

# NATIONAL INSTITUTE FOR HEALTH AND CARE EXCELLENCE

## INTERVENTIONAL PROCEDURES PROGRAMME

### Interventional procedure overview of liposuction for chronic lymphoedema

Chronic lymphoedema is the swelling and build-up of body fluid and fat, because of problems with the lymphatic system. It most commonly affects the arms and legs. Liposuction is usually used for those people for whom other conservative measures have not improved symptoms. This procedure is typically done under general anaesthesia but can be done under local anaesthesia. This procedure uses suction to remove fluid and fat through punctures in the skin. Afterwards, a compression garment must be worn for life and only removed for short periods. The aim of the procedure is to reduce swelling and improve function.

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## Abbreviations

Word or phrase	Abbreviation
Confidence interval	CI
Interquartile range	IQR
Odds ratio	OR
Quality of life	QoL
Standard deviation	SD
United Kingdom	UK
United States	US

## Introduction

The National Institute for Health and Care Excellence (NICE) prepared this interventional procedure overview to help members of the interventional procedures advisory committee (IPAC) make recommendations about the safety and efficacy of an interventional procedure. It is based on a rapid review of the medical literature and professional opinion. It should not be regarded as a definitive assessment of the procedure.

## Date prepared

This overview was prepared in July 2021 and updated in January 2022

## Procedure name

- Liposuction for chronic lymphoedema

## Professional societies

- British Association of Plastic, Reconstructive and Aesthetic Surgeons
- British Lymphology Society
- The Vascular Society of Great Britain and Ireland
- British Association of Dermatology

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## Description of the procedure

### Indications and current treatment

Lymphoedema is the abnormal accumulation of subcutaneous fluid and fat in body tissues. It leads to chronic swelling that can cause disability, pain, and cosmetic issues. Any part of the body can be affected, but the condition is most common in the arms and legs. Lymphoedema can be complicated by recurrent infection (cellulitis), which further damages the lymphatic vessels and aggravates the condition. Primary lymphoedema results from a range of conditions that affect how the lymphatic system develops and functions. Secondary lymphoedema results from damage to the lymphatic system or removal of lymph nodes by surgery, radiation, infection, or injury. Liposuction may be particularly appropriate for select people with primary lymphoedema and for people with cancer-related lymphoedema.

The current conservative treatment for lymphoedema is decongestive lymphatic therapy. This involves compression bandaging, skin care and exercise. For some people, manual lymphatic drainage massage that stimulates lymph to move away from the affected limb may also be helpful. Once decongestive lymphatic therapy sessions are stopped, the person is fitted with a custom-made compression garment, which is worn every day for life. These techniques aim to reduce the pain and discomfort associated with lymphoedema. In severe and chronic cases, in people with lymphoedema that does not respond to conservative treatment, liposuction can be used. Procedures to restore lymphatic flow from the limb, such as lymphovenous anastomosis or lymph node transfer, are less commonly used and are usually reserved for earlier-stage lymphoedema.

### What the procedure involves

Liposuction for chronic lymphoedema is usually done under general anaesthesia, but using regional nerve blockade is also possible. A tourniquet is applied to the proximal limb. A few small incisions are made in the limb. Cannulas, connected to a vacuum pump, are inserted into the incisions and oedematous adipose tissue is removed by vacuum aspiration. Liposuction is done around and all the way along the limb up to the distal border of the tourniquet. The tourniquet is then removed; the proximal limb, which is unable to be controlled by tourniquet, is infused with tumescent solution; and the fat and fluid from this area are aspirated. Immediately after liposuction, a compression bandage is applied to the limb to control any bleeding and to prevent post-surgical oedema. Antibiotics and prophylaxis against venous thromboembolism are typically prescribed before and after the operation. After the procedure, a custom-made compression garment must be worn for life to maintain the volume reduction. This garment needs to be

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revised multiple times until the oedema volume has been reduced as much as possible and a steady state has been reached, but must be worn for life.

## Outcome measures

### Lymphoedema staging

The International Society of Lymphology classifies lymphoedema into 4 stages:

- **Stage 0:** latent or subclinical condition where swelling is not yet evident despite impaired lymph transport, subtle alterations in tissue fluid/composition, and changes in subjective symptoms. It can be transitory and may exist months or years before overt oedema occurs (Stages 1 to 3).
- **Stage 1:** represents an early accumulation of fluid relatively high in protein content (for example, in comparison with ‘venous’ oedema) which subsides with limb elevation. Pitting may occur. An increase in various types of proliferating cells may also be seen.
- **Stage 2:** involves more changes in solid structures, limb elevation alone rarely reduces tissue swelling, and pitting is manifest. Later in Stage II, the limb may not pit as excess subcutaneous fat and fibrosis develop.
- **Stage 3:** encompasses lymphostatic elephantiasis where pitting can be absent and trophic skin changes such as acanthosis, alterations in skin character and thickness, further deposition of fat and fibrosis, and warty overgrowths have developed.

## Coroner – regulation 28 letter

NICE received a regulation 28 letter from a Coroner in February 2020 highlighting the absence of UK guidance relating to indications for safe practice for lipoedema-related liposuction. The coroner’s letter triggered the development of IP1843 – liposuction for chronic lipoedema, and an update of IP409/3 (IPG588) – liposuction for chronic lymphoedema.

The coroner specifically suggested guidance would be helpful in respect of:

1. the frequency of procedures on a single patient.
2. the amount of fluid to put into the patient during the procedure.
3. the amount of fluid to remove from the patient during the procedure.
4. the post procedure patient recovery plan.

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A summary of the literature relevant to these 4 points is provided in the [Coroner-Regulation 28 letter findings summary](#) in the [Safety summary](#).

## Efficacy summary

### Limb volume

In a meta-analysis of 2 studies, 25 people who had liposuction and controlled compression therapy had a statistically significant 63.95% (95% CI: 49.57 to 78.33%) greater reduction in limb volume compared with 23 people who had controlled compression therapy only at a follow up of 12 months. Furthermore, 46 people who had liposuction and controlled compression therapy had a statistically significantly greater reduction in their lymphoedema volume of 895.81 ml (95% CI: -1,140.63 to -650.98 ml) more than 23 people who had controlled compression therapy only at a follow up of 12 months (Chang, 2021).

### Limb excess volume

In a meta-analysis of 2 studies, 163 people who had liposuction and compression therapy had a statistically significant reduction in excess limb volume of 26.59% (95% CI: 18.64 to 34.54%) at a follow up of 9 to 12 months (depending on study) compared with before surgery assessment. Furthermore, in a meta-analysis of 6 studies, 256 people who had liposuction and compression therapy had a statistically significant reduction in excess limb volume of 1,524.93 ml (95% CI: 748.84 to 2,301.01 ml) at a follow up of 12 to 24 months (depending on study) compared with before surgery assessment (Chang, 2021).

A before-and-after study of 105 people reported a statistically significant decrease in excess arm volume from before surgery assessment to 2 weeks after surgery ( $p < 0.0001$ ) which was maintained to 5 years. The before surgery mean excess volume was 1,573 ml (SD 645 ml; range 570 to 3,520 ml). At 6 months follow up, the excess volume was -51 ml (SD 273 ml; range -760 to 730 ml) (Hoffner, 2018).

A before-and-after study of 130 people reported a statistically significant decrease in excess arm volume of 1,607 ml (range 570 to 3,950 ml, SD 707 ml) at before surgery assessment to -43 ml (range -945 to 1,390 ml, SD 379 ml) at 6 months follow up ( $p < 0.001$ ). This reduction persisted throughout the follow-up period, to a maximum of 18 years (Lee, 2016).

A before-and-after study of 69 people reported a decrease in mean leg excess volume from 4,372 ml (range 229 to 15,166 ml) before surgery to 1,005 ml (range 1,987 to 5,613 ml) at 3 months follow up. No test of statistical significance was

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reported. This reduction in leg excess volume was maintained to 9 years follow up (Stewart, 2018).

A before-and-after study of 23 people with arm lymphoedema reported, using circumferential measurements, a statistically significant decrease in the excess arm volume from a median of 799 ml (IQR 638 to 1,125 ml) before surgery to 60 ml (IQR -76 to 202 ml) at 1 month follow up ( $p < 0.002$ ). This excess reduction was maintained throughout the 12-month follow-up period. Similar results were obtained using perometry. Additionally, 18 people with leg lymphoedema reported, using circumferential measurements, a statistically significant decrease in excess leg volume from a median of 3,355 ml (IQR 2,843 to 5,428 ml) before surgery to 710 ml (IQR 116 to 1,450 ml) at 1 month follow up ( $p < 0.001$ ). This excess reduction was maintained throughout the 12-month follow-up period. Similar results were obtained using perometry (Granoff, 2020).

A before-and-after study of 15 people reported a mean reduction in excess extremity volume of 73% (range 48 to 94%) from before surgery assessment to a follow up of 3.1 years. No test of statistical significance was reported (Greene, 2016).

## **QoL**

### **Disease-specific QoL**

In a systematic review, 5 studies (115 people) were identified that assessed the QoL of people with lymphoedema having liposuction compared with before surgery data or with control, using disease-specific QoL instruments. Four of these studies found that people had statistically significantly improved QoL after liposuction as measured by at least 1 instrument. One study reported improved QoL, but no test of statistical significance was reported (Tang, 2021).

The before-and-after study of 23 people with arm lymphoedema reported an increase in score on the Lymphoedema Quality of Life (LYMQOL) instrument from 6.5 before surgery to 8.3 at an average follow up of 8.0 months (28% increase). Additionally, 18 people with leg lymphoedema reported an increase in LYMQOL score from 5.9 before surgery to 8.5 at an average follow up of 9.1 months (44% increase). The LYMQOL is scored on a scale from 0 (poor QoL) to 10 (excellent QoL) (Granoff, 2020).

### **General QoL**

In the systematic review, 4 studies (127 people) were identified that assessed the QoL of people with lymphoedema having liposuction either compared with before surgery data or with control, using generic QoL instruments. One of these studies

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found that people had statistically significantly improved QoL after liposuction. Four studies reported improved aspects of QoL, but no test of statistical significance was reported (Tang, 2021).

## **Cellulitis/erysipelas reduction**

The systematic review and meta-analysis identified 1 case series of 10 people that reported the before-and-after surgery prevalence of cellulitis. The prevalence of severe cellulitis was statistically significantly reduced from 70% (7/10 people) before surgery compared with 10% (1/10 people) after surgery (OR: 21.00; 95% CI: 1.78 to 248.10) (Chang, 2021).

The before-and-after study of 130 people reported a statistically significant reduction in the incidence of erysipelas from 0.47 bouts per year (range 0 to 5, SD 0.8) before surgery, to 0.06 bouts per year after surgery (87% reduction,  $p < 0.001$ ) (Lee, 2016).

The before-and-after study of 69 people reported 3 cases of cellulitis over a follow-up period of up to 9 years. Before surgery, 21 people had cases of cellulitis. No test of statistical significance was reported (Stewart, 2018).

The before-and-after study of 39 people reported 2 episodes of cellulitis in the follow-up period (0.07 episodes per year). A total of 92 episodes of cellulitis were reported before surgery (0.26 episodes per year). No test of statistical significance was reported (Granoff, 2020).

## **Safety summary**

### **Blood transfusion**

The before-and-after study of 105 people reported that 20 people needed after surgery blood transfusions (Hoffner, 2018). The need for blood transfusions differed based on the technique used. The technique used depended on when people had surgery – the first people (from 1993 to 1997) had the ‘dry’ technique without tourniquet; the authors then progressed to using the dry technique with a tourniquet; and then finally to the tumescent technique with a tourniquet.

- The first 27 people had the ‘dry’ liposuction technique without a tourniquet. Using this technique, there were 15 people that needed blood transfusions (56%).
- The next 35 people had the ‘dry’ liposuction technique with a tourniquet. Using this technique, there were 5 people that needed blood transfusions (14%).

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- The final 43 people had the tumescent liposuction technique with a tourniquet. Using this technique, there were 0 people that needed blood transfusions.

The before-and-after study of 69 people reported that 2 people needed after surgery blood transfusions (2.9%) (Stewart, 2018).

The before-and-after study of 39 people reported that 1 person needed a blood transfusion (Granoff, 2020).

The before-and-after study of 15 people reported that 2 people needed blood transfusions (13.3%). People had localised skin loss that healed secondarily (Greene, 2016).

## Infections

The following infections are reported in addition to those described in the [cellulitis/erysipelas reduction section of the efficacy summary](#).

The systematic review and meta-analysis noted that 1 case series of 8 people reported 1 case of cellulitis (Chang, 2021).

The before-and-after study of 130 people reported that, of 54 people who were not diagnosed with erysipelas before surgery, 6 had erysipelas in the follow-up period (11.1%) (Lee, 2016).

The before-and-after study of 15 people reported that 1 person had an infection that needed operative debridement (Greene, 2016).

## Skin necrosis

The before-and-after study of 69 people reported 3 cases of skin necrosis (4.3%), 1 of which needed excision and direct closure (Stewart, 2018).

## Other adverse events

### Ulcers

The systematic review and meta-analysis noted that 1 case series of 41 people reported 1 case of decubitus ulcer (Chang, 2021).

The before-and-after study of 39 people reported 3 skin ulcers secondary to garment use (7.7%). All resolved with modification of their garments (Granoff, 2020).

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## Hyperpigmentation

The systematic review and meta-analysis noted that 1 case series of 8 people reported 2 cases of hyperpigmentation (Chang, 2021).

## Peroneal nerve palsies

The before-and-after study of 69 people reported 2 cases of temporary peroneal nerve palsies because of tight compression garments (2.9%). Both resolved at 6 months after surgery (Stewart, 2018).

## Anecdotal and theoretical adverse events

In addition to safety outcomes reported in the literature, professional experts are asked about anecdotal adverse events (events they have heard about) and about theoretical adverse events (events they think might possibly occur, even if they have never happened). For this procedure, professional experts listed the following anecdotal adverse events: thromboembolism, recurrent falls (from overcompensating for their no-longer bulky limb), foot drop.

## Coroner Regulation 28 letter findings summary

### Number of procedures needed

**Summary:** 1 before-and-after study reported that for people with bilateral lower leg oedema, liposuction was done on each leg separately, with a minimum of 3 months between operations (Stewart, 2018). All other studies that reported details of the technique reported a single procedure only.

### Volume of fluid infiltrated during the procedure

**Note:** the typical procedure of liposuction for lymphoedema involves application of a tourniquet on the proximal limb, followed by liposuction of the limb distal to the tourniquet. The tourniquet is then removed, and the proximal limb, unable to be controlled by tourniquet, is infused with tumescent solution, and then aspirated. Calculating fluid balance from the figures below may be inaccurate because only some of the limb is infiltrated with fluid, but fluid from all of the limb is aspirated.

**Summary:** 4 before-and-after studies reported details about the volume of fluid infiltrated. Three studies reported infiltrating approximately 1,000 ml; 1 study reported infiltrating 1,000 ml into the arm, and 2,000 ml into the leg.

The before-and-after study of 105 people (all had arm lymphoedema) reported that, in the proximal limb unable to be controlled by tourniquet, 1,000 ml of saline

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mixed with 1 mg adrenaline and 40 ml lidocaine 2% was infiltrated (Hoffner, 2018)

The before-and-after study of 69 people (all had leg lymphoedema) reported that, in the proximal limb unable to be controlled by tourniquet, 20 ml of 0.5% levobupivacaine (5 mg/ml) and 1 mg of 1:1,000 adrenaline in 1,000 ml of Hartmann's solution was infiltrated (Stewart, 2018).

The before-and-after study of 39 people reported that the proximal limb unable to be controlled by tourniquet was tumesced with 1,000 ml (arm) or 2,000 ml (leg) of tumescent solution (Granoff, 2020).

The before-and-after study of 15 people reported that 1,000 ml of tumescent solution (1 mg 1:1,000 epinephrine, 50 ml 1% lidocaine in 1 ml of normal saline) was infused into the subcutaneous space, not to exceed 35 mg/kg of lidocaine (Greene, 2016).

### **Volume of fluid aspirated during the procedure**

**Note:** the typical procedure of liposuction for lymphoedema involves application of a tourniquet on the proximal limb, followed by liposuction of the limb distal to the tourniquet. The tourniquet is then removed, and the proximal limb, unable to be controlled by tourniquet, is infused with tumescent solution, and then aspirated. Calculating fluid balance from the figures below may be inaccurate because only some of the limb is infiltrated with fluid, but fluid from all of the limb is aspirated.

**Summary:** 4 before-and-after studies reported details about the volume of aspirate during liposuction. For people with arm lymphoedema, the mean volume of aspirate ranged from 855 ml to 1,831 ml in 3 studies. For people with leg lymphoedema, the mean volume of aspirate ranged from 2,550 ml to 4,550 ml. Of studies reporting ranges, the lowest volume of aspirate removed was 575 ml and the highest volume was 12,150 ml.

The before-and-after study of 105 people (all had arm lymphoedema) reported that the total aspirate mean volume was 1,831 ml (SD 599 ml; range 650 to 3,780 ml) for all people (Hoffner, 2018).

The before-and-after study of 69 people (all had leg lymphoedema) reported that the mean volume of aspirate was 4,550 ml (range 575 to 12,150 ml) (Stewart, 2018).

The before-and-after study of 39 people reported that for liposuction of the arm, the mean volume of aspirate removed was 855 ml (SD 398 ml). For liposuction of

the leg, the mean volume of aspirate removed was 2,550 ml (SD 907 ml). (Granoff, 2020).

The before-and-after study of 15 people reported that the mean lipoaspirate volume was 1,612 ml (range, 1,200 to 2,800 ml) for the arm and 2,902 ml (range, 2,000 to 4,800 ml) for the leg (Greene, 2016).

### **Post-procedure patient recovery plan**

**Summary:** 5 before-and-after studies reported details of the post-procedure patient recovery plan. This typically involved antibiotic prophylaxis for 7 to 11 days. Thrombosis prophylaxis was also given in 1 study. Compression garments were prescribed in 4 studies.

In addition, 2 of the guidelines/consensus statements described in [existing assessments of this procedure](#) discuss the importance of long-term, continuous compression to maintain reductions in limb excess volume (McLaughlin, 2017; Executive Committee of the International Society of Lymphology, 2020).

The before-and-after study of 105 people reported that antibiotics were given intravenously for 24 hours and then orally for approximately 10 days after surgery. Compression garments were worn 24 hours per day after surgery (Hoffner, 2018).

The before-and-after study of 130 people reported that people had isoxazole penicillin (clindamycin if allergic to penicillin) before and after surgery over 7 days (Lee, 2016).

The before-and-after study of 69 people reported that people were on bed rest and had intravenous antibiotics for the first 48 hours, then oral antibiotics for 7 days. Thrombosis prophylaxis was given daily. People wore compression garments after surgery and were remeasured after 2 weeks (Stewart, 2018).

The before-and-after study of 39 people reported that people were admitted to the hospital for after surgery for monitoring. During this time, people worked closely with physical therapy regarding garment and skin care. People with arm lymphoedema were educated on the management of hand swelling. Compression garments were worn immediately after liposuction (Granoff, 2020).

The before-and-after study of 15 people reported that operative dressings were worn for 2 to 3 days after surgery. Compression bandages were changed daily for 6 weeks when a new bandage was fitted (Greene, 2016).

## The evidence assessed

### Rapid review of literature

The medical literature was searched to identify studies and reviews relevant to liposuction for chronic lymphoedema. The following databases were searched, covering the period from their start to 30 November 2021: MEDLINE, PREMEDLINE, EMBASE, Cochrane Library and other databases. Trial registries and the Internet were also searched. No language restriction was applied to the searches (see the [literature search strategy](#)). Relevant published studies identified during consultation or resolution that are published after this date may also be considered for inclusion.

The [inclusion criteria](#) were applied to the abstracts identified by the literature search. Where selection criteria could not be determined from the abstracts, the full paper was retrieved.

### Inclusion criteria for identification of relevant studies

Characteristic	Criteria
Publication type	<p>Clinical studies were included. Emphasis was placed on identifying good quality studies.</p> <p>Abstracts were excluded where no clinical outcomes were reported, or where the paper was a review, editorial, or a laboratory or animal study.</p> <p>Conference abstracts were also excluded because of the difficulty of appraising study methodology, unless they reported specific adverse events that were not available in the published literature.</p>
Patient	People with lymphoedema.
Intervention/test	Liposuction.
Outcome	Articles were retrieved if the abstract contained information relevant to safety and/or efficacy.
Language	Non-English-language articles were excluded unless they were thought to add substantively to the English-language evidence base.

### List of studies included in the IP overview

This IP overview is based on 693 people (accounting for the overlap between Chang, 2021 and Tang, 2021, and between Hoffner, 2018 and Lee, 2016) from 1 systematic review and meta-analysis, 1 systematic review, and 5 before-and-after studies.

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Other studies that were considered to be relevant to the procedure but were not included in the main [summary of the key evidence](#) are listed in the [appendix](#).

## Summary of key evidence on liposuction for chronic lymphoedema

### Study 1 Chang DW (2021)

#### Study details

<b>Study type</b>	Systematic review, meta-analysis, and consensus conference statement*
<b>Country</b>	Not reported for individual studies
<b>Recruitment period</b>	Publication date: database inception to 2019
<b>Study population and number</b>	n=371, 9 studies Adult people with lymphoedema.
<b>Age and sex</b>	Not reported for individual studies
<b>Patient selection criteria</b>	Inclusion criteria: Adult people with primary or secondary lymphoedema. Surgical interventions for treatment of lymphoedema included lymphovenous bypass, (lymphaticovenular anastomosis), vascular lymph node transplantation, and liposuction. Studies that used a combination of techniques were included.  Exclusion criteria: Paediatric people were excluded. Other types of surgery (for example excisional) and microsurgery (for example lymph vessel transplant) used for the treatment of lymphoedema were excluded.
<b>Technique</b>	Not reported for individual studies
<b>Follow-up</b>	9 to 24 months
<b>Conflict of interest/source of funding</b>	Conflict of interest: the authors state that they do not have a financial interest in any of the products or devices mentioned. Funding source: not reported.

\*Consensus statements are described in the [Existing assessments of this procedure](#) section.

## Analysis

**Study design issues:** This systematic review and meta-analysis investigated the safety and efficacy of surgical interventions for upper and lower extremity lymphoedema. The results of this were then used by the authors to inform consensus statements. The primary outcomes were reduction in limb volume (as a percentage or in millilitres) as measured by a validated system for limb volume measurement and reduction in limb circumference (as a percentage or in centimetres).

Meta-analysis was conducted if the interventions, patient groups, and outcomes were sufficiently similar. For dichotomous outcomes obtained from case-control and cohort studies, ORs and 95% CIs were calculated. For dichotomous outcomes from randomised controlled trials, risk ratios and 95% confidence intervals were calculated. For continuous outcomes, the mean differences and 95% confidence intervals were calculated. Heterogeneity was assessed using the chi-square test. A value of  $p=0.10$  was considered statistically significant. The  $I^2$  statistic was used to quantify heterogeneity.

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## Key efficacy findings

### Limb volume

Number of people analysed: 25/46

Follow-up: 12 months

- In a meta-analysis of 2 studies, 25 people who had liposuction and controlled compression therapy had a statistically significant 63.95% greater reduction in limb volume compared to 23 people who had controlled compression therapy only (95% CI: 49.57 to 78.33%).
- In a meta-analysis of 2 studies, 46 people who had liposuction and controlled compression therapy statistically significantly reduced their lymphoedema volume by 895.81 ml more than 23 people who received controlled compression therapy only (95% CI: -1,140.63 to -650.98 ml).

### Limb excess reduction

Number of people analysed: 163/294

Follow-up: 9 to 24 months (varying between studies)

- In a meta-analysis of 2 studies (163 people), liposuction and compression therapy statistically significantly reduced excess limb volume by an average of 26.59% (95% CI: 18.64 to 34.54%).
  - In 78 people with arm lymphoedema, liposuction and compression therapy statistically significantly reduced excess limb volume by 28.68% (95% CI: 6.06 to 51.29%).
  - In 89 people with leg lymphoedema, liposuction and compression therapy statistically significantly reduced excess limb volume by 29.23% (95% CI: 5.56 to 52.90%).
- In a meta-analysis of 6 studies (256 people), liposuction and compression therapy statistically significantly reduced excess limb volume by an average of 1,524.93 ml (95% CI: 748.84 to 2,301.01 ml) *[Note: there are discrepancies in the figures quoted in the publication text and figure. The reduction in excess volume reported in the text is 1,702.44 ml (95% CI: 1,558.64 to 1,846.23 ml)].*
  - In 207 people with arm lymphoedema, liposuction and compression therapy statistically significantly reduced excess limb volume by 1,294.16 ml (95% CI: 460.47 to 2,127.85 ml) *[Note: there are discrepancies in the figures quoted in the publication text and figure. The reduction in excess volume reported in the text is 1,666.04 ml (95% CI: 1,543.97 to 1,788.10 ml)].*
  - In 49 people with leg lymphoedema, liposuction and compression therapy statistically significantly reduced excess limb volume by 2,736.60 ml (95% CI: 1,767.00 to 3,706.20 ml) *[Note: there are discrepancies in the figures quoted in the publication text and figure. The reduction in excess volume reported in the text is 2,181.22 ml (95% CI: 1,328.00 to 3,034.44 ml)].*

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## Prevalence of cellulitis

Number of people analysed: 10

Follow-up: 25 months

- One case series of 10 people with upper and lower extremity lymphoedema reported on before surgery and after surgery cellulitis.
  - Cellulitis was statistically significantly reduced after treatment with liposuction and compression therapy. The prevalence of severe cellulitis before surgery was 70% (7/10 people) compared with 10% (1/10 people) after surgery (OR: 21.00; 95% CI: 1.78 to 248.10).

## Key safety findings

The following complications were reported by the studies identified:

- Case series of 8 people reported:
  - Hyperpigmentation, n=2
  - Cellulitis, n=1
- Case series of 41 people reported:
  - Decubitus ulcer, n=1



## Study 2 Tang NSJ (2021)

### Study details

<b>Study type</b>	Systematic review
<b>Country</b>	Not reported for individual studies
<b>Recruitment period</b>	Publication date: database inception to 2020
<b>Study population and number</b>	n=196 people, 7 studies Adult people with lymphoedema.
<b>Age and sex</b>	Not reported for individual studies
<b>Patient selection criteria</b>	Inclusion criteria: (i) any form of lymphoedema as the primary indication for surgery; (ii) any form of surgical management for lymphoedema; (iii) a validated QoL tool, either generic or disease-specific, with data adequately reported; and (iv) comparisons with before surgery QoL status or appropriate control.
<b>Technique</b>	Not reported for individual studies
<b>Follow-up</b>	1 to 12 months
<b>Conflict of interest/source of funding</b>	Conflict of interest: the authors declare no conflict of interest. Funding source: not reported.

### Analysis

**Study design issues:** This systematic review investigated the effect of surgical interventions as compared to a non-operative control (including before-and-after studies that used a before surgery control) on QoL of people with lymphoedema. Outcomes included a variety of generic and disease-specific QoL instruments, including:

- Disease-specific:
  - Derriford Appearance Scale (DAS-59): 59-item questionnaire across 5 dimensions: general self-consciousness, social self-consciousness, negative self-concept, sexual and bodily self-consciousness of appearance, and facial self-consciousness of appearance. Each item scored on a scale of 1 to 5.
  - Modified Blepharoplasty Outcomes Evaluation (MBOE): 6-item questionnaire that aims to monitor people' self-perception of appearance. Each question scored on a scale of 1 to 5. A change of 2 or more points is considered significant. Higher scores indicates improved self-perception.
  - Visual Analogue Scale pain score (VAS): 'Yes' and 'No' symptoms-based questions on a visual scale graded from 0 to 100, where 0 is considered 'normal' and 100 is considered 'extreme difficulty'.

- Lymphoedema Quality of life Inventory (LyQLI): 45 items across overall QoL and 3 multi-item domains: physical, psychosocial, and practical. Each item scored from 0 to 3. Higher scores in individual domains indicate lower QoL. Higher scores in overall QoL items indicate higher QoL.
- Generic:
  - Hospital Anxiety and Depression Score (HADS): 14 items across 2 subscales that describe anxiety and depression, with each item scored from 0 to 3 depending on severity of symptoms. Assesses psychological aspects of QoL.
  - Nottingham Health Profile (NHP): 2 parts – part 1: 38 items divided into 6 categories (sleep, physical mobility, pain, energy, emotion, social); part 2: 7 statements that relate to areas of life most affected by health.
  - Patient Specific Functional Scale (PSFS): 3 to 5 items chosen by the patient that are currently limited by their condition. Each item scored from 0 to 10, with higher number indicating improved function. Average of scores provides indication of QoL.
  - Psychological General Well-Being Index (PGWBI): 22-item QoL questionnaire which produces a self-perceived evaluation of psychological well-being expressed by a summary score.
  - 36-Item Short-Form Survey (SF-36): 36 items across eight domains that describe physical and emotional dimensions:
    - Physical components: 1. physical function; 2. role physical; 3. bodily pain
    - Emotional components: 4. social function; 5. role emotional; 6. mental health
    - Joint physical + emotional components: 7. general health; 8. vitality.

## Key efficacy findings

### Disease-specific QoL

Number of people analysed: 115

Follow-up: 1 to 12 months

- Five studies were identified that reported results from disease-specific QoL instruments (Table below).

## Summary of studies reporting disease-specific QoL outcomes following liposuction

Author (year)	People, n	Follow-up	Control	QoL outcomes
Alamoudi U, Taylor B, MacKay C et al. (2018) Submental liposuction for the management of lymphedema following head and neck cancer treatment: a randomized controlled trial. <i>Journal of otolaryngology - head &amp; neck surgery</i> 47(1):22	10	6 months	No intervention; before surgery QoL	<b>MBOE:</b> Statistically significant improvement in overall summation of all 5 questions compared to control. <b>DAS-59:</b> Statistically significant improvement in overall summation of 5 categories compared to control.
Brake MK, Jain L, Hart RD et al. (2014) Liposuction for submental lymphedema improves appearance and self-perception in the head and neck cancer patient. <i>Otolaryngology - Head and Neck Surgery (United States)</i> 151: 221-225.	9	12 months	Before surgery QoL	<b>MBOE:</b> Statistically significant improvement in overall summation of all 5 questions compared to control. 4 of 5 questions statistically significant improvements. <b>DAS-59:</b> General self-consciousness of appearance subsection showed statistically significant improvement. No other subgroups demonstrated statistically significant improvement.
Brorson H, Ohlin K, Olsson G et al. (2006) Quality of life following liposuction and conservative treatment of arm lymphedema. <i>Lymphology</i> 39:8-25	35	12 months	Controlled compression therapy; before surgery QoL	<b>VAS:</b> Improved QoL regarding pain, swelling of hand, difficulties with activities of daily living at 12 months with intervention, no change in control. Improved QoL in reduced mobility, swollen arm, heavy arm, fatigue/weakness at 6, 12 months. Controlled compression therapy showed lesser changes.
Klernas P, Johnsson A, Boyages J et al. (2018) Test of Responsiveness and Sensitivity of the Questionnaire "Lymphedema Quality of Life Inventory". <i>Lymphatic research and biology</i> 16(3):300-8	50	1 month	Rehabilitation program; before surgery QoL	<b>LyQLI:</b> Intervention group showed statistically significant improvement in QoL in physical, psychosocial, practical, Item 44, Item 45 domains. Control group demonstrated statistically significant reductions in physical, psychosocial and practical domains to a limited extent. Practical, Item 44 and Item 45 domains demonstrated statistically insignificant improvements.
Schaverien MV, Munro KJ, Baker PA et al. (2012) Liposuction for	11	3 months	Before surgery QoL	<b>VAS:</b> 3-month follow-up showed statistically insignificant improvement in VAS scores from 64.60 to 81.20.

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Author (year)	People, n	Follow-up	Control	QoL outcomes
chronic lymphoedema of the upper limb: 5 years of experience. Journal of Plastic, and Reconstructive & Aesthetic Surgery: JPRAS 65: 935-942.				

## Generic QoL

Number of people analysed: 127

Follow-up: 3 to 12 months

- Four studies were identified that reported results from generic QoL instruments (Table below).

## Summary of studies reporting generic QoL outcomes following liposuction

Author (year)	People, n	Follow-up	Control	QoL outcomes (control vs. intervention)
Boyages J, Kastanias K, Koelmeyer LA et al. (2015) Liposuction for advanced lymphedema: a multidisciplinary approach for complete reduction of arm and leg swelling. Annals of surgical oncology 22: 1263-1270	21	6 months	Before surgery QoL	<b>PSFS:</b> All people reported improvement in following standardized domains vs. control. Functional impairment upper limb (UL) (11.1 vs. 22.1), lower limb (LL) (7.4 vs. 28.0). Pain UL (3.9 vs. 0.8), LL (3.7 vs. 0.2). Heaviness UL (6.7 vs. 0.3), Lower Limb (8.2 vs. 0.4). Self-consciousness UL (6.9 vs. 0.6), LL (8.2 vs. 0). Anxious UL (5.1 vs. 0.2), LL (7.2 vs. 0). Swollen UL (6.9 vs. 1.8), LL (9.0 vs. 1.6). Emotions UL (6.0 vs. 1.0), LL (7.8 vs. 0.6).
Brorson H, Ohlin K, Olsson G et al. (2006) Quality of life following liposuction and conservative treatment of arm lymphedema. Lymphology 39:8-25	35	12 months	Controlled compression therapy; before surgery QoL	<b>HADS:</b> Intervention group showed decreased anxiety at 6 months, with no change in depression. Control group showed increased anxiety at 12 months.  <b>NHP:</b> Improved in QoL in total score and domains of pain, physical mobility, housework at 6, 12 months. Emotions only improved at 6 months, with no further improvement.

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Author (year)	People, n	Follow-up	Control	QoL outcomes (control vs. intervention)
				<b>PGWBI:</b> Intervention group showed improvements in total score and general health, with no changes in other subdomains. Control group showed no changes.
Hoffner M, Bagheri S, Hansson E et al. (2017) SF-36 Shows Increased Quality of Life Following Complete Reduction of Postmastectomy Lymphedema with Liposuction. Lymphatic Research and Biology 15, 87-98.	60	12 months	Before surgery QoL	<b>SF-36:</b> 1 month after surgery – significant increase in mental health domain. 3 months after surgery – significant increase in physical functioning, bodily pain, vitality domains. 1 year after surgery – significant increase in social functioning.
Schaverien MV, Munro KJ, Baker PA et al. (2012) Liposuction for chronic lymphoedema of the upper limb: 5 years of experience. Journal of Plastic, and Reconstructive & Aesthetic Surgery: JPRAS 65: 935-942.	11	3 months	Before surgery QoL	<b>HADS:</b> 3-month follow-up showed reduction in anxiety scores (9.09 vs. 4.60) and depression scores (5.73 vs. 1.70).

## Key safety findings

No safety findings were reported.

## Study 3 Hoffner M (2018)

### Study details

<b>Study type</b>	Single arm, single centre, non-randomised, before-and-after study*
<b>Country</b>	Sweden
<b>Recruitment period</b>	1993 to 2012
<b>Study population and number</b>	n=105 People receiving liposuction for arm lymphoedema secondary to breast cancer treatment
<b>Age and sex</b>	64 years (SD 9.9 years); 100% female
<b>Patient selection criteria</b>	Inclusion criteria: (1) diagnosis of secondary arm lymphoedema following breast cancer treatment; (2) a significant excess volume, that is the volume of the affected arm was at least 10% larger than that of the unaffected arm and concomitant subjective discomfort; (3) inability of previous conservative treatment to reduce the excess volume completely; (4) no or minimal pitting (less than 5 mm) as a sign of adipose tissue hypertrophy; and (5) accustomed to the use of compression garments before surgery.
<b>Technique</b>	<p><b>Technique summary:</b> power-assisted liposuction (Lipomatic, Nutational Infrasonic Liposculpture, Euromi, Andrimont, Belgium). Between 1993 and 1997, the 'dry technique' was used. Between 1997 and 2012, a tourniquet was used in combination with the tumescence technique to minimise blood loss.</p> <p><b>Infiltration volume:</b> 1,000 ml of saline mixed with 1 mg adrenaline and 40 ml lidocaine 2% was infused subcutaneously.</p> <p><b>Aspiration volume:</b> total aspirate mean volume was 1,831 ml (SD 599 ml; range 650 to 3,780 ml) for all people. The mean volume of aspirate removed when a tourniquet was applied (n=76) was 951 ml (SD 405 ml; range 310 to 2,060) and contained 94% (SD 11%; range 58 to 100%) fat.</p> <p><b>After surgery care:</b> antibiotics were given intravenously for 24 hours and then orally for approximately 10 days after surgery. Compression garments were worn 24 hours per day after surgery.</p>
<b>Follow-up</b>	5 years
<b>Conflict of interest/source of funding</b>	Conflict of interest: the authors declared no financial interest in relation to the content of the publication. Source of funding: supported by the Swedish Cancer Society, Stockholm, Skåne County Council's Research, and the Development Foundation, and Blekinge County Council's Research and Development Foundation.

\*There was likely complete patient overlap between Hoffner, 2018 and Lee, 2016 based on the similar authorship, same recruitment period, and same centre.

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## Analysis

**Follow-up issues:** between 1993 and 2012, a total of 127 consecutive people were operated on. Twenty-two could not be followed for 5 years and were excluded from this analysis.

**Study design issues:** This single arm, single centre, non-randomised, before-and-after study evaluated the 5-year efficacy and safety of liposuction in people with secondary nonpitting arm lymphoedema. The primary efficacy outcome was excess volume reduction, calculated by water displacement. Complications were also recorded.

A parametric Student's paired t-test (2-tailed) was used to analyse differences between before and after surgery outcomes of surgery. No adjustment for multiple comparisons was performed. A p-value of less than 0.05 was considered statistically significant.

**Study population issues:** Ninety-eight people (93%) had irradiation therapy, 81 people (77%) had axillary clearance, and 74 people (70%) had both. Fifty-seven people (54%) were affected in their dominant arm.

## Key efficacy findings

### Limb excess reduction

Number of people analysed: 105

Follow-up: 5 years

- There was a statistically significant decrease in excess arm volume from before surgery assessment to 2 weeks after surgery ( $p < 0.0001$ ) which was maintained to 5 years.
  - The before surgery mean excess volume was 1,573 ml (SD 645 ml; range 570 to 3,520 ml), and the ratio between the lymphoedematous and healthy arm was 1.5 (SD 0.2; range 1.2 to 2.1).
  - At 6 months follow-up, the excess reduction was 107% (SD 22%; range, 73 to 179%) with an excess volume of -51 ml (SD 273 ml; range -760 to 730 ml), ratio between the lymphoedematous and healthy arm was 1.0 (SD 0.1; range, 0.8 to 1.2).
  - This was maintained throughout follow-up to 5 years.

## Key safety findings

Number of people analysed: 105

Follow-up: 5 years

- In the 27 people who received the 'dry' liposuction technique without a tourniquet, there were 15 people that required blood transfusions (56%).

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- In the 35 people who received the 'dry' liposuction technique with a tourniquet, there were 5 people that required blood transfusions (14%).
- In the 43 people who received the tumescent liposuction technique with a tourniquet, there were 0 people that required blood transfusions.

There were no other major or minor during or after surgery complications recorded.



## Study 4 Lee DP (2016)

### Study details

<b>Study type</b>	Single arm, single centre, non-randomised, before-and-after study*
<b>Country</b>	Sweden
<b>Recruitment period</b>	1993 to 2012
<b>Study population and number</b>	n=130, all people treated by liposuction for lymphoedema secondary to breast cancer in the lymphoedema unit, Malmö, Sweden
<b>Age and sex</b>	63 years (range 39 to 89, SD 10 years), females
<b>Patient selection criteria</b>	All people treated by liposuction for lymphoedema secondary to breast cancer.
<b>Technique</b>	<b>After surgery care:</b> people had isoxazole penicillin (clindamycin if allergic to penicillin) before and after surgery over 7 days.
<b>Follow-up</b>	Up to 18 years
<b>Conflict of interest/source of funding</b>	Conflict of interest: not reported. Funding source: Supported by the Swedish Cancer Society, the Skåne County Council's Research and Development Foundation, and the Scientific Committee of Blekinge County Council's Research and Development Foundation.

\*There was likely complete patient overlap between Hoffner, 2018 and Lee, 2016 based on the similar authorship, same recruitment period, and same centre.

### Analysis

**Follow-up issues:** The maximum before and post-liposuction observation period was 38 years and 18 years respectively.

**Study design issues:** This before-and-after study evaluated the incidence of erysipelas (superficial cellulitis) before-and-after liposuction in people with postmastectomy arm lymphoedema. The primary outcome was the incidence of erysipelas. Arm excess volume was also recorded.

Parametric t-tests were used to compare the incidence of erysipelas before-and-after liposuction.

**Study population issues:** All people except 8 had irradiation, lymphoedema onset occurred on average 2.9 years (range 0 to 32, SD 4.8) after mastectomy.

### Key efficacy findings

#### Limb excess reduction

Number of people analysed: 130

Follow-up: 6 months

- The mean before surgery excess arm volume was 1,607 ml (range 570 to 3,950 ml, SD 707 ml).

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- At follow-up, the mean excess volume was -43 ml (range -945 to 1,390 ml, SD 379 ml), corresponding to a statistically significant reduction of 109% ( $p < 0.001$ ).
  - This reduction persisted throughout the follow-up period, to a maximum of 18 years.

### **Incidence of erysipelas**

Number of people analysed: 130

Follow-up: 6.3 to 13.5 years (dependent on subgroup)

- Before surgery incidence of erysipelas: 76 people, 534 episodes over 1,147 person years – 0.47 bouts/year (range 0 to 5, SD 0.8)
- After surgery incidence of erysipelas: 16 people, 60 episodes over 983 person years – 0.06 bouts/year (range 0 to 3, SD 0.3)
- This corresponds to a statistically significant incidence reduction of 87% ( $p < 0.001$ ).

### **Key safety findings**

Number of people analysed: 130

Follow-up: 13.5 years

- Of 54 people who were not diagnosed with erysipelas before surgery, 6 (11.1%) had erysipelas in the follow-up period.

## Study 5 Stewart CJ (2018)

### Study details

<b>Study type</b>	Single arm, single centre, non-randomised, before-and-after study
<b>Country</b>	UK
<b>Recruitment period</b>	2007 to 2016
<b>Study population and number</b>	n=69 People with leg lymphoedema treated with liposuction
<b>Age and sex</b>	46 years; 90% female
<b>Patient selection criteria</b>	Inclusion criteria: a non-pitting lymphoedema of the leg and a lack of volume reduction by conservative treatment.
<b>Technique</b>	<p><b>Technique summary:</b> power-assisted liposuction (Microaire) under general anaesthesia using a tourniquet.</p> <p><b>Procedural frequency:</b> for people with bilateral lower leg oedema, liposuction was performed on each leg separately, with a minimum of 3 months between operations.</p> <p><b>Infiltration volume:</b> 20 ml of 0.5% levobupivacaine (5 mg/ml) and 1 mg of 1:1000 adrenaline in 1,000 ml of Hartmann's solution.</p> <p><b>Aspiration volume:</b> the mean volume of aspirate was 4,550 ml (range 575 to 12,150 ml), and the proportion of fat in the aspirate was 71% (range 15% to 100%).</p> <p><b>After surgery care:</b> people received bed rest and intravenous antibiotics for the first 48 hours, then oral antibiotics for 7 days. Thrombosis prophylaxis was given daily. People wore compression garments after surgery and were remeasured after 2 weeks.</p>
<b>Follow-up</b>	Up to 9 years
<b>Conflict of interest/source of funding</b>	Conflict of interest: the authors declared no conflict of interest. Funding source: not reported.

### Analysis

**Follow-up issues:** 17 people were lost to follow-up at a mean of 16 (range 6 to 48) months.

**Study design issues:** This single arm, single centre, non-randomised, before-and-after study assessed the long-term outcomes of liposuction for people with leg lymphoedema. Outcomes included limb volume, calculated by circumferential measurements, and complications.

No statistical analysis was performed.

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**Study population issues:** All people were of an International Society of Lymphology Stage 2 or 3. Forty-two legs had primary lymphoedema and 30 had secondary lymphoedema. Sixty-six people had unilateral leg oedema, and 3 people had bilateral leg oedema (1 bilateral primary, 1 bilateral secondary, and 1 initially treated for unilateral secondary lymphoedema, who subsequently developed contralateral primary lymphoedema).

## Key efficacy findings

### Limb excess reduction

Number of people analysed: 69

Follow-up: up to 9 years

- Liposuction substantially reduced the mean leg excess volume from 4,372 ml before surgery to 1,005 ml at 3 months follow-up. No test of statistical significance was reported.
- This reduction in leg excess volume was maintained to 9 years follow-up.

### Mean leg excess volume throughout the follow-up period

Assessment time	Number of legs	Mean leg excess volume, ml (range)
Before surgery	72	4,372 (229 to 15,166)
3 months	72	1,005 (1,987 to 5,613)
6 months	60	822 (1,168 to 5,161)
1 year	60	768 (761 to 4,952)
2 years	41	629 (1,088 to 3561)
3 years	31	393 (1,321 to 2,799)
4 years	24	478 (1,190 to 3,214)
5 years	15	695 (911 to 3,284)
6 years	10	549 (1,037 to 2,722)
7 years	7	801 (408 to 2,660)
8 years	6	600 (211 to 2,097)
9 years	5	406 (405 to 1,497)

### Prevalence of cellulitis

Number of people analysed: 69

Follow-up: up to 9 years

- There were 3 episodes of cellulitis in the follow-up period. Before surgery, 21 people had cases of cellulitis.

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## Key safety findings

Number of people analysed: 69

Follow-up: up to 9 years

- Temporary peroneal nerve palsies, n=2 (2.9%)
  - Due to tight compression garments; resolved at 6 months after surgery.
- Skin necrosis, n=3 (4.3%)
  - One of which required excision and direct closure.
- After surgery blood transfusion, n=2 (2.9%)
  - Neither had above average volume excess or aspirate.

## Study 6 Granoff MD (2020)

### Study details

<b>Study type</b>	Single arm, single centre, non-randomised, before-and-after study
<b>Country</b>	US
<b>Recruitment period</b>	2017 to 2020
<b>Study population and number</b>	n=39 People with chronic lymphoedema receiving liposuction
<b>Age and sex</b>	58 years (SD 14 years); 87.2% female
<b>Patient selection criteria</b>	People were selected for liposuction via a multidisciplinary evaluation. People had confirmed lymphoedema diagnosis, were appropriate surgical candidates, and had moderate-severe fat hypertrophy.
<b>Technique</b>	<p><b>Technique summary:</b> power-assisted liposuction (MicroAire Surgical Instruments, Virginia, USA) with a tourniquet.</p> <p><b>Infiltration volume:</b> the proximal limb, unable to be controlled by tourniquet, was tumesced with 1,000 (upper extremity) or 2,000 (lower extremity) ml of tumescent solution (50 ml 2% lidocaine, 1 ml epinephrine in 1,000 ml Lactated Ringers).</p> <p><b>Aspiration volume:</b> for liposuction of the arm, the mean volume of aspirate removed was 855 ml (SD 398 ml). For liposuction of the leg, the mean volume of aspirate removed was 2,550 ml (SD 907 ml).</p> <p><b>After surgery care:</b> people were admitted to the hospital for after surgery monitoring. During this time, people worked closely with physical therapy regarding garment and skin care. People with arm lymphoedema were educated on the management of hand swelling. Compression garments were worn immediately after liposuction.</p>
<b>Follow-up</b>	1 year
<b>Conflict of interest/source of funding</b>	<p>Conflict of interest: the authors report that they have no financial disclosures or conflicts of interest.</p> <p>Funding source: the authors reported that they did not receive any funding for this study.</p>

## Analysis

**Study design issues:** This single arm, single centre, non-randomised, before-and-after study assessed the efficacy and safety of liposuction in people with lymphoedema. Outcomes included excess volume reduction (measured by both circumferential measurement and perometry), QoL (using the LYMQOL instrument), and complications. The LYMQOL is scored on a scale from 0 (poor QoL) to 10 (excellent QoL).

Before and after surgery data were compared using paired Wilcoxon signed-rank tests.  $p < 0.05$  was considered statistically significant.

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**Study population issues:** The main aetiology of lymphoedema was cancer-related (84.6%), 63.6% of which was secondary to breast cancer, 33.3% to gynaecologic cancer, and 3.0% to Hodgkin's Lymphoma. Of lymphoedema cases that were not secondary to cancer (15.4%), the primary aetiology was congenital (66.7%).

## Key efficacy findings

### Limb excess reduction

#### Arm lymphoedema

Number of people analysed: 23

Follow-up: up to 1 year

- By circumferential measurement, there was a statistically significant decrease in the excess arm volume from a median of 799 ml (IQR 638 to 1,125 ml) before surgery to 60 ml (IQR -76 to 202 ml) at 1 month follow-up ( $p < 0.002$ ). This was maintained throughout the follow-up period where median excess volume reduction by circumferential measurement was 93% at 1 month ( $n=19$ ,  $p=0.002$ ), 107% at 3 months ( $n=17$ ), 111% at 6 months ( $n=16$ ), and 116% at 12 months ( $n=8$ ).
- By perometry, there was a there was a statistically significant decrease in the excess arm volume from a median of 1,038 ml (IQR 763 to 1,273 ml) before surgery to 44 ml (IQR -27 to 246 ml) at 1 month follow-up ( $p < 0.001$ ). This was maintained throughout the follow-up period where median excess volume reduction by perometry was 96% at 1 month ( $n=19$ ,  $p < 0.001$ ) and 3 months, 108% at 6 months, and 116% at 12 months.

#### Leg lymphoedema

Number of people analysed: 18

Follow-up: up to 1 year

- By circumferential measurement, there was a statistically significant decrease in the excess leg volume from a median of 3,355 ml (IQR 2,843 to 5,428 ml) before surgery to 710 ml (IQR 116 to 1,450 ml) at 1 month follow-up ( $p < 0.001$ ). This was maintained throughout the follow-up period where median excess volume reduction by circumferential measurement was 79% at 1 month ( $n=12$ ,  $p < 0.001$ ), 78% ( $n=10$ ) at 3 months, 82% at 6 months ( $n=7$ ), and 115% at 12 months ( $n=5$ ).
- By perometry, there was a there was a statistically significant decrease in the excess leg volume from a median of 3,360 ml (IQR 2,791 to 4,639 ml) before surgery to 506 ml (IQR -27 to 1,242 ml) at 1 month follow-up ( $p < 0.001$ ). This was maintained throughout the follow-up period where median excess volume reduction by perometry was 85% at 1 month ( $n=12$ ,  $p < 0.001$ ), 87% at 3 months, 91% at 6 months, and 104% at 12 months.

## Quality of life

### Arm lymphoedema

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Number of people analysed: 23

Follow-up: 8.0 months

- The mean overall QoL reported at the before surgery visit was 6.5 versus 8.3 (28% increase) at the last point of contact with the person, which on average was 8.0 months after surgery.

### **Leg lymphoedema**

Number of people analysed: 18

Follow-up: 9.1 months

- The mean overall QoL reported at the before surgery visit was 5.9 versus 8.5 (44% increase) at the last point of contact with the person, which on average was 9.1 months after surgery.

### **Incidence of cellulitis**

Number of people analysed: 39

Follow-up: Up to 12 months

- There were 2 episodes of cellulitis in the follow-up period (0.07 episodes per year). A total of 92 episodes of cellulitis were reported before surgery (0.26 episodes per year).

### **Key safety findings**

Number of people analysed: 39

Follow-up: Up to 12 months

- Blood transfusion, n=1
- Skin ulcers secondary to garment use, n=3 (7.7%)
  - All resolved with modification of their garments.



## Study 7 Greene AK (2016)

### Study details

<b>Study type</b>	Single arm, single centre, non-randomised, before-and-after study
<b>Country</b>	US
<b>Recruitment period</b>	2007 to 2015
<b>Study population and number</b>	n=15 People with primary and secondary lymphoedema
<b>Age and sex</b>	Mean 45 years (17 to 71); 80% female
<b>Patient selection criteria</b>	People that had liposuction for lymphoedema between 2007 and 2015 that had after surgery follow-up.
<b>Technique</b>	<p><b>Technique summary:</b> standard or power-assisted tumescent liposuction under general anaesthesia.</p> <p><b>Infiltration volume:</b> tumescent solution (1 mg 1:1000 epinephrine, 50 ml 1% lidocaine in 1,000 ml of normal saline) was infused into the subcutaneous space, not to exceed 35 mg/kg of lidocaine.</p> <p><b>Aspiration volume:</b> mean lipoaspirate volume was 1,612 ml (range, 1,200 to 2,800 ml) for the arm and 2,902 ml (range, 2,000 to 4,800 ml) for the leg.</p> <p><b>After surgery care:</b> operative dressings were worn for 2 to 3 days after surgery. Compression bandages were changed daily for 6 weeks when a new bandage was fitted.</p>
<b>Follow-up</b>	Mean 3.1 years
<b>Conflict of interest/source of funding</b>	Conflict of interest: the authors declared no conflicts of interest. Funding source: the authors declared no funding source.

### Analysis

**Study design issues:** This single arm, single centre, non-randomised, before-and-after study evaluated the efficacy and safety of liposuction for people with lymphoedema. Outcomes included improvement in symptoms, reduction of limb volume (calculated by water displacement), and complications.

No statistical analysis was performed.

**Study population issues:** 6 people had secondary upper extremity lymphoedema after breast cancer treatment and 8 people had primary lower limb lymphoedema, 1 person had obesity-induced lymphoedema of the leg and 8 people had a history of repeated cellulitis involving the lymphoedematous extremity.

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## Key efficacy findings

### Limb excess reduction

Number of people analysed: 15

Follow-up: mean 3.1 years

- The mean reduction in excess extremity volume was 73% (range 48 to 94%).

## Key safety findings

Number of people analysed: 15

Follow-up: mean 3.1 years

- Blood transfusion, n=2 (13.3%)
  - People had localised skin loss that healed secondarily.
- Infection that required operative debridement, n=1

## Validity and generalisability of the studies

- The studies were broadly similar regarding patient age and sex.
- There may be differences in the liposuction technique between studies pooled in the meta-analysis, including those that use power-assisted or standard liposuction, and those that use 'dry' or tumescent liposuction.
- CE marked devices were used in at least 3 studies. Studies included in the systematic reviews may have used CE-marked devices, but this information was not reported.
- Studies were conducted in the UK, Sweden, and the US. The majority of the evidence came from outside of the UK. There may exist differences in clinical practice that prevent generalisation of these study findings to a UK context.
- All studies had a before-and-after design. There were no randomised experimental studies identified.
- The longest follow-up assessment was 18 years.

## Existing assessments of this procedure

In 2021, results of consensus conference on the surgical treatment of lymphoedema were published (Chang, 2021). Consensus statements were informed by a systematic review and meta-analysis. The results of this meta-analysis are described in Chang, 2021, in the [Summary of key evidence](#). The strength of recommendations was assessed by the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) framework, where recommendations are classified as strong (grade 1) or weak (grade 2). Recommendations were further classified as A, B, or C based on the quality of evidence informing the recommendation. There were 2 recommendations made relevant to this procedure:

- Debulking procedures such as liposuction are effective in addressing nonfluid component such as fat involving lymphoedema (grade 1C).
- There is a role for liposuction combined with physiologic procedures, although the timing of each procedure is currently unresolved (grade 1C).

In 2020, the Executive Committee of the International Society of Lymphology published a consensus update on the diagnosis and treatment of peripheral lymphoedema (Executive Committee of the International Society of Lymphology, IP overview: Liposuction for chronic lymphoedema

2020). This update was based on discussions at several International Congress of Lymphology meetings. The consensus statement notes that 'liposuction (or suction-assisted lipectomy) using a variety of methods has been shown to completely reduce non-pitting, primarily non-fibrotic, extremity lymphedema due to excess fat deposition (which has not responded to non-operative therapy) in both primary and secondary lymphoedema'. Further, that 'even patients with signs of fibrosis can benefit from the procedure when using power-assisted liposuction'. The statement cautions that 'this surgical technique and follow-up are very different from cosmetic liposuction and should be performed by an experienced team' and that liposuction 'does not alter the need for compression therapy beyond appropriate garment after surgery'.

In 2017, the American Society of Breast Surgeons published recommendations from an expert panel on the diagnosis, prevention, and treatment of breast cancer-related lymphoedema (McLaughlin, 2017). The expert panel agree that 'lymphatic liposuction with long-term compression is effective for severe late-stage breast cancer-related lymphoedema unresponsive to conservative management.'

In 2011, the Institut national d'excellence en santé et en services sociaux (INESSS) published a systematic review on treatment of cancer-related secondary lymphoedema (Larouche, 2011). The report notes that 'liposuction may be somewhat effective for a very specific type of secondary lymphedema, especially advanced stage 2 lymphoedema'. However, the report cautions that, at the time of publication, liposuction 'treatment is still experimental' and that 'it is essential for patients to wear compression garments permanently (24 hours a day) after the operation to maintain volume reductions.'

## Related NICE guidance

Below is a list of NICE guidance related to this procedure.

### NICE guidelines

- Advanced breast cancer: diagnosis and treatment. NICE Clinical guideline [CG81] (2009; last updated 2017). Available from: <https://www.nice.org.uk/guidance/cg81>
- Early and locally advanced breast cancer: diagnosis and management. NICE guideline [NG101] (2018). Available from: <https://www.nice.org.uk/guidance/ng101/>

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## **Additional information considered by IPAC**

### **Professional experts' opinions**

Expert advice was sought from consultants who have been nominated or ratified by their professional Society or Royal College. The advice received is their individual opinion and is not intended to represent the view of the society. The advice provided by professional experts, in the form of the completed questionnaires, is normally published in full on the NICE website during public consultation, except in circumstances but not limited to, where comments are considered voluminous, or publication would be unlawful or inappropriate. Three Professional expert questionnaires for liposuction for chronic lymphoedema were submitted and can be found on the [NICE website](#).

### **Patient organisation opinions**

Patient organisation submissions for liposuction for lipoedema were received and can be found on the [NICE website](#).

### **Patient commentators' opinions**

NICE's Public Involvement Programme sent questionnaires to NHS trusts for distribution to patients who had the procedure (or their carers). NICE received 10 completed questionnaires. The patient commentators' views on the procedure were consistent with the published evidence and the opinions of the professional experts.

### **Company engagement**

A structured information request was sent to 1 company who manufacture a potentially relevant device for use in this procedure. NICE received 1 completed submission. This was considered by the IP team and any relevant points have been taken into consideration when preparing this overview.

### **Issues for consideration by IPAC**

- The procedure is followed with non-surgical management, specifically the use of compression garments. The requirement for continuation of this treatment is not always adequately described and needs to be lifelong for optimal volume reduction.

## References

1. Chang DW, Dayan J, Greene AK et al. (2021) Surgical Treatment of Lymphedema: A Systematic Review and Meta-Analysis of Controlled Trials. Results of a Consensus Conference. *Plastic and reconstructive surgery* 147(4);975-93
2. Tang NSJ, Ramakrishnan A, and Shayan R. (2021) Quality-of-life outcomes after operative management of primary and secondary lymphoedema: a systematic review. *ANZ journal of surgery*
3. Hoffner M, Ohlin K, Svensson B et al. (2018) Liposuction Gives Complete Reduction of Arm Lymphedema following Breast Cancer Treatment-A 5-year Prospective Study in 105 Patients without Recurrence. *Plastic and reconstructive surgery. Global open* 6(8)
4. Lee D, Piller N, Hoffner M et al. (2016) Liposuction of postmastectomy arm lymphedema decreases the incidence of erysipelas. *Lymphology* 49, 85-92
5. Stewart CJ and Munnoch DA. (2018) Liposuction as an effective treatment for lower extremity lymphoedema: A single surgeon's experience over nine years. *Journal of plastic, reconstructive & aesthetic surgery: JPRAS* 71(2):239-45
6. Granoff MD, Lee BT, Singhal D et al. (2020) A Single Institution Multi-Disciplinary Approach to Power-Assisted Liposuction for the Management of Lymphedema. *Annals of surgery*
7. Greene AK and Maclellan Reid A. (2016) Operative treatment of lymphedema using suction-assisted lipectomy. *Annals of Plastic Surgery* 77:337-340.
8. Executive Committee of the International Society of Lymphology. (2020) The diagnosis and treatment of peripheral lymphedema: 2020 consensus document of the International Society of Lymphology. *Lymphology* 49(4):170-84
9. McLaughlin SA, DeSnyder SM, Klimberg S et al. (2017) Considerations for Clinicians in the Diagnosis, Prevention, and Treatment of Breast Cancer-Related Lymphedema, Recommendations from an Expert Panel: Part 2: Preventive and Therapeutic Options. *Annals of Surgical Oncology* 24(10):2827-35
10. Larouche K and Witty MF (2011) Treatment of cancer-related secondary Lymphedema. *ETMIS* 7(3)

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## Literature search strategy

Databases	Date searched	Version/files
Cochrane Database of Systematic Reviews – CDSR (Cochrane Library)	30/11/2021	Issue 11 of 12, November 2021
Cochrane Central Database of Controlled Trials – CENTRAL (Cochrane Library)	30/11/2021	Issue 11 of 12, November 2021
International HTA database (INAHTA)	30/11/2021	-
MEDLINE (Ovid)	30/11/2021	1946 to November 29, 2021
MEDLINE In-Process (Ovid)	30/11/2021	1946 to November 29, 2021
MEDLINE Epubs ahead of print (Ovid)	30/11/2021	November 29, 2021

### Trial sources searched

- Clinicaltrials.gov
- ISRCTN
- WHO International Clinical Trials Registry

### Websites searched

- National Institute for Health and Care Excellence (NICE)
- NHS England
- Food and Drug Administration (FDA) - MAUDE database
- Australian Safety and Efficacy Register of New Interventional Procedures – Surgical (ASERNIP – S)
- Australia and New Zealand Horizon Scanning Network (ANZHSN)
- General internet search

### MEDLINE search strategy

The MEDLINE search strategy was translated for use in the other sources.

Number	Search term
1	Lymphedema/
2	(lymphoed* or lymphoo* or lymphed*).tw.
3	(lymph* adj4 (edema* or oedema* or cyst* or fluid*)).tw.
4	((nonne-milroy* or milroy* or meige*) adj4 (diseas* or syndrome*)).tw.
5	Lymphocele/
6	lymphocel*.tw.
7	(Lymphatic adj4 (obstruct* or disrupt* or impair* or dysfunct* or insufficien* or malfunction* or block* or compromise*)).tw.
8	(fluid adj4 (drain* or block* or retent* or build-up* or buildup* or accumulat*)).tw.
9	(subcutaneous* adj4 (adipos* or fat*) adj4 (build-up* or buildup* or disorder* or disease* or increase* or deposit* or depot* or collect*)).tw.

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10	((fat* or adipos*) adj4 (tissue* or cell*) adj4 (swell* or swollen or enlarge* or build-up* or buildup* or disorder* or disease*)).tw.
11	or/1-10
12	Lipectomy/
13	(lipectom* or lipoplast* or lipolysis or liposuction* or lipo-suction*).tw.
14	adipectom*.tw.
15	dermolipectom*.tw.
16	(fat* adj4 (suction* or excision* or remov*)).tw.
17	Adipose Tissue/su
18	(adipose tissue adj4 surg*).tw.
19	plastic surgery/
20	((plastic or cosmetic or esthetic) adj4 surger*).tw.
21	or/12-20
22	11 and 21
23	CA-Mi Hospivac*.tw.
24	Vitruvian infiltration pump*.tw.
25	Vacusat power*.tw.
26	or/23-25
27	22 or 26
28	animals/ not humans/
29	27 not 28
30	limit 29 to english language
31	limit 30 to ed=20170302-20210531

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## Appendix

The following table outlines the studies that are considered potentially relevant to the IP overview but were not included in the [summary of the key evidence](#). It is by no means an exhaustive list of potentially relevant studies.

### Additional papers identified

Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
Agko M, Ciudad P, and Chen HC. (2018) Staged surgical treatment of extremity lymphedema with dual gastroepiploic vascularized lymph node transfers followed by suction-assisted lipectomy-A prospective study. Journal of Surgical Oncology 117(6):1148-56	n=12  FU=23.5 months	Vascularised lymph node transfer followed by suction-assisted lipectomy can allow people with late Stage 2 lymphoedema achieve near normal limb size and eradication of infectious episodes. At follow-up, these desirable outcomes were maintained well after discontinuation of compression therapy. Complications included blood transfusion and transient numbness.	Studies with more people and longer follow-up included. Combination of surgical techniques used. No new safety outcomes reported.
Alamoudi U, Taylor B, MacKay C et al. (2018) Submental liposuction for the management of lymphedema following head and neck cancer treatment: a randomized controlled trial. Journal of otolaryngology - head & neck surgery 47(1):22	n=10  FU=6 months	There was a statistically significant improvement in people' self-perception of appearance and statistically significant subjective scoring of appearance following submental liposuction.	Studies with more people and longer follow-up included. Included in the Tang, 2021 systematic review.
Al-Farhan AH, Allawi BSA, Wais	n=15	Liposuction assisted brachioplasty has a lower	Studies with more people and

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
MM et al. (2020) Liposuction assisted brachioplasty, evaluation of its efficacy and safety. Archivos Venezolanos de Farmacologia y Terapeutica 39(7):884-9	FU=1 year	complication rate than the standard procedure (without liposuction) and has better aesthetic and functional satisfaction.	longer follow-up included. No new safety outcomes reported.
Bolletta A, Di Taranto G, Chen SH et al. (2020) Surgical treatment of Milroy disease. Journal of Surgical Oncology 121(1):175-81	n=4 FU=20.2 months	Vascularised lymph node transfer together with therapeutic lipectomy proved to be a reliable technique in moderate cases of Milroy disease, providing an alternative path for lymph drainage, and reducing the lymph load and the excess of subcutaneous adipose tissues, thus improving patients' quality of life.	Studies with more people and longer follow-up included. Combination of surgical techniques used. No new safety outcomes reported.
Boyages J, Kastanias K, Koelmeyer LA et al. (2015) Liposuction for advanced lymphedema: a multidisciplinary approach for complete reduction of arm and leg swelling. Annals of surgical oncology 22: 1263-1270.	n=21 FU=1 year	All people had improved symptoms and function. Bioimpedance spectroscopy showed reduced but ongoing extracellular fluid, consistent with the underlying lymphatic pathology. Liposuction is a safe and effective option for carefully selected people with advanced lymphoedema. Assessment, treatment, and follow-up by a multidisciplinary team is essential.	Studies with more people and longer follow-up included.

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
Brake MK, Jain L, Hart RD et al. (2014) Liposuction for submental lymphedema improves appearance and self-perception in the head and neck cancer patient. <i>Otolaryngology - Head and Neck Surgery (United States)</i> 151: 221-225.	n=9  FU=12 months	Submental liposuction improves the appearance and quality of life for head and neck cancer patients suffering from posttreatment lymphoedema by way of improving their self-perception and self-confidence.	Studies with more people and longer follow-up included. Included in the Tang, 2021 systematic review.
Brazio PS and Nguyen DH. (2021) Combined Liposuction and Physiologic Treatment Achieves Durable Limb Volume Normalization in Class II-III Lymphedema: A Treatment Algorithm to Optimize Outcomes. <i>Annals of plastic surgery</i> 86(5):s384-s389	n=21  FU=mean 250 to 301 days, dependent on type of therapy received.	People with predominantly nonpitting presentation benefit from liposuction to maximize removal of fibroadipose tissue and optimize after surgery compression, followed by lymphovenous anastomosis or Vascularised lymph node transfer to improve lymphatic drainage.	Studies with more people and longer follow-up included. No new safety outcomes reported.
Brorson H (2012) Pitting and non-pitting lymphedema: The presence of adipose tissue in lymphedema. <i>European Journal of Lymphology and Related Problems</i> 23: 27-28.		Liposuction can be performed in people who do not respond to conservative management or microsurgical reconstruction because the hypertrophy of the subcutaneous adipose tissue cannot be removed or reduced by these techniques. The long-term	Studies with more people and longer follow-up included.

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
		results of liposuction for chronic large postmastectomy arm lymphoedema (17 years) and primary and secondary leg lymphoedema (8 years) leading to complete reduction, without recurrence, will be described.	
Brorson H, Ohlin K, Olsson G, et al. (2008) Controlled compression and liposuction treatment for lower extremity lymphedema. <i>Lymphology</i> 41: 52-63.	n=1	This paper explains the authors philosophical approach: a pitting lymphoedema first should be treated conservatively to remove excess fluid, then liposuction can be performed to remove remaining excess volume bothersome to the person.	No new safety or efficacy outcomes. Studies with more patients included.
Brorson H, and Svensson H (1998) Liposuction combined with controlled compression therapy reduces arm lymphedema more effectively than controlled compression therapy alone. <i>Plastic and reconstructive surgery</i> 102, 1058-67, discussion 1068	n=28 FU=1 year	Liposuction combined with controlled compression therapy reduces arm lymphoedema more efficiently than the therapy alone. Continued use of compression garments is, however, important to maintain the primary surgical outcome.	Studies with more people and longer follow-up included.

Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
Brorson H (2000) Liposuction gives complete reduction of chronic large arm lymphedema after breast cancer. Acta oncologica (Stockholm, and Sweden) 39, 407-20	n=20  FU=1 year	The use of a compression garment after liposuction is necessary in order to maintain the normalised arm volume. Liposuction and combined compression therapy did not affect the already impaired lymph transport; it merely increased skin microcirculation. A reduced incidence of cellulitis was noted.	Studies with more people and longer follow-up included.
Campisi CC et al. (2016) Fibro-lipo-lymph-aspiration with a lymph vessel sparing procedure to treat advanced lymphedema after multiple lymphatic-venous anastomoses: the complete treatment protocol. Annals of Plastic Surgery 00: 1-7.	n=146  FU=1 year	Liposuction is efficient. An entire leg can be completed within 90 minutes. Recovery time is short, and cosmetic results are immediate. More importantly, the removal of excess tissue is completed without further damage to lymphatic vessels.	Study is included in the Chang, 2021 systematic review.
Carl HM, Walia G, Bello R et al. (2017) Systematic Review of the Surgical Treatment of Extremity Lymphedema. J Reconstr Microsurgery.	n=105 people, 4 studies  FU=12 to 38 months	This systematic review and meta-analysis evaluated literature on surgical treatment of extremity lymphoedema. Four studies were identified that used liposuction. The weighted excess volume reduction was 96.6% (95% CI: 86.2 to 107%, I <sup>2</sup> : 0.0%). Three studies reported better patient QoL outcomes after surgery. There were no complications reported.	More recent systematic review and meta-analysis included.

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
Cook KH, Park MC, Lee IJ et al. (2016) Vascularized Free Lymph Node Flap Transfer in Advanced Lymphedema Patient after Axillary Lymph Node Dissection. Journal of Breast Cancer 19, 92-5	n=1  FU=1 year	In this study, a two-stage operation in a person with advanced lymphoedema was done. First, a debulking procedure was performed using liposuction. A vascularised free lymph node flap transfer was then conducted 10 weeks after the first operation. In this case, good results were obtained, with reduced circumferences in various parts of the upper extremity noted immediately post operation.	Larger case series already included. No new safety outcomes reported.
Damstra RJ, Voesten HGJM, Brorston H et al. (2009) Circumferential suction-assisted lipectomy for lymphoedema after surgery for breast cancer. BMJ 96: 859-864.	n=35  FU=12 months	Circumferential lipectomy combined with lifelong compression hose is an effective technique in end-stage lymphoedema after treatment for breast cancer.	Overlap with paper 3 table 2. Only outcome reported is limb size reduction.
Di Taranto G, Bolletta A, Chen SC et al. (2021) A prospective study on combined lymphedema surgery: Gastroepiploic vascularized lymph nodes transfer and lymphaticovenous anastomosis followed by suction lipectomy.	n=37  FU=2 years	Lymphaticovenous anastomosis, vascularised lymph node transfer, and suction lipectomy can be integrated together in a combined approach, in synergy to enhance the outcomes	Studies with more people and longer follow-up included. Combination of surgical techniques used. No new safety outcomes reported.

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
Microsurgery 41(1):34-43			
Doren EL, Smith PD, Sun W al. (2012) Feasibility of liposuction for treatment of arm lymphedema from breast cancer. Cancer Research 72	n=6 FU=15 months (mean)	Liposuction can safely reduce volume of arm lymphoedema and improve functionality/quality of life. Larger studies (longer follow-up) are needed to validate the durability of these early results	Studies with more people and longer follow-up included.
Eryilmaz T, Kaya B, Ozmen S, and Kandal S (2009) Suction-assisted lipectomy for treatment of lower-extremity lymphedema. Aesthetic Plastic Surgery 33: 671-673.	n=1 FU= not reported	A case of lymphoedema reduction with suction-assisted lipectomy in a person with bilateral lower-extremity lymphoedema.	Studies with more people and longer follow-up included.
Espinosa-de-Los-Monteros A, Hinojosa CA, Abarca L et al. (2009) Compression therapy and liposuction of lower legs for bilateral hereditary primary lymphedema praecox. Journal of Vascular Surgery 49: 222-224.	n=1 FU= 14 months	No complications were seen and compression therapy was continued. Fourteen month follow-up reveals no increase in leg volume over time, absence of pain, and no further episodes of cellulitis with complete ability to ambulate and return to normal activities. Even when it does not eliminate the underlying cause of primary lymphoedema, combined therapy consisting of compression and liposuction is safe and is able to achieve control, at least on a short term, of clinically disabling	Studies with more people and longer follow-up included.

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
		conditions associated with advanced stages.	
Forte AJ, Huayllani MT, Boczar D et al. (2019) Cureus 11(10)	n=191 people, 8 studies  FU=14 to 96 months	This systematic review evaluated literature on liposuction for lower limb lymphoedema. articles. A volume reduction greater than 50% was found in all people. Complete volume reduction was found after four to five years of follow-up. A greater volume reduction was found for secondary lymphoedema when compared to primary lymphoedema.	More recent systematic reviews included.
Granoff MD, Pardo, J, and Singhal D. (2021) Power-assisted liposuction: An important tool in the surgical management of lymphedema patients. Lymphatic Research and Biology 19(1):20-2	n=39  FU=1 year	Debulking with power-assisted liposuction is an effective treatment for chronic lymphoedema, supported by improvement in both objective and subjective metrics.	Likely identical patient population to Granoff, 2020, but presents fewer results.
Hoffner M, Bagheri S, Hansson E et al. (2017) SF-36 Shows Increased Quality of Life Following Complete Reduction of Postmastectomy Lymphedema with Liposuction. Lymphatic Research and Biology 15, 87-98.	n=60  FU=1 year	Liposuction of arm lymphoedema in combination with controlled compression therapy improves patients QoL as measured with SF-36. The treatment seems to target and improve both the physical and mental health domains.	Included in both the Chang, 2021, and Tang, 2021 systematic reviews.

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
<p>Hoffner M, Peterson P, Mansson S et al. (2018) Lymphedema Leads to Fat Deposition in Muscle and Decreased Muscle/Water Volume After Liposuction: A Magnetic Resonance Imaging Study. <i>Lymphatic research and biology</i> 16(2):174-81</p>	<p>n=13 FU=1 year</p>	<p>Using water-fat MRI-based fat quantification, the fat and water contents may be quantified and localized in the various compartments in lymphoedema.</p>	<p>Studies with more people and longer follow-up included. No new safety outcomes.</p>
<p>Kandamany N and Munnoch A (2014) Liposuction for lower limb lipodystrophy in congenital analbuminaemia: A case report. <i>Journal of Plastic, and Reconstructive and Aesthetic Surgery</i> 67: e54-e57.</p>	<p>n=1 FU= 12 months</p>	<p>We have demonstrated that liposuction along with controlled compression therapy is a safe and effective treatment for managing lipodystrophy secondary to congenital analbuminaemia. Although rare, clinicians need to be aware that liposuction is a successful treatment modality, which should be made available to this select group of people.</p>	<p>Studies with more people and longer follow-up included.</p>
<p>Karafa M, Karafova A, and Szuba A. (2020) A compression device versus compression stockings in long-term therapy of lower limb primary lymphoedema after liposuction. <i>Journal</i></p>	<p>n=1 FU=3 months</p>	<p>This case study shows that in primary oedema one class of compression garment is not always sufficient, nor is the combination of two garments with varying degrees of compression. In some cases, the situation requires the use of non-elastic leg binders to help</p>	<p>Studies with more people and longer follow-up included. No new safety outcomes.</p>

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
of wound care 29(1):28-35		improve clinical outcomes after liposuction.	
Karlsson T, Karlsson M, Ohlin K et al. (2021) Liposuction of Breast Cancer-Related Arm Lymphedema Reduces Fat and Muscle Hypertrophy. Lymphatic research and biology.	n=18 FU=1 year	Liposuction and combined compression therapy effectively remove the excess fat in people with nonpitting breast cancer-related lymphoedema, and a total reduction of excess arm volume is achievable. An after surgery decrease in excess muscle volume was also seen, probably due to the reduced weight of the arm after surgery.	Studies with more people and longer follow-up included. No new safety outcomes.
Klernas P, Johnsson A, Boyages J et al. (2018) Test of Responsiveness and Sensitivity of the Questionnaire "Lymphedema Quality of Life Inventory". Lymphatic research and biology 16(3):300-8	n=50 FU=1 month	The Lymphoedema Quality of life Inventory responsiveness and sensitivity indicated that the tool can be used to evaluate people undergoing conservative or surgical lymphoedema treatments.	Studies with more people and longer follow-up included. No new safety outcomes. Included in the Tang, 2021 systematic review.
Klernas P, Johansson A, Boyages J et al. (2020) Quality of Life Improvements in Patients with Lymphedema after Surgical or Nonsurgical Interventions with 1-Year Follow-Up. Lymphatic Research and Biology 18(4):340-50	n=57 FU=12 months	People were assigned to a rehabilitation programme or liposuction. Treatment with either the conservative rehabilitation programme in moderate lymphoedema or with liposuction combined with controlled compression therapy in severe lymphoedema improves health-related QoL.	QoL outcomes covered extensively in the Tang, 2021 systematic review. No safety outcomes.

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
Lamprou DAA, Voesten HG, Damstra RJ et al. (2017) Circumferential suction-assisted lipectomy in the treatment of primary and secondary end-stage lymphoedema of the leg. The British journal of surgery 104, 84-89.	n=88 FU=2 years	Circumferential suction-assisted liposuction is an effective method for treating both primary and secondary lymphoedema of the leg.	Included in the Tang, 2021 systematic review.
Lee M, Perry L, and Granzow J. (2016) Suction Assisted Protein Lipectomy (SAPL) Even for the Treatment of Chronic Fibrotic and Scarified Lower Extremity Lymphedema. Lymphology 49(1):36-41	n=1 FU=15 months	Following liposuction, a stable excess volume reduction of 86% was achieved along with a significant improvement in range of motion of the knee. Furthermore, the person had no further episodes of recurrent cellulitis. We have found SAPL to be effective even in people with complex, chronic lymphoedema presentations with, extensive pre-existing scarring from prior surgery.	Studies with more people and longer follow-up included.  No new safety outcomes.
Leppapuska IM, Suominen E, Viitanen T et al. (2019) Combined Surgical Treatment for Chronic Upper Extremity Lymphedema Patients: Simultaneous Lymph Node	n=21 FU=48.9 months	Liposuction can safely be performed with lymph node transfer in 1 operation to achieve optimal results in people with chronic lymphoedema. The combined technique provides immediate volume reduction and further regenerative effects on the lymphatic circulation.	Studies with more people included. Combination of surgical techniques used. No new safety outcomes.

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
Transfer and Liposuction. Annals of plastic surgery 83(3):308-17			
Maclellan RA, Chaudry G, Greene AK (2016) Combined Lymphedema and Capillary Malformation of the Lower Extremity. Plastic and Reconstructive Surgery - Global Open 4, e618	n=8	Lymphoedema and capillary malformation can occur together in the same extremity. Both conditions independently cause limb overgrowth primarily because of subcutaneous adipose deposition. Compression garments and suction-assisted lipectomy can improve the condition. Lymphoedema-capillary malformation should not be confused with other vascular malformation overgrowth diseases that have different morbidities and treatments.	Studies with more people included.
Masià J, Pons G, and Rodríguez-Bauzá E. (2016) Barcelona Lymphedema Algorithm for Surgical Treatment in Breast Cancer-Related Lymphedema. Journal of reconstructive microsurgery 32(5)	n=52 FU=16 months	Considerable improvements in results of limb circumferences and subjective symptoms were obtained after incorporating several modifications into the surgical strategy for lymphoedema treatment. A detailed before surgery assessment should be performed to determine whether reconstructive surgery or palliative surgery is indicated.	Outcome data are combined for different techniques.
McGee P and Munnoch DA. (2018) Treatment of gynaecological cancer related lower limb lymphoedema with	n=21 FU=Up to 5 years	Liposuction combined with compression garments demonstrated significant and sustainable reduction in limb volume in people with lower limb lymphoedema secondary	Studies with more people and longer follow-up included.

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
liposuction. Gynecologic oncology 151(3):460-5		to gynaecological malignancy.	
Micha JP, Goldstein BH, and Nguyen DH. (2018) Successful management of persistent lower extremity lymphedema with suction-assisted lipectomy. Gynecologic Oncology Reports 23:13-5	n=1 FU=23 months	A cervical carcinoma person who developed persistent, lower extremity lymphoedema following surgery and adjuvant therapy. Despite numerous attempts at using conventional therapy (e.g., manual lymph drainage, physical therapy), the condition remained intractable. Eventually, the person had suction-assisted lipectomy to address her symptoms and has currently exhibited a beneficial, clinical outcome with 23 months of follow-up.	Studies with more people and longer follow-up included.  No new safety outcomes.
Nicoli F, Constantinides J, Ciudad P et al. (2015) Free lymph node flap transfer and laser-assisted liposuction: a combined technique for the treatment of moderate upper limb lymphedema. Lasers in medical science 30: 1377-1385.	n=10 FU=1 year	Skin tonicity was improved in all people. After surgery lymphoscintigraphy revealed reduced lymph stasis. No person suffered from donor site morbidity. Our results suggest that combining laser liposuction with lymph node flap transfer is a safe and reliable procedure, achieving a reduction of upper limb volume in treated people suffering from moderate upper extremity lymphoedema.	Studies with more people and longer follow-up included.
O'Brien BM, Khazanchi RK, Kumar PAV et al.	n=19 FU=10 months	The average reduction in this group was 20.5%. The average follow-up time was	Studies with more people and

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
(1989) Liposuction in the treatment of lymphoedema: A preliminary report. British Journal of Plastic Surgery 42: 530-533.		9.5 months. From this preliminary report it can be concluded that liposuction, either as a primary procedure or as an adjunct, can be a useful procedure in the treatment of both primary and secondary lymphoedema.	longer follow-up included.
Qi F, Gu J, Shi Y et al. (2009) Treatment of upper limb lymphedema with combination of liposuction, myocutaneous flap transfer, and lymph-fascia grafting: a preliminary study. Microsurgery 29: 29-34.	n=15 FU=6 months	Combining laser liposuction with lymph node flap transfer is a safe and reliable procedure, achieving a reduction of upper limb volume in treated people suffering from moderate upper extremity lymphoedema	Studies with more people and longer follow-up included.
Sando WC and Nahai F. (1989) Suction lipectomy in the management of limb lymphedema. Clinics in plastic surgery 16(2)	n=15 FU=3 to 30 months	The authors recommend suction lipectomy for mild temporary cases, specifically involving the upper extremity, and liposuction plus excisional debulking for more severe cases and for the lower extremity.	Studies with more people and longer follow-up included. No new safety outcomes.
Schaverien MV, Munro KJ, Baker PA et al. (2012) Liposuction for chronic lymphoedema of the upper limb: 5 years of experience. Journal of Plastic, and Reconstructive & Aesthetic Surgery:	n=11 FU=26 months	After surgery measurements in an average of 26 months follow up showed that significant decrease of circumferences of the arms on all levels at surgery side were achieved. The onsets of erysipelas were also reduced. There was no chronic lymphoedema found in the donor leg after	Studies with more people and longer follow-up included.

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
JPRAS 65: 935-942.		harvest of the lymph-fascia graft. The results suggest the strategy of liposuction, latissimus myocutaneous flap transfer, and lymph-fascia grafting may provide a useful method for treatment of the chronic upper extremity lymphoedema with severe axillary scar contracture.	
Sen Y, Qian Y, Koelmeyer L et al. (2018) Breast Cancer-Related Lymphedema: Differentiating Fat from Fluid Using Magnetic Resonance Imaging Segmentation. Lymphatic research and biology 16(1):20-7	n=5	MRI imaging may be a useful tool to quantitatively measure fat tissue and fluid for people with advanced lymphoedema and may assist in the selection of eligible liposuction candidates at initial assessment and follow-up of people who proceed with surgery.	Studies with more people included.
Smile TD, Tendulkar R, Schwarz G et al. (2016) A Review of Treatment for Breast Cancer-Related Lymphedema: Paradigms for Clinical Practice. Am J Clinical Oncology	n=145 people, 7 studies  FU=6 months to 5 years	A small number of studies suggest that liposuction may be an efficacious and safe treatment for moderate to severe breast cancer-related lymphoedema. Further study is needed with respect to comparing BCRL treatment modalities.	No meta-analysis, no new safety data. More recent systematic reviews included.
Stephen C, Munnoch DA (2016) Lymphoedema of the upper limb: a	n=1  FU=1 year	A 40-year-old woman had an elective thyroidectomy for a non-toxic, multinodular goitre. In the early after surgery period,	Studies with more people and longer follow-up included.

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rare complication of thyroid surgery? BMJ Case Reports 2016, 10.1136/bcr-2016-214376.		the person developed a significant unilateral swelling of the right upper limb, which was subsequently confirmed to be lymphoedema. This was eventually treated successfully using liposuction and compression garment therapies. This study reports a case due to its rarity and present a possible explanation for such an unexpected complication based on known anatomical variations of lymphatic drainage of the upper limb.	
Taylor S and Brake M. (2012) Liposuction for the management of submental lymphedema in the head and neck cancer patient. Otolaryngology - Head & Neck Surgery 146:1028-30.	n=10 FU=1 year	No person had recurrence and there were no adverse events from the procedure at the end of 1-year follow-up.	Studies with more people and longer follow-up included. No new safety outcomes.
Trinh L, Peterson P, Brorson H et al. (2019) Assessment of Subfascial Muscle/Water and Fat Accumulation in Lymphedema Patients Using Magnetic Resonance Imaging. Lymphatic	n=13 FU=1 year	An excess fat volume was found in the intramuscular and intermuscular compartments in people with lymphoedema. The results suggest that the subfascial compartment needs to be studied separately as no correlation between intramuscular/intermuscular fat accumulation and other	Studies with more people and longer follow-up included. No new safety outcomes.

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Article	Number of patients/ follow-up	Direction of conclusions	Reasons for non-inclusion in summary of key evidence section
research and biology 17(3):340-6		measured parameters was found.	
Tyker A, Franco J, Massa ST et al. (2019) Treatment for lymphedema following head and neck cancer therapy: A systematic review. American journal of otolaryngology 40(5):761-9	n=40 FU=6 months	This systematic review identified 3 studies that reported on use of liposuction for lymphoedema following therapy for head and neck cancer. Two of these studies reported significant self-perceived improvement in appearance and reduction of distress in people receiving liposuction in comparison to control. One study reported 100% patient satisfaction.	More recent systematic reviews included.
Wallmichrath J, Frick A, Weiss M et al. (2020) Microsurgical lymphatic vascular grafting and secondary liposuction: Results of combination treatment in secondary lymphedema. Lymphology 53(1):38-47	n=28 FU=37 months	The mean arm volumes were reduced significantly after the combination procedure. Microsurgical restoration of lymphatic outflow followed by SLS eliminates the need for additional treatment in more than two-thirds of people.	Combination of techniques used. No new safety outcomes.
Wojnikow S, Malm J, and Brorson H (2007) Use of a tourniquet with and without adrenaline reduces blood loss during liposuction for lymphoedema of the arm. Scandinavian Journal of Plastic &	n=62	Using a tourniquet significantly reduced blood loss and the number of transfusions, which was further reduced by tumescence. In the historical reference group, the number of blood transfusions increased as the volume of aspirate	Studies with longer follow-up included. No new safety outcomes.

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Reconstructive Surgery & Hand Surgery 41: 243-249		increased, and further if no adrenaline was added.	
Yoshida S, Koshima I, Imai H et al. (2021) Effect of postoperative compression therapy on the success of liposuction in patients with advanced lower limb lymphedema. Journal of Clinical Medicine 10(21):4852	n=19  FU=15.3 months	Results suggest that stable high-pressure postoperative compression therapy is key to the success of liposuction for lower limb lymphoedema and is best achieved by using both stockings and bandages. The postoperative compression pressure required for liposuction to be successful was >40 mmHg on the lower leg and >20 mmHg on the thigh. These pressures could be decreased after 6 months.	Studies with more people and/or longer follow up were included.

Abbreviations: FU, follow-up; QoL, quality of life.