise so that when he touches himself the pain begins to go away, this is one possibility. In the case of stockings in lipoedema I have no experience, as we do not operate on lipoedema patients. Lymphoedema patients are used to the stockings from an early stage and so have no problems.

Dr Freccero: This is also our experience in Sweden. We do not operate on lipoedema patients, and the lymphoedema patients who are admitted are used to compression therapy and wearing stockings and have been doing this for some time and so are happy to continue. This is what we call our pre-operative compliance.

Dr Brorson: I can also add that one of the side-effects of cosmetic liposuction is the numbness of the skin, and this is also one of the reasons for reduced pain in lipoedema patients. We have

also tried it in patients with *adiposis dolorosa* (Dercum's disease). After liposuction there seems to be a numbness and it takes up to six to 12 months before the sensitivity recovers. I think this is the main reason for lipoedema patients having less pain following surgery. You can't compare them with each other. As Dr Freccero said, all our patients wear garments beforehand, so they are used to them. If they haven't done so, we have to send them to a therapist. These patients usually also have pitting.

Dr Voesten: For two years now, lipoedema patients have been part of a special project. They all have a psychological assessment and they all undergo a leg muscle test. In our experience, all lipoedema patients have about 30% less muscle strength than normal people. They are all given a training programme to follow — they need to exercise and they need psychological support and advice. This could be a way of making stockings more acceptable.

Question: What is the main reason and advantage for using long-stretch garments?

Professor Schmeller: Short-stretch garments have a high pressure on working and a low pressure on resting. So, when you walk you get compression from the outside to get rid of the oedema in the leg. This is not what we need after surgery. After surgery we need compression either at rest or during work that is always the same and presses the skin onto the rest of the subcutaneous fat. So, that is why we use long-stretch garments.

Question: Is it not dangerous to leave these kinds of garments on during the night?

Professor Schmeller: We leave them overnight for the first week. Basically for the reason that no bleeding will go on underneath the skin in the first few days. That is why it is overnight. But, you need a less tight compression than you need for venous and lymphatic disorders disorders. It is a different approach.

Question: Why don't you use compression bandages, as is usually the case in phase 1 of compression therapy? It is more trouble, but you can control the amount of pressure. Why don't you use short-stretch postoperatively which can be adjusted daily?

Professor Schmeller: You don't need new adjustment every day. We have removed fat once and the volume is therefore fixed. You don't need to constantly readjust. We only add a compression bandage in the case of lower limbs to increase the pressure. Why? Because the healing process takes longest in the lower limb; the fibrosis which appears after two, three or four weeks is the worst and we can, therefore, reduce the healing time of the wound slightly.

Question: A question from one of our colleagues from Italy, who has some concerns about colleagues who have presented a paper where they state the pathophysiology of lipoedema relates to oedema as inter/intra-cellular oedema. He feels it's interstitial oedema. Do you agree or disagree?

Dr Brorson: I think the fluid is between the cells and not within the cells, so it's interstitial — nobody has actually proven that yet. The thing is when you do high resolution MRI you need to have an MRI that can take one cell and we are not there yet. We have tried. There are some reports about clusters of cells and then you get the interstice between the cells, so you can't tell.

Professor Schmeller: I'm not sure. I also believe that it is interstitial oedema. When we do tumescent local anaesthesia we do it the other way round — we bring fluid into the subcutaneous fat. So, what happens with this fluid? It goes first into the interstitial space, to the extra lobular space and fills up the volume there. When the pressure increases, more and more fluid

is going into the subcutaneous tissue. It finally goes into the lobules and makes an intra-lobular oedema. That is how it is written in the books. So, the intra-cellular oedema is obviously at a very late stage.

Dr Brorson: I would like to ask Professor Schmeller a question. Have you ever done lymphoscintigraphy before and after liposuction?

Professor Schmeller: I have not done it but it has been done in Dusseldorf by a colleague. It is difficult to interpret the results of lymphoscintigraphies because we know in lipoedema the lymph flow is quicker than in normal patients. There is more oedema in the leg, the lymph vessels are all OK, so they try to work hard to get rid of the oedema, thus the lymph flow is greater than in a normal individual. This is the basic situation. If you have a patient, you do liposuction and after half a year you do lymphoscintigraphy again. There are two or three choices: either the lymph flow is the same — what does this say? There is an improvement of the form, of the shape, there is improvement of the symptoms, but the lymph flow is the same — how do you interpret this? Second choice: lymph flow is less than before, then some people would say, 'look what you have done, you have damaged the lymph vessels'. But another person would say, 'no you're not right, the lymph flow is slower so it is more normal, it shows you that the whole system has moved towards being normal.' Whatever result you get from your study, you will have difficulties in interpreting it.

Dr Brorson: What I was asking was if you saw that after liposuction you had dermal backflow over a period of time. It has been shown that when you do cosmetic liposuction on the lower leg, there is dermal backflow in the immediate postoperative peroid. So, I thought maybe that lipoedema patients were more susceptible to developing this tendency of lower leg swelling that you usually see after cosmetic procedures.

Professor Schmeller: Yes, I understand your point. It's a good idea. I cannot answer this question. After a week, many patients will experience slight oedema. The physiotherapists call it post-traumatic oedema. It is well-known. It lasts for a couple of days and then it disappears. If you do lymph therapy at this time, it is great, if you don't, it will also pass away.

Dr Brorson: Is there an upper limit of BMI when you say, sorry, you weigh too much.

Professor Schmeller: Our upper limit is 120–130kg. But, there are patients who weigh this amount who have very tight tissue, you don't need much volume to make it tense. You can operate on these patients. There are other patients of the same weight who have very soft tissue, so you fill the volume and you fill and fill, and it doesn't get tense. We would not operate on these patients as they would need an enormous amount of solution. 125kg is the limit.

Dr Brorson: Do you sometimes say: you weigh too much, you need, for example, to have a gastric bypass. Do you refer such patients for consultation for a bypass?

Professor Schmeller: Well, I do not deal with obesity and we don't do liposuction to treat obesity. Let's say, if you are a GP, you have patients with diabetes who are a normal weight, some are overweight, and some are very overweight. You treat them all with insulin. You can't say you're too big and I won't treat you. As a surgeon, I have a similar problem: I have patients who are normal weight, no problem; I have patients who are a bit overweight, again, no problem; I have patients who are quite overweight, I can operate on them; and then, I have patients who are more than 130kg. I cannot operate on them because the amount of fluid needed would be too dangerous. For patients who are obese, I refer them to someone else who understands more about this. That is my approach.

Professor Schmeller: I have a question for Dr Brorson and his colleague. I want to come back to a point that was mentioned but I would like to emphasise it more. When we operate on patients with lipoedema, we improve the shape and we improve the symptoms and function. Patients are better afterwards, they need less compression hosiery and less physiotherapy. When you operate on patients with lymphoedema, you have an improvement of shape, patients look better, but do you not have a worsening of function?

Dr Brorson: No, as I told you, that was one of the papers in my thesis and I repeat this again. We did lymphoscintigraphies on 11 patients before surgery and after three and twelve months. We did two at each instance, one with the garment on and one without the garment. So, each patient has six scintographies. Then we analysed them. We saw that there was no further decrease in an already decreased lymph transport capacity.

Professor Schmeller: This doesn't convince me. From what I have understood, patients need to wear compression garments day and night after surgery. They did not do this before, so why do they need to do it now?

Dr Brorson: Patients who come to us have always worn compression garments before surgery.

Professor Schmeller: Yes, but not day and night.

Dr Brorson: Yes, they always do.

Professor Schmeller: That is new to me.

Dr Brorson: Patients that are referred to us know about our policy. These patients have been in garments night and day, thus have optimal conservative therapy showing no pits on pressure.

Professor Schmeller: From what I know of lymphoedema patients, they wear their garments during the day and take them off at night.

Dr Brorson: That is a pity.

Professor Schmeller: You disagree with this?

Dr Brorson: I disagree with this regarding lymphoedema because we have measured patients in the night and in the morning and they accumulate fluid in the night. Also, if you want to have a compliant patient, if they take off the garment, it feels nice and so they leave it off for longer, they have a cup of coffee, maybe a shower and walk the dog, and, by 11 o' clock, they have forgotten that they should put their garment back on. If we leave the patient with no alternative, they know what it's all about and they have no option.

Also, the reason why we didn't get any decrease in the lymph transport capacity was because they have lymphoedema — it was as low as it could go, we didn't worsen it.

Dr Freccero: Patients who show pits on pressure when we see them are sent back to the therapist to optimise compression, including wearing garments continously, until no pitting is seen. If the condition reaches a plateau, i.e. still significant excess volume and no pitting, the compression garment has done its job and you know what compression is needed for this particular patient; you know how far you can get with conservative treatment. You can then decide to add in operative treatment. But that does not make any difference to the lymph flow. Surgery only reduces the adipose tissue.

Dr Voesten: The interesting thing is that we have done three prospective studies. The first one is grip strength testing. The impression is that about 10% better grip strength is achieved after surgery. The second is the range of motion of the shoulder, which improves because the arm has less weight, and the third is that we have observed about a 95% reduction of erysipelas attacks. If someone presents with a great number of erysipelas attacks we see this as an indication for surgery, even if they do not have a dramatic difference in leg volume.

Question: Do you routinely apply compression therapy for 24 hours, also at night?

Dr Freccero: Yes.

Question: Routinely — lifelong?

Dr Freccero: Patients who are referred to us use compression garments continously. Therapists know that this is necessary to be eligible for surgery. When we see the patients most of them show no pits on pressure and we can tell them that the excess volume is adipose tissue, not accumulated lymph. This excess tissue can only be removed with liposuction.

Question: I enjoyed your talk about compression therapy very much, how thoroughly it is carried through and how frequently the compression garments are changed to maintain their effectiveness. I wish the same was done here by patients as well as by physiotherapists, doctors and health services. If this were done immediately after the diagnosis of lymphoedema, surgical treatment would be far less frequently needed. There are huge shortfalls even in identifying lymphoedema. There are all sorts of statistics regarding the frequency of lymphoedema, and these varied statistics only support how difficult it is to diagnose.

Dr Freccero: Another point is that it is difficult to know at what point lymphoedema will begin. It does not always appear after surgery, but often years later.

In principle, the diagnosis of lymphoedema is easy if you know what is going on. This knowledge should just be distributed more.

Question: I have a question for Dr Brorsen. We heard from Professor Földi today that about 20% of primary and secondary lymphoedema develop into fatty and not fibrotic tissue. You have shown today that you also perform liposuction after drainage in cases of primary and secondary lymphoedema. We know that this tissue after drainage is not fatty tissue, but rather fibrotic tissue. How do you determine pre-operatively that it is not a question of fatty tissue or connective tissue, do you use MRI or how do you do it?

Dr Freccero: We remove the fatty tissue that can be removed. We rarely see fibrosis. The figures presented by Dr Földi have not been published. Fibrosis is difficult to detect with CT or MRI.

Question: Is there always fatty tissue even in the case of fibrous tissue?

Dr Brorson: Yes. Professor Földi is not here. I would have liked to ask her how she found out it was 20%. How did she measure it? How did she measure the fibrotic tissue? It cannot be measured with MRI or CT, so I do not know where these figures come from. Quite rarely we see these fibrotic things — as I told you earlier, it is in male patients and in women with a male distribution of fat. You can feel with a cannula that it is a little tougher to remove the fat. But the connective tissue remains.

Question: Can you explain how you use the tourniquet and tumescent technique?

Dr Brorsen: We use both a tourniquet and tumescent technique. The tourniquet is put on to have a bloodless field and the fat is removed up to the tourniquet. Then the garment that was measured two weeks before, according to the normal arm, is applied. The tourniquet is removed. Then the proximal part of the upper arm, where the tourniquet had been placed, is infiltrated with saline and diluted adrenaline (tumescent technique). This is how it works.

Question: Do you perform lymphoscintigraphy before liposuction for lipoedema and lymphoedema? With liposuction, do you perform lymphoscintigraphy before and after?

Dr Brorson: Not routinely. We undertook a study because everybody said, how dare you do liposuction on the arm? You will destroy the lymphatics. And I said that these patients' lymphatics do not work and this is why they have lymphoedema, but the question was a good one. When we did this study we performed six lymphoscintigraphies on each patient and we saw no change after liposuction, so there is no need to do it as a routine thing — it was just for scientific evaluation.

Question: Maybe there was an improvement of the lymph flow after the treatment?

Dr Brorson: In 10 patients we saw that there was no improvement, except in one patient who could remove the garments afterwards, but, as we say in Sweden, 'one swallow doesn't make a summer.' In some cases, we still do lymphoscintigraphy. In primary lipoedema we always do it, just as a diagnostic tool, not for seeing any increase or decrease in lymphatic flow. We do it only before for diagnostic reasons, nothing more.

Question: Did I understand this correctly? When fat is sucked out of the arm, under the tourniquet in the lower arm, there is no tumulescent anaesthesia?

Dr Freccero: That's correct.

Question: Liposuction is an operation. Operations bring complications with them, more or less. When I see the pictures you have shown us doing liposuction on the lower arm, did you notice any nerve damage? For example, on the radial nerve?

Dr Brorson: So far, we have been lucky. We tell the patient before surgery that they will feel a numbness in the skin which can take up to a year to disappear, but usually it disappears within three months. We have had no radial, ulnar or medial nerve damage, just a numbness of the skin, which is always seen after liposuction. This is not a complication, but a side-effect. We have only had one infection in 15 years and that was resolved.

Question: I have a question for the people from Jobst and a question for the listeners. I want to go back to the lymphoedema theme and compression treatment, and the question of daytime only or daytime and night. How is this managed? Are there recommendations that, for example, arm or leg garments should be worn day and night in the case of a lymphoedema? Or should it only be daytime? Or is it dependent on findings? Are there any rules?

Delegate comment: In Austria the recommendations are, as I learnt from Professor Földi, to wear compression garments during the day and night. Patients are also educated during the therapy, or family members or clinic employees are briefed. In Austria, and I am sure in Germany, 24-hour compression therapy is already being carried out. But, of course, everything is dependent on compliance, and it is important to promote and enlighten the patient about this during treatment to show him how crucial cooperation is for his own health and well being. Not everybody is going to go along, that is for sure. I did some research and asked patients to be

honest and to fill out a calendar showing if they wore the compression garments day and night for six months. After six months I took some measurements. This showed that all those who wore the compression garments day and night had a significant volume reduction. Those who did not, showed either the same volume or a volume increase. On the other hand, those who managed their garments consistently, did better than those who did nothing. Patients need to be motivated. Twenty-four-hour compression therapy is unavoidable.

Professor Földi also recommends wearing a compression stocking with slightly less pressure at night, for example, a class 1 arm garment or an older stocking that has weakened.

Dr Freccero: For practical reasons we sometimes do the opposite regarding gloves. Many patients are able to go back to work after the operation and after the volume has been reduced. It may be difficult to wear a glove during the day. Sometimes patients remove the glove during the day, making up for what they have not done during the day at nighttime, thus they have more pressure at night than in the daytime.

Professor Schmeller: Another argument is that in the early stages of primary leg lymphoedema, the oedema runs in during the day and goes back considerably at night. In early diagnosis of primary leg lymphoedema there is often the question of compliancy. I tell my patients that if in the morning, after they have been lying down all night, a lymphoedema is still visible, stockings must be worn all day so that the flow during the day does not become too great, and so at night it is still possible for it to go back by itself.

Question: Are there any guidelines or indications how this should be managed? Is it fixed in any clear way?

Answer: Somebody from Jobst is in the process of working on these guidelines and giving indications, but it is not yet completed.

Dr Brorson: I would like to comment. When we started this in Sweden 15 years ago, as I said, our knowledge of lymphoedema was limited. We went into this with open eyes, not biased with what had been written before — don't do this or don't do that. If I had followed instructions, I would never have put a liposuction cannula in a lymphoedema and I would never have used compression garments during the night, but we just did it and the patients got used to wearing the garments at night. They said that if they didn't wear their garment at night, they felt naked, that they were used to it like brushing their teeth. It was normal for them to use a garment at night, even if it exerted compression 3 on the leg, plus compression 2 on the arm. It's just a habit. Many patients find it cumbersome to do the bandaging with low-stretch bandages during the night. Some elderly patients cannot do it at all, so why not make it simple and use the garment 24 hours. It has worked for 15 years in Sweden and could work the same in Germany. By the way, I was surprised to hear that continuous compression in now used in many countries. When I suggested this 15 years ago nobody recommended it.

Delegate comment: A further problem in my view is toe oedema rising in primary leg lymphoedema. It is often the case that there are compliance problems with toe caps during the day and this is when I have found it important, if they are not worn during the day, that they at least be worn at night. There will be a iatrogen toe lymphoedema, if only the compression stocking is worn and the toes are neglected. This should also be considered.

Delegate comment: There are certain recommendations made in the case of children and certain lymphoedema patients, and bandages at night are worn because the compression pressure is reduced at

night but, of course, skin care is also important and should be given greater consideration with the use of compression bandages over a gauze stocking.

Dr Brorsen: Yes, but who says that? What is the scientific evidence for this? If you can use the garment for 24 hours you do not need to have a cumbersome procedure of cotton wool and low-stretch bandages. I try to make it easy. Evolution and science is to see what everyone has seen and to think what nobody else has thought, keep your eyes open and don't follow all the rules that have been put there before — you can find new ways to treat lymphoedema, like using the garments all the time. Our patients have no problem with that.

Question: I have another question in relation to costs in Sweden. With regard to the cost of stockings, I recall that you had 150 euros a year in your budget? Perhaps you could explain this in more detail. It's a bit of a puzzle to me – if you renew the stockings regularly, sometimes monthly.

Dr Brorson: In Sweden a garment for an arm costs about 60 euros, a glove is 90 euros, so that's about 150 euros and you need two of them, so that's 300 euros. And, if you're lucky, these will last for six months. Young patients need a set a month. It's like medicine or insulin. You have to find out how many units of garment the particular patient needs. As I have said before, patients pay nothing for the compression garments, thus we are able to provide optimal compression, leading to complete reduction.

Question: Two more questions to Professor Schmeller. Why is there always symmetry in lipoedema? What is the cause?

Professor Schmeller: Nobody really knows. It's nearly always symmetrical, bilateral and rarely do you see a patient who has a larger amount of fat volume in one leg than the other. When I ask my colleagues in lymphology, they say by definition this is not lipoedema, but it does seem to exist rarely. Why it is like this, I don't know.

Delegate comment: After a certain point and a certain strength, lipoedema becomes asymmetrical. By stage 3 the symmetry is lost. It always begins symmetrical though.

The symmetry can also disappear after an accident, for example, post-traumatic lipoedema.

Dr Brorson: I have a question for Professor Schmeller. Do you use the test Professor Földi told us about?

Professor Schmeller: I also wanted to ask our colleagues if there was anybody using this test. I have only heard of the Földi clinic doing it. I'm not sure whether it is really necessary. It is interesting, but for patients with lipoedema you can make the diagnosis of oedema and that is enough. The volume of oedema is interesting for scientific enquiry but they all have oedema. So, do I still need to provoke the oedema by the amount of fluid I have to drink? Has anybody else experienced this 'Straeten probe'?

Delegate comment: I can't imagine the test is very specific. You can see in the case of many men that the test is positive and they have no lipoedema, just orthostatic oedema, so the results are varied.

Delegate comment: Also, if somebody suffers from a heart deficiency and drinks a lot of fluid, they will store a lot more, and if you have a woman who has orthostatic oedema and drinks a lot, then she will also store more — I don't think it is lipoedema specific.

Dr Brorson: I think it's an interesting test. I have heard about it before, but it was made years ago and I think it should be validated again to see if the figures are correct and if you can rely on them.

Professor Schmeller: I have spoken with one patient who was at the Földi clinic. She said that she had undergone this test and found it very brutal because she had to stand for four hours in one place which was not fun.