THE FACTS ABOUT LIPOSUCTION AS A TREATMENT FOR LYMPHOEDEMA

Håkan Brorson, Karin Ohlin, Barbro Svensson

There is some controversy regarding liposuction for late-stage lymphoedemas. While it is clear that conservative therapies such as complex decongestive therapy (CDT) and controlled compression therapy (CCT) should be tried in the first instance, options for the treatment of late-stage lymphoedema that is not responding to treatment is not so clear. Liposuction has been used for many years to treat lipodystrophy. Some results have been far from optimal, however, improvements in technique, patient preparation and patient follow-up, has led to a greater and a wider acceptance of liposuction as a treatment for lymphoedema. This paper outlines the benefits of using liposuction and presents the evidence to support its use.

Key words

Liposuction
Controlled compression therapy
Lymphoedema
Adipose tissue

There is an increasing body of evidence, based on well-controlled clinical trials and long-term follow-up, that liposuction can result in significant objective and subjective benefit to patients who have long-term chronic lymphoedema (Brorson et al, 2007a, b). There are, however, different views on the immediate, short- and long-term benefits of liposuction for treating lymphoedema, with a strong dichotomy between those who support surgical and conservative treatments.

Excess subcutaneous adiposity and chronic lymphoedema

The incidence of postmastectomy arm lymphoedema varies between 8% and 80%, depending in part on whether axillary lymph nodes have been removed and postoperative irradiation has been given (Kissin et al, 1986; Segerstrom et al, 1992).

The outcome of the surgical procedure as well as of the irradiation of the tissue often results in the destruction of lymphatic vessels. When this is combined with the removal of lymph nodes and tissue scarring, the lymphatic vessels that remain are likely to be unable to remove the load of lymph. The remaining lymph collectors become dilated and overloaded and their valves become incompetent, preventing the lymphatics from performing their function. This failure spreads distally until even the most peripheral lymph vessels, draining into the affected system, also become dilated (Olszewski, 1991).

In a parallel process, the cells of the mononuclear phagocytic system of the mesenchymal tissues begin to lose their capability to remove the protein that accumulates. The accumulated interstitial proteins, as osmotically active molecules, attract fluid to the area. This accumulation of protein and fluid is usually a transitory phase, lasting between one and three weeks (Olszewski, 1991).

In the latent phase, there may still be no clinical signs initially of any discernable lymphoedema. The latent phase normally varies from about four months to 10 years. At the end of the latent phase, pitting of the oedematous arm on pressure can be observed. This can be objectively measured by plethysmography and by decreased tissue compressibility using a tissue tonometer (Olszewski, 1991; Bagheri et al, 2005).

The enlargement of the arm leads to discomfort and complaints in the form of heaviness, weakness (Johansson and Piller, 2007), pain, tension and a sensory deficit of the limb, as well as anxiety, psychological morbidity, maladjustment and social isolation (Ridner, 2005; Piller and Thelander, 1998) and increasing hardness of the limb (Brorson et al, 2006a). In time, there is also an increase in the adipose tissue content of the swollen arm. The author has observed this clinically since 1987, when the first lymphoedema patient in his department was operated on (Brorson and Svensson, 1997a; Brorson and Svensson, 1998).

There are various possible explanations for the adipose tissue hypertrophy. There is a physiological imbalance of blood flow and lymphatic drainage, resulting in the impaired clearance of lipids and their uptake by macrophages (Vague and Fenasse, 1965; Ryan, 1995). There is increasing support, however, for the view that the fat cell is not simply a container of fat, but is an endocrine organ and a cytokine-activated cell (Mattacks et al, 2005; Pond, 2005), and chronic inflammation plays a role here (Borley et al, 2000; Sadler et al, 2005). The same pathophysiology goes for primary and secondary leg lymphoedema.

For more information about investigational advances and the relationship between slow lymph flow and adiposity, as well as that between structural changes in the lymphatic system and adiposity, see Harvey et al, 2005 and Schneider et al, 2005.

Other indications for adipose tissue hypertrophy include:

Håkan Brorson, Senior Consultant Plastic Surgeon; Karin Ohlin, OCT; and Barbro Svensson, PT, LT, Department of Clinical Sciences Malmö, Lund University, Lymphoedema Unit, Plastic and Reconstructive Surgery, Malmö University Hospital, SE-205 02 Malmö, Sweden

- Consecutive analyses of the content of the aspirate removed under bloodless conditions using a tourniquet, showed a very high content of adipose tissue in 44 women with postmastectomy arm lymphoedema (mean 90%, range 58–100) was found (Brorson et al, 2004a)
- Analyses with dual X-ray absorptiometry (DXA) in women with arm lymphoedema following a mastectomy showed a significant increase of adipose tissue in the non-pitting swollen arm before surgery (Brorson 2004b)
- Preoperative investigation with volume rendered computer tomography (VR-CT) images in eight patients showed a significant preoperative increase of adipose tissue in the swollen arm, the excess volume consisting of 81% (range 68–96) fat (Brorson et al, 2006b)
- 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 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 methods. 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).

The common understanding among clinicians is that the swelling of a lymphoedematous extremity is due purely to the accumulation of lymph fluid, which can be removed by use of non-invasive conservative regimens such as complex decongestive therapy (CDT) and controlled compression therapy (CCT). These therapies work well when the excess swelling consists of accumulated lymph, but do not work when the excess volume is dominated by adipose tissue (Brorson et al, 1998). The same may go for microsurgical procedures using lymphovenous shunts and lymph vessel transplantation (Baumeister and Siuda, 1990; Baumeister and Frick, 2003; Campisi et al, 2006).

The outcome of liposuction

Today, chronic non-pitting arm lymphoedema of up to four litres in excess can be effectively removed by use of liposuction, without any further reduction in lymph transport. Long-term results have not shown any recurrence of the arm swelling (*Figures 1a, b* and *2*) (Brorson and Svensson, 1997a; Brorson and Svensson, 1998; Brorson et al, 1998; Brorson, 2003; Brorson et al, 2007c). Promising results can also be achieved for leg lymphoedema (*Figures 3a and 3b*) (Brorson et al, 2007a, d).

Liposuction

Liposuction is the most common procedure in plastic surgery and is mainly performed for cosmetic purposes. To a lesser extent it has been used for reconstructive surgery, for example, in the treatment of lymphoedema (Brorson and Svensson, 1997a; Brorson et al, 1998), problems of leakage around colostomies and urostomies caused by bulging fatty skin folds (Samdal et al, 1991; Samdal and Myrvold, 1992), 'insulin tumours' caused by the injection of insulin into the subcutaneous fat (Samdal et al, 1993), multiple familial angiolipomatosis (Kanter and Wolfort, 1988), gynaecomastia (Courtiss, 1987), and benign symmetrical lipomatosis (Brorson et al, 1995).

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 blood be lost or 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 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

Figure 1a. A 74-year-old woman with a non-pitting arm lymphoedema for 15 years. Preoperative excess volume was 3090ml. Figure 1b. Postoperative result.

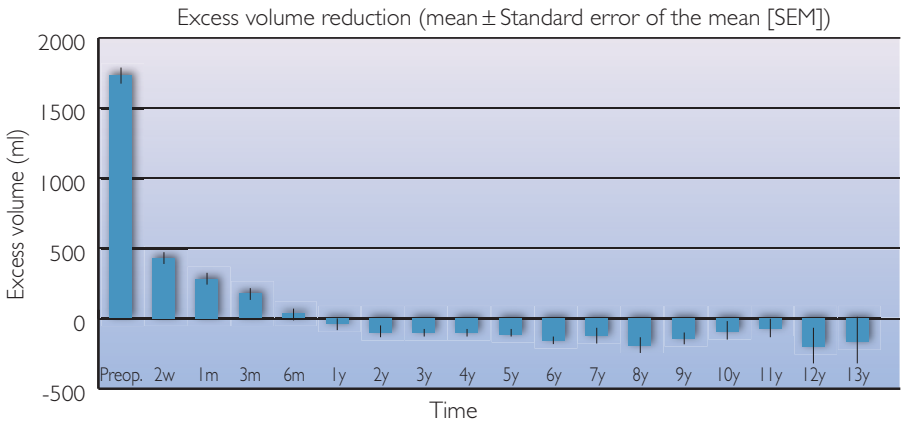

Figure 2. Mean postoperative excess volume reduction in 95 women with arm lymphoedema following breast cancer (Brorson, 2007c).

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 our team started to treat arm lymphoedema following breast cancer treatment, we 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 was released. The area covered by the tourniquet was infiltrated with dilute adrenaline before the liposuction was completed (Wojnikow et al, 2007) (*Figure 4*).

How to perform liposuction for lymphoedema

Surgical technique

Liposuction technique for leg lymphoedema is similar to that for the arm. By the use of liposuction the excess hypertrophied adipose tissue is removed under bloodless conditions (*Figure 4*). General anaesthesia is used in most cases but some patients with arm lymphoedema prefer nerve blockade in the combination of 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 — and even the hand when indicated — are treated (*Figures 4* and *5*).

Cannulas are connected to a vacuum pump giving a negative atmospheric pressure of 0.9. The cannulas are 15cm long with an outer diameter of 3 and 4mm, and they have three openings at the tip. The finer cannula is used mainly for the hand and 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.

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. In stock we always have standard interim gloves and gauntlets (= a glove without fingers, but with a thumb), used as described below. Liposuction is executed circumferentially, step-by-step from hand to shoulder, and the hypertrophied fat is removed as completely as possible (*Figures 4, 5* and *6*).

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. 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. The tourniquet is removed and the most proximal part of the upper arm is treated using 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 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 (Jobst® Elvarex BSN medical, compression class 2) is put over the interim glove after the thumb of the gauntlet has been cut off to ease the pressure on the thumb. If the gauntlet is put on straight after surgery, it can exert too much pressure on the hand when the patient is still not able to move the fingers after the anaesthesia. Operating time is, on average, two hours. An isoxazolylpenicillin or a cephalosporin is given intravenously for the first 24 hours and then in tablet form until incisions are healed, about 10–14 days after surgery.

Postoperative care

The arm is held raised by the patient herself during the hospital stay. Garments are removed two days postoperatively so that the patient can take a shower. Then, 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 she is discharged. The standard glove and gauntlet is usually changed to the made-to-measure glove at the end of the stay (*Figure 7*).

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. It also removes perspirated salt, that can cause dry and irritated skin. During the subsequent course, this rigorous compression regime, referred to as

Figure 3a. Preoperative excess volume 5380ml (left). Postoperative result after three years where excess volume is –255 ml, i.e. the treated leg is somewhat smaller than the normal one (right).

Figure 3b. Preoperative excess volume 6630ml (left). Postoperative result after two years where excess volume is 30ml (right).

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 most 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. 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 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 and a steady state is 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. 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

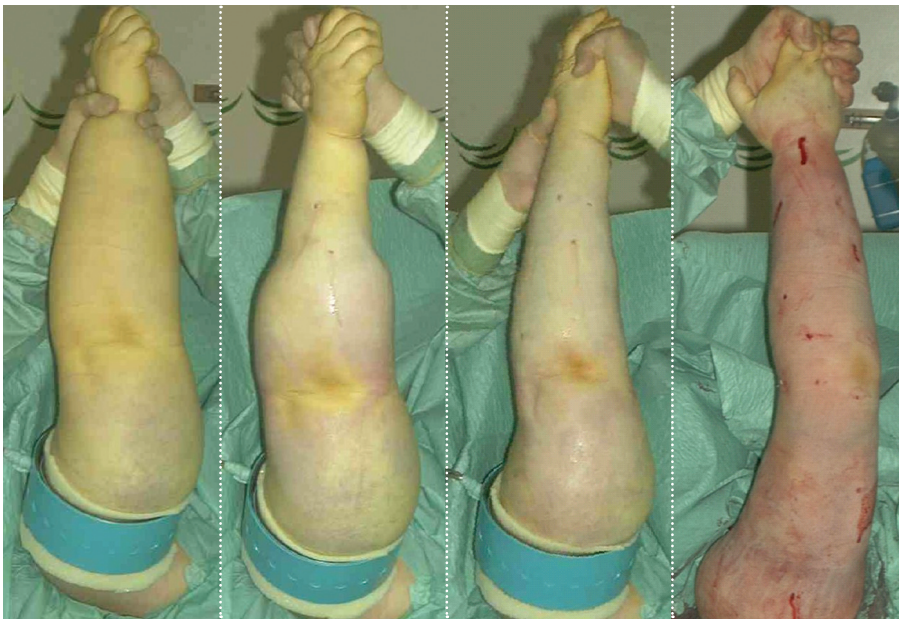

Figure 4. Liposuction of arm lymphoedema. The procedure takes about two hours. From preoperative to postoperative state (left to right). Note the tourniquet, which has been removed at the right, and the concomitant reactive hyperaemia.

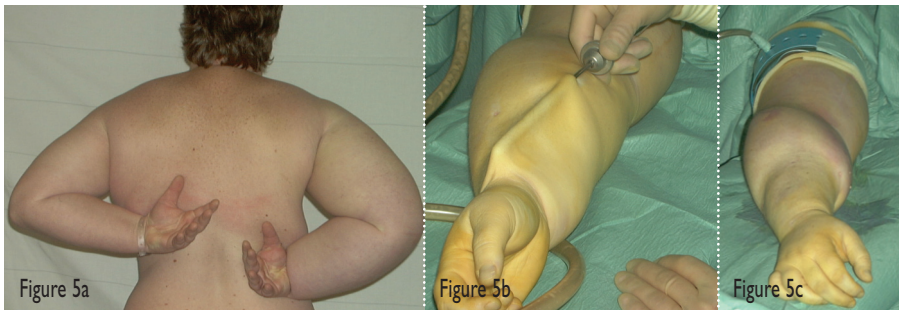

Figure 5a. Preoperative picture showing a patient with a large lymphoedema (2865ml) and decreased mobility of the right arm. Figure 5b. The cannula lifts the loose skin of the treated forearm. Figure 5c. The distal half of the forearm has been treated. Note the sharp border between treated (distal forearm) and untreated (proximal arm) area.

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 such sets can last for 2–4 months. That means that they must be prescribed 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.

CCT can also be used primarily to effectively treat a pitting oedema as an alternative to CDT, which, in contrast to CCT, comprises daily interventions (Brorson and Svensson, 1998).

Arm volume measurements

Arm volumes are recorded for each patient using the water displacement technique. The displaced water is weighed on a balance to the nearest 5g, corresponding to 5ml. Both arms are always measured at each visit, and the difference in arm volumes is designated as the oedema volume. The decrease in the oedema volume is calculated in a percentage of the preoperative value (Brorson and Svensson, 1997a).

The lymphoedema team

To investigate and treat patients with lymphoedema, a team comprising a plastic surgeon, an occupational therapist, a physiotherapist and a social welfare officer is needed. An hour is reserved for each scheduled visit to the team when arm volumes are measured, garments are adjusted or renewed, the social circumstances are assessed, and other matters of concern are discussed. The patient is also encouraged to contact the team whenever any unexpected problems arise, so that these can be tackled without delay. In retrospect, a working group such as this one seems to be a prerequisite both for thorough preoperative consideration and informing patients, and for successful maintenance of immediate postoperative improvements. The team also monitors the long-term outcome, and the authors' experience so far indicates that a visit once a year is necessary, in most cases, to maintain a good functional and cosmetic result after complete reduction.

Other liposuction techniques

Newer techniques involve ultrasonic-assisted liposuction (UAL), laser-assisted liposuction (LAL), and power-assisted liposuction (PAL). UAL and LAL generate energy that is transformed into heat that can damage the skin. The authors do not use these techniques for lymphoedema. On the other hand, PAL is of great benefit as the vibrating cannula facilitates the liposuction, especially in the leg.

How liposuction helps

For many people conservative treatment does not work well or come up to their expectations, and no matter what therapy they receive, neither conservative treatment nor microsurgical procedures can remove excess adipose tissue (Andersen et al, 2000; Campisi et al, 2006; Baumeister and Siuda, 1990; Baumeister and Frick, 2003). Subcutaneous tissue debulking seems the only option to reduce the limb volume and lead to an improvement in the patient's quality of life (Brorson et al, 2006).

Lymph transport system and liposuction

All surgery can lead to postoperative swelling due to tissue trauma and damage to the lymph and vascular systems. This swelling, depending on the type of surgery performed (ankle fractures take three to six months before the swelling disappears, free flaps tend to regenerate quickly, after a rhinoplasty, swelling can persist for more than one year, and, naturally, minor surgery, e.g. after excising a mole, leads to no swelling at all), usually disappears within a few weeks when the lymphatics regenerate

Figure 6. The aspirate contains 90–100% adipose tissue in general. This picture shows the aspirate collected from the lymphoedematous arm of the patient shown in *Figures 4, 5,* and 7 before removal of the tourniquet. The aspirate sediments into an upper adipose fraction (90%) and a lower fluid (lymph) fraction (10%).

(Slavin et al, 1997). The same goes for liposuction performed for cosmetic reasons. In patients with lymphoedema, the lymph transport is greatly reduced. To investigate the effect of liposuction on lymph transport, the author conducted an investigation using indirect lymphoscintigraphy in 20 patients with postmastectomy arm lymphoedema. Scintigraphies were performed before liposuction, with and without wearing a garment. This was repeated after three and 12 months. In conclusion, it was found that the already decreased lymph transport was not further reduced after liposuction (Brorson et al, 1998).

When to use liposuction to treat lymphoedema

A surgical approach, with the intention of removing the hypertrophied adipose tissue, seems logic when conservative treatment has not achieved satisfactory oedema reduction and the patient has subjective discomfort of a heavy arm. This condition is especially seen in chronic, large arm lymphoedemas around one litre in volume, or when the volume ratio (oedematous arm/healthy arm) = 1.3.

Liposuction should never be performed in a patient with a pitting oedema, as it is dominated by accumulated lymph which can be removed by conservative treatment. Only a lymphoedematous limb where no or minimal pitting is shown should be operated upon. By removing the excess adipose tissue, the risk of developing lymphangiosarcoma may decrease.

At the Department of Plastic and Reconstructive Surgery, Malmö University Hospital, Malmö, Sweden, the first liposuction of an arm lymphoedema was undertaken in 1987, but it was not until 1993 that a more detailed treatment protocol was established and a lymphoedema unit with a team was founded. The aim was arm lymphoedema after breast cancer treatment, as this is a large and common problem. There is no upper age limit to be accepted for surgery, but active tumour disease and ulcerations are contraindications.

Initially, lymphoedema starts as a swelling that shows pits on pressure. If treated immediately by conservative regimens the swelling can disappear. If not, or improperly treated, the swelling increases in time and can end up in an even larger pitting oedema with concomitant adipose tissue formation.

The first and most important goal is to transform a pitting oedema into a non-pitting one by conservative regimens like CDT or CCT. 'Pitting' means that a depression is formed after pressure on the oedematous tissue by the fingertip, resulting in lymph being squeezed into the surroundings (*Figure 8a*). To standardise the pitting test, one presses as hard as possible with the thumb on the region to be investigated for one minute, the amount of depression being estimated in millimetres. A swelling which is dominated by hypertrophied adipose tissue shows little or no pitting (*Figure 8b*) (Brorson, 2003).

Stemmer's sign implies that you can pinch the skin at the base of the toes or fingers with difficulty, or not at all. This is due to increased fibrosis and is characteristic for chronic lymphoedema. On the other hand, a negative sign does not exclude lymphoedema. The author has not seen any relationship between either a positive or negative sign and the occurrence of adipose tissue.

When a patient has been treated conservatively and shows no pitting, liposuction can be performed. If quality of life is low, this can be especially effective. The cancer itself is a worry, but the swollen and heavy arm introduces an additional handicap for the patient from a physical, psychosocial and psychological point of view. Physical problems include pain, limited limb movement and physical mobility and problems with clothing, thus interfering with everyday activities. Also, the heavy and swollen arm is impractical and cosmetically unappealing, all of which contribute to emotional distress (Brorson et al, 2006a).

When liposuction should never be used

Liposuction should never be performed in a patient that shows pits on pressure (*Figure 8a*) (see above). In a patient with an arm lymphoedema, the authors accept around 4–5mm of pitting, and in a leg lymphoedema 6–7mm. Patients with more pitting should be treated conservatively until the pitting has been reduced. The reason for not doing liposuction in a pitting oedema is that liposuction is a method to remove fat, not fluid, even if theoretically it could remove

Figure 7. The compression garment is removed two days after surgery to take measurements for a custom-made compression garment. A significant reduction of the right arm has been achieved, as compared with the preoperative condition seen in *Figure 5a*.

all the accumulated fluid in a pitting lymphoedema without excess adipose tissue formation.

Benefits to the patient

Liposuction improves patients' quality of life; particularly qualities associated with everyday activities, hence those that can be directly related to the complete arm oedema reduction (Brorson et al, 2006a). CCT is also beneficial, but the effect is less obvious than when combined with surgery, conceivably because the reduction of excess volume is less (Brorson and Svensson, 1998).

Skin blood flow and cellulitis after surgery

Liposuction reduces the incidence of erysipelas; the annual incidence of cellulitis was 0.4 before liposuction and 0.1 after (Brorson and Svensson 1997b). Improved local skin blood flow may be an important contributing factor to the reduced episodes of arm infection (Brorson and Svensson, 1997b). The point of bacterial entry may be a minor injury to the oedematous skin, and impaired skin blood flow may respond inadequately to counteract impending infection. Reducing the excess volume by liposuction increases skin blood flow in the arm, and decreases the reservoir of adipose tissue, which may enhance bacterial overgrowth.

Potential negative effects to the patient

Liposuction typically leads to a numbness in the skin, which disappears within three to six months. Continuous, i.e. lifelong wearing of compression garments is a prerequisite of maintaining the effect of any lymphoedema treatment and should not be considered as a negative effect.

When to perform liposuction

In all patients with arm lymphoedema treated so far at our department (n=94), the mean age of the patient at the time of surgery was 64 years (range 41–89), with a mean duration of arm swelling of nine years (range = 1–38). Mean age at breast cancer operation and mean interval between breast cancer operation and onset of lymphoedema was 52 years (34–80), and three years (0–32) respectively. The preoperative mean excess arm volume was 1729ml (570–3195) (Brorson et al, 2007c).

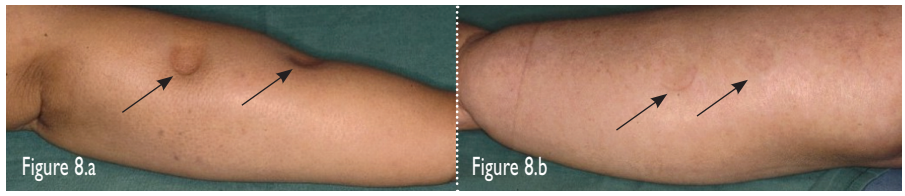

Figure 8a. Marked lymphoedema of the arm after breast cancer treatment, showing pitting several centimetres in depth (grade I oedema). The arm swelling is dominated by the presence of fluid, i.e. the accumulation of lymph. Figure 8b. Pronounced arm lymphoedema after breast cancer treatment (grade II oedema). 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.

In short, there is no age limit for performing surgery. Any patient with a non-pitting swelling that causes a considerable decreased quality of life can be a candidate for surgery. Surgery should not be performed if the patient has active cancer or wounds.

Conclusion

There need be no tension between those who favour conservative treatment and proponents of liposuction. Accumulated lymph should be removed using the well-documented conservative regimens until minimal or no pitting is seen. If there is still a significant excess volume, this can be removed by the use of liposuction. In some patients increased fibrous tissue can be present, especially in male patients and in women with a male distribution of body fat. When seen, fibrous tissue is more common in leg than in arm lymphoedema. Continuous wearing of a compression garment prevents recurrence. JL

References

Andersen L, Højris I, Erlandsen M, Andersen J (2000) Treatment of breast-cancer-related lymphedema with or without manual lymphatic drainage— a randomized study. *Acta Oncol* **39(3)**: 399–405

Bagheri S, Ohlin K, Olsson G, Brorson H (2005) Tissue tonometry before and after liposuction of arm lymphedema following breast cancer. *Lymphat Res Biol* **3(2)**: 66–80

Baumeister RG, Siuda S (1990) Treatment of lymphedemas by microsurgical lymphatic grafting: what is proved? *Plast Reconstr Surg* **85(1)**: 64–74; discussion 75–6

Baumeister RG, Frick A (2003) [The microsurgical lymph vessel transplantation]. *Handchir Mikrochir Plast Chir* **35(4)**: 202–9

Borley NR, Mortensen NJ, Jewell DP, Warren BF (2000) The relationship between inflammatory and serosal connective tissue changes in ileal Crohn's disease: evidence for a possible causative link. *J Pathol* **190(2)**: 196–202

Brorson H (2003) Liposuction in arm lymphedema treatment. *Scand J Surg* **92(4)**: 287–95

Brorson H, Ohlin K, Olsson G, Långström G, Wiklund I, Svensson H (2006a) Quality of life following liposuction and conservative treatment of arm lymphedema. *Lymphology* **39(1)**: 8–25

Brorson H, Ohlin K, Olsson G, Nilsson M (2006b) Adipose tissue dominates chronic arm lymphedema following breast cancer: an analysis using volume rendered CT images. *Lymphat Res Biol* **4(4)**: 199–210

Brorson H, Ohlin K, Olsson G, Svensson B (2007a) Liposuction of leg lymphedema: Preliminary 2 year results. *Lymphology* **40(Suppl)**: 250–2

Brorson H, Ohlin K, Olsson G, Svensson B (2007b) Long term cosmetic and functional results following liposuction for arm lymphedema: An eleven year study. *Lymphology* **40(Suppl)**: 253–5

Brorson H, Ohlin K, Olsson G, Svensson B (2007c) Liposuction of postmastectomy arm lymphedema completely removes excess volume: a thirteen year study (*Quad erat demonstrandum*). *Eur J Lymphol* **17**: 9

Brorson H, Ohlin K, Olsson G, Svensson B (2007d) Liposuction normalizes elephantiasis of the leg — a prospective study. *Eur J Lymphol* **17**: 8

Brorson H, Svensson H (1997a) Complete reduction of lymphoedema of the arm by liposuction after breast cancer. *Scand J Plast Reconstr Surg Hand Surg* **31(2)**: 137–43

Brorson H, Svensson H (1997b) Skin blood flow of the lymphedematous arm before and after liposuction. *Lymphology* **30(4)**: 165–72

Brorson H, Svensson H (1998) Liposuction combined with controlled compression therapy reduces arm lymphedema more effectively than controlled compression therapy alone. *Plast Reconstr Surg* **102(4)**: 1058–67; discussion 1068

Brorson H, Svensson H, Maly P (1995). *Treatment of benign symmetric lipomatosis of the neck with liposuction. 11th Congress of*

the International Confederation for Plastic, Reconstructive and Aesthetic Surgery. Yokohama, Kugler Publications: 325

Brorson H, Svensson H (1998) Liposuction combined with controlled compression therapy reduces arm lymphedema more effectively than controlled compression therapy alone. *Plast Reconstr Surg* **102**: 1058–67

Brorson H, Svensson H, Norrgren K, Thorsson O (1998) Liposuction reduces arm lymphedema without significantly altering the already impaired lymph transport. *Lymphology* **31(4)**: 156–72

Brorson H, Åberg M, Svensson H (2004a). Chronic lymphedema and adipocyte proliferation: Clinical therapeutic implications. *Lymphology* **37(Suppl)**: 153–5

Brorson H (2004b) Adipose tissue in lymphedema: the ignorance of adipose tissie in lymphedema. *Lymphology* **37(4)**: 135–7

Campisi C, Davini D, Bellini C, Taddei G, Villa G, Fulcheri E, et al (2006) Lymphatic microsurgery for the treatment of lymphedema. *Microsurgery* **26(1)**: 65–9

Clayton DN, Clayton JN, Lindley TS, Clayton JL (1989) Large volume lipoplasty. *Clin Plast Surg* **16(2)**: 305–12

Courtiss EH (1987) Gynecomastia: analysis of 159 patients and current recommendations for treatment. *Plast Reconstr Surg* **79(5)**: 740–53

Courtiss EH, Choucair RJ, Donelan MB (1992) Large-volume suction lipectomy: an analysis of 108 patients. *Plast Reconstr Surg* **89(6)**: 1068–79; discussion 1080–2

Goodpasture JC, Bunkis J (1986) Quantitative analysis of blood and fat in suction lipectomy aspirates. *Plast Reconstr Surg* **78(6)**: 765–72

Harvey NL, Srinivasan RS, Dillard ME, Johnson NC, Witte MH, Boyd K, Sleeman MW, Oliver G (2005) Lymphatic vascular defects promoted by Prox1 haploinsufficiency cause adult-onset obesity. *Nat Genet* **(37)10**: 1072–81

Illouz YG (1983) Body contouring by lipolysis: a 5-year experience with over 3000 cases. *Plast Reconstr Surg* **72(5)**: 591–7

Johansson K, Piller N (2007) Weight-bearing exercise and its impact on arm lymphoedema. *J Lymphoedema* **2(1)**: 15–22

Jones B, Fishman EK, Hamilton SR, Rubesin SE, Bayless TM, Cameron JC, et al (1986) Submucosal accumulation of fat in inflammatory bowel disease: CT/pathologic correlation. *Int J Comput Assist Tomogr* **10**: 759–63

Kanter WR, Wolfort FG (1988) Multiple familial angiolipomatosis: treatment of liposuction. *Ann Plast Surg* **20(3)**: 277–9

Kissin MW, Querci della Rovere G, Easton D, Westbury G (1986) Risk of lymphoedema following the treatment of breast cancer. *Br J Surg* **73(7)**: 580–4

Klein JA (1987) The tumescent technique for lipo-suction surgery. *Am J Cosmetic Surg* **4(4)**: 263–7

Klein JA (1993) Tumescent technique for local anesthesia improves safety in large-volume liposuction. *Plast Reconstr Surg* **92(6)**: 1085–100

Lantz M, Vondrichova T, Parikh H, Frenander C, Ridderstrale M, Asman P, et al (2005) Overexpression of immediate early genes in active Graves' ophthalmopathy. *J Clin Endocrinol Metab* **90(8)**: 4784–91

Mattacks CA, Sadler D, Pond CM (2005) The control of lipolysis in perinodal and other adipocytes by lymph node and adipose tissue-derived dendritic cells in rats. *Adipocytes* **1(1)**: 43–56

Olszewski WL (1991) *Lymph Stasis: Pathophysiology, Diagnosis and Treatment*. Boca Raton, Ann Arbor, Boston, London, CRC Press: 648

Piller NB, Thelander A (1998) Treatment of chronic postmastectomy lymphedema with low level laser therapy: a 2.5 year follow-up. *Lymphology* **31(2)**: 74–86

Pond CM (2005) Adipose tissue and the immune system. *Prostaglandins Leukot Essent Fatty Acids* **73(1)**: 17–30

Ridner SH (2005) Quality of life and a symptom cluster associated with breast cancer treatment-related lymphedema. *Support Care Cancer* **13(11)**: 904–11

Rohrich RJ, Mathes SJ (1990) Suction lipectomy. In: MJ Jurkiewicz, TJ Krizek, SJ Mathes and S Ariyan, eds. *Plastic Surgery: Principles and Practice*. Mosby, St. Louis: 1553

Ryan TJ (1995) Lymphatics and adipose tissue. *Clin Dermatol* **13(5)**: 493–8

Sadler D, Mattacks CA, Pond CM (2005) Changes in adipocytes and dendritic cells in lymph node containing adipose depots during and after many weeks of mild inflammation. *J Anat* **207(6)**: 769–81

Samdal F, Amland PF, Bugge JF (1995) Blood loss during suction-assisted lipectomy with large volumes of dilute adrenaline. *Scand J Plast Reconstr Surg Hand Surg* **29(2)**: 161–5

Samdal F, Amland PF, Sandsmark M, Birkeland KI (1993) Diabetic lipohypertrophy treated with suction-assisted lipectomy. *J Intern Med* **234(5)**: 489–92

Samdal F, Brevik B, Husby OS, Abyholm F (1991) A troublesom e urostomy treated with liposuction. Case report. *Scand J Plast Reconstr Surg Hand Surg* **25(1)**: 91–2

Samdal F, Myrvold HE (1992) A troublesome colostomy treated with liposuction. *Eur J Surg* **158(5)**: 323–4

Schneider M, Conway, EM, Carmeliet P (2005) Lymph makes you fat. *Nat Genet* **(37)10**: 1023–4

Segerstrom K, Bjerle P, Graffman S, Nystrom A (1992) Factors that influence the incidence of brachial oedema after treatment of breast cancer. *Scand J Plast Reconstr Surg Hand Surg* **26(2)**: 223–7

Sheehan AL, Warren BF, Gear MW, Shepherd NA (1992) Fat-wrapping in Crohn's disease: pathological basis and relevance to surgical practice. *Br J Surg* **79(9)**: 955–8

Key points

- Excess arm or leg volume without pitting implies that excess adipose tissue is present.
- Excess adipose tissue can be removed by the use of liposuction. Conservative treatment and microsurgical reconstructions cannot remove adipose tissue.
- As in conservative treatment, the lifelong use (24 hours a day) of compression garments is mandatory for maintaining the effect of surgery.
- Patients that are happy with an excess volume in the arm or leg are not candidated for liposuction.
- To date, the author has trained and approved five teams to perform liposuction for lymphoedema (Vejle Hospital, Denmark; Ninewells Hospital Dundee, Scotland, UK; Nij Smellinghe Hospital, Drachten, Holland; Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, USA; Center for Lymphatic and Venous Disorders, Stanford University School of Medicine, Falk Cardiovascular Research Center, Stanford, USA).

Slavin SA, Upton J, Kaplan WD, Van den Abbeele AD (1997) An investigation of lymphatic function following free-tissue transfer. *Plast Reconstr Surg* **99(3)**: 730–41; discussion 742–3

Vague J, Fenasse R (1965) Comparative anatomy of adipose tissue. In: Renold AE, Cahill GF, eds. *American Handbook of Physiology*. Washington DC, American Physiology Society. Section 5: 25–36

Wojnikow S, Malm J, Brorson H (2007) Use of a tourniquet with and without adrenaline reduces blood loss during liposuction for lymphoedema of the arm. *Scand J Plast Reconstr Surg Hand Surg* **41(5)**: 243–9