



Summary document on liposuction safety & recommendations

Joint BAAPS/BAPRAS expert liposuction group

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This document serves to critically review the evidence in the literature, as well as explain the differences between the lipodema population compared to the aesthetic surgery population undergoing liposuction. They are two distinct patient groups with widely differing risk and complications profiles. It also reviews the various contemporary approaches to liposuction and associated risks in the aesthetic population.

This document is divided into sections reviewing liposuction as a procedure with an initial focus on aesthetic patients, who make up the significant majority of those undergoing the procedure. Following this an in-depth review of the use of liposuction for lipodema has been undertaken as it is crucial to recognise the differences of using liposuction in these patient groups.

Recommendations and guidelines

It is important to note that these recommendations are guidelines and are not rules nor are they standards. Their aim is to identify best practice to maximise the safety of patients. Ultimately, however, the decisions are made by the treating surgeon and medical team for the individual patient, based on the evidence, their assessment of the patients, their experience and the resources available to them.

No one single liposuction technique is best suited for all patients in all circumstances. Factors such as the patient's overall health, body mass index, estimated volume of aspirate to be removed, as well as any additional procedures to be performed should be considered to determine the best technique for the individual patient.

Consent

Informed consent must be taken by the surgeon prior to surgery. Ideally consent will include the provision of written educational material (as a letter to the patient or information sheet etc.) and include a discussion with the patient that includes but is not limited to the following:

- a) The alternatives to liposuction
- b) All usual and occasional side effects and complications
- c) Patient specific risks
- d) All potentially life-threatening complications
- e) The possibility of a poor cosmetic outcome
- f) The training and experience of the treating consultant



Pre-Operative Surgical Assessment

Surgery for liposuction should not proceed, or proceed with extreme caution and justification, if any of the following conditions are identified at pre-operative assessment and not addressed:

- a) Significant medical conditions that may be aggravated by surgery or anaesthesia
- b) Clinically significant anaemia
- c) Coagulopathies
- d) Medications that interact adversely with epinephrine (adrenaline) and lidocaine (lignocaine)
- e) Local conditions of skin or subcutaneous tissue that make liposuction hazardous (e.g. certain scars, hernias and injuries)
- f) Psychological contraindications such as mood disorders, thought disorders, severe anxiety, or unrealistic expectations.

Pre-Operative Anaesthetic Assessment

For liposuction taking place under a general anaesthetic a pre-assessment patient review should be undertaken.

A face to face pre-operative anaesthetic assessment should be completed and recorded. The face to face appointment can only be undertaken by:

- a) A Pre-operative assessment registered nurse.
- b) A Cosmetic Nurse that has completed a recognised pre-operative assessment course and their competence has been assessed.

The nurse assessment must include

1. An anaesthetic assessment, prior to the day of admission. If there are any concerns then the anaesthetist should be contacted with an anaesthetic review, as appropriate.
2. If indicated by the patient's history, a full blood cell count, clotting screen and a chemistry profile, including liver function tests and any other tests deemed necessary. For larger volume liposuctions, then a G+S may also be appropriate.

Documentation of Care

The clinical records must meet the GMC standards for documentation. In addition, the clinical records should contain:

- a) The patient's pre-operative weight and height (BMI) for cases involving aspirated fat volumes of over 1 litre;
- b) The composition of the infiltration;
- c) The volumes of infiltration fluid infused;
- d) The volumes of intravenous fluid infused;
- e) The volumes of fat and fluid extracted;
- f) The size of the cannulas used;



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- g) The anatomical sites treated;
- h) The use of external or internal ultrasonic techniques, if any;
- i) The use of drains, if any;
- j) Complications encountered, if any;
- k) Post-operative garments used, if any;
- l) Pre-operative photographs;
- m) Post-operative photographs and weight at follow up;
- n) Use of sequential compression devices;
- o) Use of a body warming device

General management

For liposuction taking place under a general anaesthetic, and for cases with aspirated fat volumes over 1 litre, the following are recommended.

- Intravenous access should be initiated prior to the procedure and maintained throughout.
- Use warming blankets to preserve body core temperatures and sequential compression devices to prevent deep vein thrombosis.
- Visualization of some portion of the patient, other than the operative site, under appropriate lighting.
- VTE prophylaxis as appropriate
- Monitoring of vital signs.
- Post-operative monitoring for liposuction volumes over 1 litre
- Patient warming is advised
- Antibiotic prophylaxis suggested, however debate exists as to the requirements for this as infection rates are low and it should be a “clean” procedure
- Good operating theatre communication regarding volume of fluid aspirated and its composition
- Careful patient positioning and awareness of deeper structures

Fluid management

- Fluid management and liposuction surgery must account for maintenance requirements, pre-existing deficits and intraoperative losses of aspirated issue and third space deficit.
- Pre-existing fluid deficit should be minimal.

Infiltration

- There are various infiltration regimens described; wet (200ml-300ml per area), super-wet (1 ml infiltrate:1 ml of aspirate) and tumescent (3-4ml infiltrate:1ml aspirate). The choice of regimen depends on various factors and is determined by the surgeon.
- In large volume liposuction (>5l aspirate), it is best to limit the total volume of infiltration to avoid fluid overload.
- Epinephrine dosage for standard infiltration is normally 1mg/L



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- Local anaesthetic administered in wetting solutions in large or multiple regions has the potential to cause systemic toxicity and should therefore be used with caution.
- Consideration to the use of nerve blocks in addition to the use of general anaesthetic to reduce necessary lidocaine doses in large volume liposuction.

Aspiration

- There is no clear evidence regarding volume of infiltration or aspirate. This is further confounded by the different liposuction techniques, some of which require the significant infiltration and simultaneous aspiration of water (WAL), which have little bearing on the patient's circulating volume.
- Large volume liposuction is defined as removal of 5l or more total aspirate during a single procedure. There is no data to support specific volume maximum at which liposuction is no longer safe.
- The weight of the patient is probably the most important determinant in considering the maximum volume of fat that can be extracted safely. The volume of aspirate and fat that can be safely removed is in the order of 5-8% of the body weight. For a 100 kg patient this would equate to 8 L of aspirate. In a 60kg patient, it would be 4.8 L aspirate.
- For aesthetic liposuction, a maximum limit of 5l aspirate will usually be adequate to address the areas of concern. If further liposuction is needed, it should be considered as a separate surgery.
- High volume liposuction (over 5l) combined with other procedures has resulted in serious complications and such combination should be considered with caution.

Liposuction for Lipodema

Specific further recommendations for liposuction for lipodema include:

- Blood loss estimate should be made and confirmed with pre-operative and post-operative haemoglobin measurements. However, due to fluid shifts, haemoglobin levels may not be reliable during the first 24-hours post operatively.
- For patients with fat deposition disorders, a proposed safe limit of liposuction is 8-10 L in carefully selected patients. This is generally reserved for patients with fat deposition disorders such as lipoedema, Dercum's disease and lymphoedema and a higher BMI. It must be performed in a level 2 or 3 hospital by experienced surgeons with a specialist interest in these conditions.
- It may be in the best interest of the patient to perform large volume liposuction as separate serial procedures and to avoid combining them with additional procedures.
- Post-operative vital signs and urinary output should be monitored overnight in an appropriate facility by qualified and competent staff .
- Should be managed by surgeons with a special interest in this condition
- Should be managed in a multi-disciplinary team, including surgeon, anaesthetist and potentially physician (as appropriate), dietician (if indicated)



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- Should be managed in a hospital with high dependency facilities
- It is mandatory that patients should be psychologically assessed and screened for body dysmorphic disorder preoperatively by a suitably qualified mental health professional in managing psychological disorders

APPENDIX 1

Background to Liposuction

Liposuction (suction assisted lipectomy or SAL) refers to the closed removal of fat via suction cannulas (blunt tipped metal tubes). It can be performed under general anaesthetic (with the patient asleep) or under local anaesthetic (with the patient awake) for smaller volume fat removal. In the USA, in 2016, over 414,000 cosmetic liposuction cases were performed; a 4.6% increase since 2015 and 132% increase since 1997. Although liposuction might initially appear to be a technically simple procedure with a low risk of complications, critical analysis of the evidence demonstrates the potential for significant harm if poor patient selection, sub-optimal technical execution of the surgery or sub-optimal peri-operative patient management is employed.

The volume of fat removed during a single procedure can range from a few hundred millilitres (mls or cc) to several litres. There is no universally accepted definition of “high volume” liposuction, but this phrase often refers to volumes above 5 litres of fat removed in a single operation, although some authors refer to anything over 3.5 litres as being high volume.

A routine step in most liposuction procedures is the use of pre-liposuction fluid (referred to as infiltration) that is injected before the actual liposuction begins. This will usually consist of a saline solution containing adrenaline (to reduce blood flow) and possibly other components such as local anaesthetic.

It is important to recognise that the aspirate (what is aspirated or sucked out) that is part of the liposuction procedure is composed of a mixture of fat, some blood and frequently a degree of pre-liposuction infiltration fluid. The composition and proportions of the aspirate depends on a variety of factors, including (but not limited to) how much infiltration is used, and how long it is left in the tissues before liposuction begins. This therefore introduces variables in measuring aspiration from liposuction as the same volume (e.g. 1 litre) in two different patients may contain a widely differing amount of actual fat.



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Pre-operative safety considerations

Safety is paramount in any plastic surgery procedure, and liposuction is no exception. The clinical judgement of the physician treating the individual patient will determine the balance of surgical outcome and risk/safety profile. This will vary from patient to patient dependent on a number of factors including, but not limited to obesity, smoking history, heart disease, blood pressure issues and kidney function.

In all patients with advanced age, obesity (body mass index [BMI] > 30 kg/m²), and those with significant cardiopulmonary disease, a frank discussion is recommended with patients, their primary care physicians (GP) or cardiologists, and the anaesthetic team to determine a patient's eligibility for liposuction. This is particularly pertinent in the lipodema population (see below).

Optimal candidates for liposuction are non-smokers, who actively participate in a healthy lifestyle of diet and exercise, with a BMI < 30 and limited medical or psychological comorbidities. For patients of advanced age and those with significant co-morbidities, the plastic surgeon together with the anaesthetist and patient's primary care provider, must perform a risk stratification to determine whether the patient is a suitable candidate for liposuction.

Liposuction techniques

There are a number of techniques of liposuction and each will vary regarding the volume of pre-liposuction infiltrate required as well as amount of fat (and fluid) aspirated as well as the technical aspects of the procedure.

Dry liposuction – a no pre-liposuction infiltration is used.

Wet or superwet liposuction – a procedure where pre-infiltration is used and usually a similar volume of fat to the amount of infiltrate used is aspirated. For wet liposuction a ratio of infiltrate to aspirate is around 1:2 and for superwet, the ratio is 1:1.

Tumescent liposuction – a technique where extensive infiltration is used, often with a ratio of 3:1.

Water assisted liposuction (WAL) – a technique with a continuous flow of water into the patient that is simultaneously sucked out.

Power assisted liposuction (PAL) – mechanical vibration of a power assisted hand piece help to ease fat extraction – usually used with a super wet technique.

EVL (expansion vibration liposuction) – similar to PAL but with the power assisted hand piece used for the infiltration as well as the aspiration.

Laser and ultrasound assisted liposuction – additional technology used to dissolve the fat prior to fat extraction.



Risks in aesthetic liposuction:

Risks exist with liposuction surgery as for all surgical procedures. The following complications have been reported with liposuction:

- Bleeding (0.15%)
- Infection (0.1-0.3%)
- Aesthetic complications (uneven fat extraction resulting in contour irregularities)
- Seroma (fluid build up)
- VTE (0.06%) – blood clots such as DVTs and PEs
- Pulmonary (lung) complications (0.1%)

Other rare, but reported complications include:

- Fat embolism
- Necrotising fasciitis

It should be noted that frequently liposuction is performed not only by itself but as part of other treatment modalities such as lipoabdominoplasty (tummy tuck with liposuction) or fat grafting. The complication profile of dual procedures as one would expect is higher than in cases of liposuction alone as operative times tend to be longer and the procedure more invasive. The complications mostly relate to wound site infections (1%) and thrombotic events (0.5%) and pulmonary complications (0.3%) - being increased from 0.3%, 0.1% and 0.1% respectively.

APPENDIX 2

Specific safety concerns related to large volume liposuction (LVL)

A meta-analysis of all published literature on LVL to date (Kanapathy et al. 2020) found that the most frequently reported major complication was bleeding, requiring blood transfusion (2.89%), followed by pulmonary embolism (0.18%), haematoma (0.16%), necrotising fasciitis (0.13%) and deep vein thrombosis (0.12%).

Metabolic complications included alteration in lipid profile, glucose profile, changes in body weight and changes in haematocrit (general reduction in all) but no statistically robust analysis was possible due to the small number of studies in this arena.

Recent concerns relating to large volume liposuction specifically relate to a limited number of reported cases in which circulatory collapse has resulted. This phenomenon occurs in the immediate post operative period and can be due to either inadequate fluid resuscitation (hypovolaemic shock) or alternatively too aggressive fluid administration will result in fluid overload with pulmonary oedema (“water on the lungs”) and congestive cardiac failure (“heart overload”).



To explain in further detail:

1. Post operatively, fluid can move out of the circulating volume (blood volume) into the space vacated by the fat cells as part of the normal inflammatory process. This is known as fluid shift and can occur in large liposuction volume cases. This is also known as 'third spacing' (referring to the interstitial space between the body's tissue cells). In these situations, the fluid loss from the circulating volume might result in reduced blood flow to vital organs. Therefore, when large volume liposuction procedures are performed in an 'office' setting, with the patient sent home or to a hotel room (where they cannot be monitored for signs of circulatory collapse requiring volume correction with intra-venous fluids) these patients are vulnerable.
2. Other situations that can also lead to poor end organ oxygenation (the definition of shock) are due to anaemia from blood loss. For instance, increased bleeding might occur due to the failure of administration of adrenaline to the infiltration solution. Alternatively, further liposuction to an already emptied area of fat can result in an increased risk of bleeding (recognised by the tactile feedback from the surgical procedure as well as the aspirate changing to a bright red colour). Finally, large volume liposuction (volumes significantly in excess of 5L) will increase the risk of blood loss, particularly in situations when a real time assessment of haemoglobin and assessment of haematocrit have not been performed.
3. The final circumstance that can lead to organ failure occurs when too much infiltration has been used. This fluid overload enters the circulating volume and the patient is essentially flooded with fluid, precipitating pulmonary oedema in those with compromised cardiac function or renal function.

APPENDIX 3

Literature review

Volume of aspirate and safety:

A review of the scientific literature shows that there are no scientific data available to support a specific volume maximum at which point liposuction is no longer safe, especially when performed in the inpatient setting (Rohrich 2006; Giese; Commons; Lipschitz). However, the risk of complications may be higher as the volume of aspirate and the number of anatomical sites treated increase, and occasional deaths have been reported for patients undergoing large-volume liposuction (Talmor).

In 2009 it was the position of American Society of Plastic Surgeons (ASPS) that, regardless of the anesthetic method, large-volume liposuction (defined by ASPS as over 5000 cc of total aspirate) should be performed in an acute-care hospital or in a facility that is either accredited or licensed. Postoperative vital signs and urinary output should be monitored



overnight in an appropriate facility by qualified and competent staff members who are familiar with the perioperative care of the liposuction patient.

Adrenaline usage:

Epinephrine (adrenaline) was first introduced into wetting solutions in 1983 by Hetter et al. The typical dose is 1 ampule (1ml of 1:1000 concentration) of epinephrine per 1000 mL of isotonic fluid, resulting in a 1:1,000,000 dilution. Epinephrine's vasoconstrictive properties are key in minimising blood loss during liposuction. Maximal vasoconstriction has been shown by McKee et al to occur at 25.9 minutes, though many surgeons commonly wait 7 to 10 minutes before starting liposuction. The manufacturer recommendation for maximum epinephrine dose is 0.07 mg/kg; however, doses as high as 10 mg have been safely administered (Burk). In a study assessing epinephrine in wetting solution during liposuction, Brown et al demonstrated a peak plasma level of epinephrine at 5 hours and a total absorption of 25% to 32%. No signs or symptoms of epinephrine toxicity were seen in the patient population despite peak levels equivalent to those of major physiologic stress. Epinephrine's margin of safety may be secondary to its dilution in wetting solution, infiltration into a relatively avascular plane, local vasoconstriction, and slow delivery throughout the operation. Regardless, it should be noted that epinephrine during liposuction has been found to increase cardiac index, heart rate, and mean pulmonary arterial pressure. Therefore, as recommended above, diligent screening of patients should be performed to identify those at high risk for adverse events, as these patients are not good candidates for liposuction. This includes those with cardiovascular disease, severe hypertension, pheochromocytoma, or uncontrolled hyperthyroidism. In addition, halothane should not be given as an anaesthetic, given its effect on increasing the myocardium's sensitivity to catecholamines, potentially resulting in ventricular arrhythmias.

Risk of death

Grazer and de Jong in a North American survey of American Society for Aesthetic Plastic Surgery members found a fatality rate of 19.1 per 100,000 (0.019%) for all liposuction procedures. The major cause of death was pulmonary thromboembolism. However, a study of tumescent liposuction reported the risk of death to be zero in a series 66,000 cases (Housman). This contrasts with reports of deaths in true-awake tumescent liposuction (Lehnhardt). Major risk factors suggested for the development of severe complications (as described above) included poor standards of sterility, the infiltration of multiple litres of wetting solution, permissive postoperative discharge, and selection of unfit patients (Lehnhardt). It is worth noting that the majority of cases of death and significant morbidity in this report involved cases performed by clinicians without accreditation in plastic surgery (Lehnhardt).

Similar to the data described above, other meta analyses have shown mortality from liposuction procedures to be in the region of 1:5000 (0.02%) with the most common cause of fatality being embolism associated with thrombosis as a result of failure to apply normal anti thrombotic protocols. Lignocaine toxicity is a recognised cause of death in these studies and



it is worth noting that peak plasma levels of lignocaine typically occur 12 to 15 hours post surgery when adrenaline has been administered with the infiltration. Although adrenaline is not known to have an upper toxic level it can precipitate cardiac problems in those with underlying heart conditions.

APPENDIX 4

Lipoedema

Lipoedema (lipedema) was first described as a disease by Allen and Hines in 1940. It is now recognised by WHO as a non-inflammatory disorder of subcutaneous fat- ICD11 lipoedema (EF02) and lympho-lipoedema (BD93.1Y). The NHS describes lipoedema as a long-term (chronic) condition where there is an abnormal build-up of fat cells in the legs, thighs and buttocks, and sometimes in the arms. The feet and hands are generally unaffected, which creates a pronounced "bracelet" effect or "band-like" appearance just above the ankles and wrists. The condition is said to affect 1 in 9 women (11% of the general population). These women have a very characteristic appearance, which is the basis of the staging system.





Stage		Description
1		<ul style="list-style-type: none"> • Skin appears smooth • On palpation, the thickened subcutaneous tissue contains small nodules
2		<ul style="list-style-type: none"> • Skin has an irregular texture that resembles the skin of an orange ('peau d'orange') or a mattress • Subcutaneous nodules occur that vary from the size of walnut to that of an apple in size
3		<ul style="list-style-type: none"> • The indurations are larger and more prominent than in Stage 2 • Deformed lobular fat deposits form, especially around thighs and knees, and may cause considerable distortion of limb profile
4		<ul style="list-style-type: none"> • Lipoedema with lymphoedema (lipolymphoedema)

Table1. Lipoedema staging (UK Best Practice Guidelines - Lipoedema UK, 2017 <https://www.lipoedema.co.uk/uk-best-practice-guidelines/>. With permission from Wounds UK).



Although the accumulation of fat cells is often worse in obese people, lipoedema is not caused by obesity and can affect people who are a healthy weight. The above staging system illustrates that these patients often have a high BMI, but their BMI is directly related to the amount of fat present in their limbs and not necessarily the central body. Obesity does often exist in addition to lipoedema but in order to lose this centrally core body obesity, it is important that the lipoedema should be considered separately. Sufferers are routinely told to restrict calorie intake and increase exercise. Unfortunately, dieting and/or calorie restriction often makes little difference to lipoedema. When this fails, they are often accused of lacking motivation and compelled towards a bariatric surgery pathway. Bariatric surgery, like diet restriction, has limited effectiveness and weight quickly plateaus leaving the lipoedema largely unaffected.

The cause of lipoedema is unknown, but in most cases, there is a family history of the condition and strong genetic predisposition. Lipoedema tends to start at puberty and is exacerbated at other times of hormonal change, such as during pregnancy or the menopause, which suggests hormones may also have an influence. It only affects females.

In 2013, Fetzer A and Fetzer S. used a 240 patient survey to illustrate the difficulty patients have getting a diagnosis and referral to an appropriate clinician. Failure to diagnose is common with only 4% of GPs being aware of the condition and many plastic surgeons are surprisingly unaware of the features. Clinicians tend to consider BMI alone and not the clinical picture of disproportionate fat distribution. It is rare for a lipoedema patient to have a BMI of less than 35, as a result of the sheer weight of their limbs. Body mass index (BMI) is a measure of the ratio between weight and height. It is used widely to define and diagnose obesity and to monitor efforts to lose weight. In lipoedema, however, BMI is likely to be high



even when the person is not obese and is therefore of limited value. This is discussed extensively in a review article by Reich-Schupke et al.

This image below shows a patient who can be seen to be slim yet she has disproportionate legs and a higher BMI than expected.

Images supplied by Anne Dancey



Interestingly, patient weight does not go hand in hand with the medical problems expected in obesity. Lipoedema patients tend to be remarkably fit with no, or relatively few, medical problems. Understandably, lipoedema leads to depression, anxiety and mistrust of health care professionals. Anxiety and depression are common in this patient group.

Characteristic	Lipoedema	Lymphoedema	Obesity
Gender	• Almost exclusively female	• Male or female	• Male or female
Age at onset	• Usually 10–30 years	• Childhood (mainly primary); adult (primary or secondary)	• Childhood onwards
Family history	• Common	• Only for primary lymphoedema	• Very common
Areas affected	• Bilateral • Usually symmetrical • Most frequently affects legs, hips and buttocks; may affect arms • Feet/hands spared	• May be unilateral or bilateral depending on cause	• All parts of the body • Usually symmetrical
Effect of dieting on condition	• Weight loss will be disproportionately less from lipoedema sites	• Proportionate loss from trunk and affected limbs	• Weight reduction with uniform loss of subcutaneous fat
Effect of limb elevation	• Absent or minimal	• Initially effective in reducing swelling; may become less effective as the disease progresses	• None
Pitting oedema (Box 5, page 8)	• Absent or minor in the early stages of the disease	• Usually present but pitting may cease as the disease progresses and tissues fibrose	• No
Bruises easily	• Yes	• Not usually	• No
Pain/discomfort in affected areas	• Often • Hypersensitivity to touch in affected areas	• May be uncomfortable • No hypersensitivity to touch	• No
Tenderness of affected areas	• Often	• Unusual	• No
Skin consistency	• Normal or softer/looser	• Thickened and firmer	• Normal
History of cellulitis	• Unusual (unless lipolymphoedema is present)	• Often	• Unusual
Stemmer's sign (Box 4, page 7)	• Usually negative (unless secondary lymphoedema is present)	• Usually positive	• Usually negative

Table 2: Differentiating lipoedema from lymphoedema and obesity (UK Best Practice Guidelines - Lipoedema UK." [https://www.lipoedema.co.uk/uk-best-practice-guidelines/.](https://www.lipoedema.co.uk/uk-best-practice-guidelines/))

Leg and arm size can vary between individuals with lipoedema and the condition normally gets worse with time. As well as becoming enlarged, affected areas characteristically

- feel soft, "doughy" and cold.
- bruise easily due to leaky blood vessels.
- ache or feel excruciatingly painful or tender. Even light touch is avoided.
- have small broken veins under the skin and varicose veins.

Patients with lipoedema commonly suffer from fluid retention in their legs. This type of swelling worsens by the end of the day and may improve overnight, whereas the fatty swelling of lipoedema is constant. Harwood, Evans, Bull and Mortimer used quantitative lymphoscintigraphy to demonstrate that the pressure of the fat on the lymphatics causes decompensation and resultant lymphatic damage. This can result in permanent oedema



(lipo-lymphoedema). A consequence of not treating lipoedema patients effectively is that the condition is very likely to worsen, necessitating more surgery, with increased risks, long term joint damage and loss of mobility. Moreover, a lipoedema sufferer's mental health can also worsen.

What we do know is that there is compelling evidence that liposuction is the only effective treatment that improves patients' quality of life (QoL), pain, sensitivity, swelling, bruising, mobility and has aesthetic benefits. Anecdotally, long-term comorbidities are reduced as they no longer have degenerative osteoarthritis and require subsequent hip and knee arthroplasties.

The aims of liposuction treatment are rehabilitative and not cosmetic. As a result of treatment, there are aesthetic benefits which affect QoL. Treatment enables patients to fit in normal clothes and shoes or boots. Moreover, they feel less self-conscious with resultant psychological benefits.

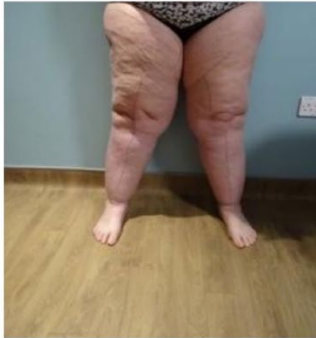
Dudek et al conducted an online study of 329 patients, using validated questionnaires. Appearance related distress and depression are directly related to quality in life in lipoedema.

Four studies found that complaint scores for impairment in QoL among lipoedema patients were significantly less after liposuction compared to preoperative values. Dadras et al. followed-up patients for a mean of 37 months and found the mean (SD) impairment in QoL score decreased significantly from a preoperative value of 8.38 (1.06) to 5.16 (1.60) ($P < 0.001$). Baumgartner et al. and Schmeller et al. reported significant reductions in impairment in QoL scores with effect sizes of 2.89 and 2.95, respectively ($P < 0.001$ in both cases). The average followed-up durations at the time of assessments were 90 months and 35 months, respectively. In the study by Rapprich et al. the results showed a reduction in mean (SD) score from 8.7 (1.7) before liposuction to 3.6 (2.5) six months after the procedure, representing significant improvement ($P < 0.001$).

It is known that lipoedema patients generally have microscopic changes in lymphatics and they have increased risk of lymphoedema. Lohrmann et al used MR lymphangiography to assess the lymphatic system of 26 lower extremities in 13 consecutive patients (5 lipoedema, 8 lipo-lymphoedema). In the 16 examined lower extremities with lipo-lymphoedema, 8 lower legs and 3 upper legs demonstrated enlarged lymphatic vessels up to a diameter of 3 mm. In two lower legs with lipo-lymphoedema, an area of dermal back-flow was seen, indicating lymphatic outflow obstruction. In the 10 examined lower extremities with clinically pure lipoedema, 4 lower legs and 2 upper legs demonstrated enlarged lymphatic vessels up to a diameter of 2 mm. This indicates there is a subclinical status of lymphoedema. In all examined extremities, the inguinal lymph nodes demonstrated a contrast material enhancement in the first image acquisition 15 min after injection, demonstrating lymphatic flow.



Lymphoedema also worsens when lipoedema gets so severe the weight of the fat damages the lymphatics, which become scarred and fibrous. It is not possible to completely reverse this damage, but liposuction has potential benefits in improving this flow.



Before surgery 1
25 November 2017



Before surgery 2 on legs
4 July 2018.



1 month post op
1 August 2018



6 weeks post 3rd leg surgery
12 January 2019

Images supplied by Anne Dancey

Two studies found that complaint scores for oedema among lipoedema patients were significantly reduced after liposuction compared to baseline. In the studies by Baumgartner et al and Schmeller et al., the mean (SD) oedema score decreased significantly from a preoperative value with effect sizes of 1.85 and 1.88, respectively ($P < 0.001$ in each case). The average followed-up durations at the time of assessments were 90 months and 35 months, respectively.



Images supplied by Anne Dancey



The only effective treatment in treating lipoedema is tumescent liposuction. If performed adequately, it stops the pain and sensitivity, bruising and swelling. It gives dramatic improvement in the shape and weight of the limbs and resolves declining mobility and easy bruising.

CADTH is the Canadian equivalent of NICE. They have conducted a comprehensive assessment of the available medical evidence supporting liposuction in lipoedema. They concluded “data from the studies indicated that in patients with lipoedema, treatment with liposuction resulted in a significant improvement of pain, sensitivity to pressure, oedema, bruising, feeling of tension, and quality of life. The patients also experienced significant reductions in size extremities and restriction of movement, and the need for conservative therapy for lipoedema. The benefits of liposuction remained even at long-term (up to 88 months) follow-up assessments. Liposuction was generally well tolerated; most adverse events occurred in <5% of patients. The clinical guideline recommends that tumescent liposuction, performed by a skilled healthcare professional at a specialized facility, be considered the treatment of choice for patients with a suitable health profile and/or inadequate response to conservative and supportive measures.”

Liposuction in limbs needs to be performed by experienced surgeons, supported by allied healthcare professionals. It is not for the inexperienced surgeon. Surgery must carefully avoid lymphatics, as well as major blood vessels and nerves. An intimate knowledge of the anatomy must be combined with careful balance of liposuction that is not too deep to disrupt lymphatics or too superficial to damage the blood supply to the skin and cause indentations. Post-operative care is also key and a lymphoedema nurse specialist with experience in lymphoedema surgery is essential. Measured compression garments are required, to reduce swelling and the risk of seroma or haematoma with wound breakdown secondary to the pressure.

Given the complex psychological problems associated with the condition, it is mandatory to exclude body dysmorphia or unrealistic expectations. Dietician input can also help to select patients that would benefit from losing weight pre-operatively. Referral to a bariatric surgeon is suitable for the select patients who have a large central component of their obesity and would benefit from weight reduction prior to surgery, to reduce risk.

MDT

Ideally, patients are discussed by an MDT team including a consultant plastic surgeon, consultant anaesthetist and lymphoedema nurse specialist . Extended members of an MDT could include physicans, dieticians, bariatric surgeons and psychologists.

BMI

Despite a higher BMI, lipoedema patients do not seem to have the comorbidities expected.



1. Diabetes

There seems to be a low risk of diabetes, despite higher body mass index (BMI): A study of 160 participants with lipoedema by Beltran K and Herbst KL. showed a low prevalence of diabetes of $6 \pm 0.2\%$ despite an average BMI of $39 \pm 12 \text{ kg/m}^2$ compared to 10.7% of women with diabetes with a similar age range.

2. Blood pressure

Pinnick et al, defined the relationship between DEXA-quantified fat depots and diabetes/cardiovascular risk factors in a healthy population-based cohort (n = 3,399). They reported that hypertension was present in less than 30% of women with Stages 2 and 3 lipoedema and not present in women with Stage 1 lipoedema. Nwankwo et al reported the results of the National Health and Nutrition Examination Survey, 2011–2012. The American National data suggests hypertension rates in women of any BMI age 40–59 year was 32.4%; higher hypertension rates of 60% were reported for obese Caucasian women mean age 63 year.

3. Normal lipid panel despite higher BMI

Mekki et al. demonstrated that lipoedema fat had lower fasting triglyceride-rich lipoprotein, and lower triglyceride levels and smaller chylomicron particle size after a mixed test meal providing 40 g triglycerides than women with android obesity. This suggests that lipoedema fat protects against abnormal blood lipids that would confer a cardiovascular risk. The majority of women with lipoedema in the study had a normal lipid profile, where only 11.7% had high total cholesterol $\geq 240 \text{ mg/dL}$ compared to 33.5% of females in the general population. and even higher percentages when females were obese.

Anaemia

Lipoedema is characterised by bruising. This is due to capillary permeability and large varicose veins which are often associated with the condition. Whilst it is common in the general population, lipoedema patients are at a high risk of vitamin D deficiency. This is linked to increased risk of infection, delayed healing, bone, back and muscle pain, fatigue and depression. It is therefore important to correct the deficiency prior to surgery. The exact aetiology of vitamin D deficiency is unknown but in part it is likely to be due to limited sunlight exposure on the limbs. This is possibly because patients are too self-conscious in public to expose their legs to sunlight.

Patients are also commonly anaemic as a result of pernicious anaemia or iron deficiency. At the pre-operative assessment, consideration should be made regarding starting a four-week course of ferrous fumarate to ensure that their haemoglobin is optimized. Consider giving patients 2 weeks of iron supplements post-surgery with rechecking of their bloods after 2 weeks.

A significant proportion of the drop in haemoglobin is due to haemodilution due to perioperative fluid administration and this would be expected to correct over the course of a



week post-surgery. The apparent haemoglobin is in fact likely to be somewhat higher than that initially recorded at 48 hours. Local guidelines regarding iron supplements and transfusion should be applied, guided by actual haemoglobin and patient symptoms.

Surgery

Large volume liposuction for lipoedema is very different to cosmetic liposuction. Not only does surgery to the limbs have higher risks and complications compared to surgery of the central body, but lipoedema patients have a recognised disease process that places them at higher risk.

Patient catheterisation should be considered once they have been anaesthetised to monitor fluid balance, ensuring that they have a good urine output and are well hydrated. Standard positioning, skin preparation and draping is performed. If the back of thighs and legs are being addressed, the patient is then may be carefully placed in the prone position. Prone positioning is a higher risk compared to supine positioning due to restriction of lung compliance, potential of corneal injury and increased airway risk. A dose of antibiotics is routinely administered in the anaesthetic room, tranexamic acid can be considered to reduce blood loss during surgery.

Operative time

On average, liposuction for lipoedema surgery can take between 3 to 4.5 hours. It is always important to reduce operative time where possible as any long procedures under general anaesthesia are linked to higher risks and complications.

Hypothermia

There is an increased risk of hypothermia in patients having large volume liposuction for lipoedema, as a result of the large areas of body surface exposed to temperature loss. Methods to reduce heat loss need to be instituted by the surgeon, anaesthetist and nurses.

Methods include:

- Pre-warming of patient,
- Limited exposure of one area at a time and operating in an organised fashion between different areas,
- Warming infiltration solutions
- Raising ambient temperature
- Limiting procedure time

It is preferable to maintain the temperature of the operating room to no less than 25°C or 77°F, even in hot climates. Whilst this is uncomfortable for staff, it is essential in reducing the complications of hypothermia. These complications include cardiac dysrhythmias, coagulopathies, oliguria, and electrolyte imbalance and an important increase in the consumption of oxygen during the chill phase. Both the hemodynamic changes and the tendency to hypothermia persist at least in the first 24 h of the postoperative phase.



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Volume of fat harvested

There is no scientific data available that support a specific maximum volume at which point liposuction is no longer safe. Complications in high volume liposuction are related to both fluid balance and bleeding. Lipoedema patients are at a higher risk of bleeding due to varicose veins and fragile capillaries. Correction of varicose veins can be considered pre-operatively to reduce this risk.

What is important is that the anaesthetist and the surgeon are vigilant for ongoing bleeding. By reviewing the volume of the lipoaspirate and the blood staining, the team are guided in establishing blood loss and total aspirate. If the surgeon experiences significant bleeding intra-operatively, which does not stop quickly, then no further liposuction should be performed. Patients should be made aware of this pre-operatively to avoid disappointment in the amount of fat harvested.

ASPS concluded that large volume liposuction can be safely performed by experienced surgeons in a hospital setting. Liposuction surgery for the rehabilitation of lipoedema patients is completely different to cosmetic liposuction and this is well documented in the literature. There are a number of plastic surgeons safely taking 8-10 litres of fat in lipoedema patients. However, this should only ever be performed in a hospital with appropriate higher care facilities.

Post-operative care

All patients should have their FBC and U+Es checked post-operatively for fluid balance shifts and anaemia. They need to be monitored carefully with fluid balance guided by the anaesthetist and surgeon. Early mobilisation is recommended, with consideration of iron supplements and anticoagulation according to local guidelines.

Complications

Liposuction is associated with mortality and morbidity. It is certainly not without risk and this unique group of patients are at an even higher risk of problems following surgery. The risk of death in cosmetic liposuction has been discussed previously. Liposuction in lipoedema, as described above, involves significantly higher volume of aspirate than aesthetic liposuction, in a more complex patient usually with co-morbidities.

Fat embolism

Fat embolism syndrome (FES) is most commonly associated with long bone and pelvic fractures, perhaps because bone marrow has high fat content. The rate of fat embolism in long bone fractures varies from 1% to 30%. However, fat globules have been detected in 67% of patients with orthopaedic injuries. Fat embolus can also arise from soft tissue trauma without fracture and from a variety of other non-traumatic and non-orthopaedic traumatic causes, including liposuction. The three most characteristic features are: respiratory distress, neurological features and skin petechiae. Respiratory distress is present in 75% of the cases and can vary from mild distress, which requires supplemental oxygen, to severe distress,



which requires mechanical ventilation. A characteristic rash can be seen in 50% of the patients and is temporary, often disappearing within one day. The mortality rate of fat-embolism syndrome is approximately 10–20%.

Diagnosis of fat embolus is based on Gurd and Wilson's criteria:

Major criteria

- Axillary or subconjunctival petechiae Hypoxaemia PaO₂ <60 mm Hg, FIO₂ = 0.4
- Central nervous system depression disproportionate to hypoxaemia Pulmonary oedema

Minor criteria

- Tachycardia more than 110 beats per minute Pyrexia more than 38.5°C
- Fat globules present in urine
- Changes in renal function (reduced urine output)
- Drop in haemoglobin values (more than 20% of the value upon admission) Drop in haematocrit values
- Drop in platelet values (more than 50% of the value upon admission) Increasing erythrocyte sedimentation rate (ESR) (greater than 71 mm per hour)
- Fat globules present in the sputum
- Emboli present in the retina on fundoscopy

A least two positive major criteria plus one minor criterion or four positive minor criteria are suggestive of fat embolism syndrome.

The pathogenesis of FES is unknown. During liposuction and fat grafting, there is rupture of small blood vessels and damage to adipocytes, producing lipid micro-fragments that can reach the venous circulation and consequently cause lung injury. Presumably lipoedema patients are at an increased risk as a result of their leaky blood vessels and large varicose veins. Liposuction-induced FES typically occurs 12 to 72 hours after surgery. There are several proposed mechanisms that cause FES and no consensus opinion to date. Once FES develops, the person should be admitted into ICU and supportive care is the only proven treatment method. Supplemental oxygen can be given if a person has mild respiratory distress. However, if there is severe respiratory distress, mechanical ventilation is indicated. Fluid replacement is required to prevent shock. Volume resuscitation with human albumin is recommended because it can restore blood volume in the circulation.



APPENDIX 5

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