

# Does tumescent liposuction damage the lymph vessels in lipoedema patients?

Chantalle B van de Pas<sup>1,2,3</sup> , Robert SM Boonen<sup>2</sup>,  
Shaula Stevens<sup>2</sup>, Sten Willemsen<sup>4</sup>, Roelf Valkema<sup>5</sup> and  
Martino Neumann<sup>1</sup>

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## Abstract

**Background:** Lymphatic insufficiency might play a significant role in the pathophysiology of lipoedema. Liposuction is up to now the best treatment. As liposuction is invasive, the technique could destruct parts of the lymphatic system and by this aggravate the lymphatic component and/or induce lymphoedema. We investigated the function of the lymphatic system in lipoedema patients before and after tumescent liposuction and thus whether tumescent liposuction can be regarded as a safe treatment.

**Methods:** Lymphoscintigraphy was performed to quantify the lymph outflow of 117 lipoedema patients. Mean clearance percentages of radioactive protein loaded after 1 min with respect to the total injected dose and corrected for decay of the radiopharmaceutical in the subcutaneous lymphatics were used as functional quantitative parameters as well as the clearance percentages and inguinal uptake 2 h post injection. The results of lymphatic function in lipoedema patients were compared with values obtained from normal healthy volunteers. We also compared 50 lymphoscintigraphies out of the previous 117 lipoedema patients before and six months after tumescent liposuction.

**Results:** In 117 lipoedema patients clearance 2 h post injection in the right and left foot was disturbed in 79.5 and 87.2% respectively. The inguinal uptake 2 h post injection in the right and left groin was disturbed in 60.3 and 64.7% respectively. In 50 lipoedema patients mean clearance and inguinal uptake after tumescent liposuction were slightly improved, 0.01 ( $p = 0.37$ ) versus 0.02 ( $p = 0.02$ ), respectively. This is statistically not relevant in clearance.

**Conclusion:** Lipoedema legs have a delayed lymph transport. Tumescent liposuction does not diminish the lymphatic function in lipoedema patients, thus tumescent liposuction can be regarded as a safe treatment.

## Keywords

Lipoedema, tumescent liposuction, lymphoscintigraphy

## Introduction

Lipoedema is a chronic, incurable disease that is often progressive and may be associated with considerable morbidity. It was first described by Allen and Hines<sup>1</sup> in 1940 as a disease characterized by bilateral enlargement, mainly of the legs, caused by abnormal depositions of subcutaneous fat that are often associated with mild oedema.<sup>2</sup> While the arms are much less affected, the hands and feet are never involved. It occurs almost exclusively in women. Although the abundance of synonyms indicates how little is known of this syndrome,<sup>3</sup> it is more common than most physicians realize. Initially, patients experience discomfort, easy bruising and tenderness of the disproportionately enlarged legs, which may progress to severe pain and limited mobility.

As well as physical problems, lipoedema may be associated with psychosocial complaints. These complaints arise because the majority has a history of dieting and exercising without any considerable

<sup>1</sup>Department of Dermatology, Erasmus MC, Rotterdam, The Netherlands

<sup>2</sup>Polikliniek de Blaak, Rotterdam, The Netherlands

<sup>3</sup>Kliniek De Medici, Blaricum, The Netherlands

<sup>4</sup>Department of Biostatistics, Erasmus MC, Rotterdam, The Netherlands

<sup>5</sup>Department of Nuclear Medicine, Erasmus MC, Rotterdam, The Netherlands

## Corresponding author:

Chantalle B van de Pas, Kliniek De Medici, Blaricum Matthijssenhoutweg 45A, Blaricum 1261CK, The Netherlands.

Email: [info@klinikdemedici.nl](mailto:info@klinikdemedici.nl)

benefit on the contours and complaints of the lower extremities.

The fact that it is normally first noticed at puberty, pregnancy or menopause suggests a causative hormonal component, and the fact that it often affects several members of the same family suggests a genetic component. However, the exact pathogenesis is unknown. Diagnosis is based on patient history and physical examination. The course of lipoedema is variable and partly depending on the possible concomitant obesity.

In lipoedema, the anatomy of the lymphatic vessel system has been found to be normal, as far as the large lymph vessels are concerned. However, the increased intercellular pressure due to expanding fat tissue (because of disproportionate enlargement of the adipocytes) may cause slight mechanical obstruction of the small lymphatic vessels in the septa, which result in mild lymphostasis and oedema of the subcutaneous tissue.<sup>4,5</sup>

However, some publications suggest that a microangiopathy of the lymph capillaries located in the connective tissue septa between fat lobes<sup>6</sup> causes increased permeability due to a fragile vessel wall. Similarly, the easy bruising might be explained by a capillary fragility. This might also explain an increased tendency to the formation of oedema.

The increased permeability of the lymph capillaries leads to an increased lymphatic volume that exceeds the existing drainage capacity and results in dilatation of the prelymphatic vasculature. The stasis of extravasation of proteins causes first inflammation followed by fibrosis, leading to pathological changes in lymphatic capillaries typical in lipoedema. In long-standing lipoedema, these small alterations of the lymphatic tissue can be visualized by indirect lymphography. The injection depots look flame-like, unlike the usually visualized round deposits. The 'tongues of flame' are likely to represent distended pre-lymphatic spaces.<sup>7-13</sup> Some investigators found enlarged and obliterated lymphatic microvessels,<sup>11</sup> lymphatic collectors following a tortuous course through the fatty subcutaneous tissue<sup>8,11</sup> and multiple microlymphatic aneurysms of lymphatic capillaries in patients with lipoedema,<sup>12</sup> of which the pathophysiological role remains to be established.

The chronic stasis of lymphoedema also ensues adipocyte hypertrophy. This adds to the lymphatic load of an already overloaded lymphatic system (vicious cycle).

The relationship between lymphatics and adipose tissue remains controversial.

The mechanism of lipoedema might be a continuing deterioration in which the growing adipocytes keep slowing the lymphatic drainage, while it is still unclear whether the primary factor is the growing adipocyte or

an intrinsic problem in the interstitial space or microlymphatic pathway.

Limb lymphatic function in lipoedema patients can be assessed using quantitative lymphoscintigraphy.<sup>8,14-17</sup> This is a reliable, reproducible, minimally invasive research method for assessing/measuring lymph flow and detecting and quantifying lymph stasis and dysfunction.

Photoplethysmography and quantitative lymphoscintigraphic studies showed that insufficiency may be present, as compared with healthy controls. However, the degree of insufficiency never reached the level of true lymphoedema, and large lymph vessels were normal and sufficient.<sup>6,8,14,15,18-21</sup>

Because the pathogenesis of lipoedema is not exactly known, a curative treatment is not available. However, the introduction of tumescent local anaesthesia in the 1980s has greatly changed the therapeutic options for lipoedema.<sup>22</sup>

In tumescent local anaesthesia, large amounts of fluid and low concentration of the anaestheticum (containing saline, lidocaine, sodium bicarbonate and adrenaline) are infiltrated in the subcutaneous tissues. Tumescent liposuction is at least as effective as the conventional ('dry') liposuction and the so-called wet liposuction in removing adipose aspirates, but has the advantage that it is significantly less likely to damage the lymphatic vessels.<sup>4,6,23,24</sup> However, there is not much scientific research done on this topic.

To establish whether the lipoedema patients initially had a dysfunction in lymph flow or whether this was normal, we quantified the lymph flow of lipoedema patients using lymphoscintigraphy. To investigate whether the function of the lymphatic system has changed after tumescent liposuction – and thus to establish whether tumescent liposuction can be regarded as a safe technique – we compared lymphoscintigraphies of lipoedema patients before and after tumescent liposuction.

## Methods

### Study population

One hundred and seventeen women with lipoedema of the legs were included in our study. All participants provided informed consent. The mean age, when the lymphoscintigraphy in 2010 was performed, was 40.9 years (range 21.0–64.1 years). The diagnosis of lipoedema of the legs was established by clinical history and physical examination.<sup>4</sup> We used standardized lymphoscintigraphy to quantify the lymph flow in all lipoedema patients. The lymphatic function in lipoedema patients was compared with those obtained from normal volunteers.<sup>1</sup>

Normal values of clearance (disappearance from the depot) and inguinal uptake after 2 h post injection have previously been established through evaluation of a series of normal healthy volunteers without leg swelling or other clinical evidence of venous or lymphatic disease.<sup>6,25–27</sup>

Fifty lymphoscintigraphies out of the former 117 before and six months after tumescent liposuction were compared. The mean age was 42.2 years (range 24.1–57.9 years).

### Lymphoscintigraphy

Quantitative lymphoscintigraphy is an established technique for assessment of limb lymphatic function. Briefly, this involves subcutaneous injection of 99mTc in the first web space. A large-field-of-view gamma camera with on-line computer facilities is positioned with the collimator facing close to the skin surface. Images are obtained sequentially over feet, knees and inguinal regions at minutes post injection.

We used mean clearance percentages of radioactive protein loaded after 1 min with respect to the total injected dose and corrected for decay of the radiopharmaceutical in the subcutaneous lymphatics as functional quantitative parameters as well as the clearance percentages and inguinal uptake percentages 2 h post injection.

Clearance was disturbed 2 h post injection if <30% (abnormal <20% plus questionable 20–30%). Inguinal uptake was disturbed 2 h post injection if <10% (abnormal <5% plus questionable 5–10%).

### Tumescent liposuction

Tumescent liposuction in our study was performed according to the standard treatment as described by Klein<sup>22</sup> and executed by an experienced professional who has treated lipoedema patients with this treatment over the last 15 years.

### Statistics

To describe our sample we calculated the mean and range of the age at the time the lymphoscintigraphy was performed. We also calculated the mean clearance and inguinal uptake on the right and left side and categorized these values as either normal (> 30% for the clearance and > 10% for the inguinal uptake) or abnormal.

We looked at the correspondence of these measurements on the left and the right using the Pearson's correlation.

To evaluate the results of the tumescent liposuction, we compared the left, right and average clearance and inguinal uptake using a paired t-test. We looked at the

**Table 1.** Clearance foot 2 h post injection.

	Frequency (in numbers)	Per cent (in %)
Clearance right foot 2 h post injection		
Disturbed ( $\leq 30\%$ )	93	79.5
Normal ( $> 30\%$ )	24	20.5
Total	117	100
Clearance left foot 2 h post injection		
Disturbed ( $\leq 30\%$ )	74	87.2
Normal ( $> 30\%$ )	15	12.8
Total	117	100

differences (before–after) and provided a 95% confidence interval.

All analyses were performed using R 3.2 (R Foundation for Statistical Computing, Vienna, Austria). We considered results to be statistically significant whenever their p-value was below 0.05. No multiplicity correction was applied.

## Results

### Lymphoscintigraphy results of 117 lipoedema patients

The mean age of 117 lipoedema patients at the time the lymphoscintigraphy was performed was 40.9 years (range 21.0–64.1 years). Clearance in the right and left foot was disturbed (=abnormal + questionable) in 79.5 and 87.2% respectively and normal in 20.5 and 12.8% respectively compared to normal volunteers (Table 1). The inguinal uptake after 2 h in the right and left groin was disturbed in 60.3 and 64.7% respectively and normal in 39.7 and 35.3% respectively compared to normal volunteers (Table 2).

The clearance and inguinal uptake correlation coefficient 2 h post injection of radioactive protein between right and left after 2 h were both 0.39.

### Lymphoscintigraphy results of 50 lipoedema patients before and after tumescent liposuction

All lipoedema patients were female. The mean age of the 50 lipoedema patients at which the first lymphoscintigraphy was performed before tumescent liposuction was 42.2 years (range 24.1–57.9 years).

Mean clearance before minus after tumescent liposuction of both right and left foot (or of both feet) was slightly improved, 0.01 ( $p = 0.37$ ). However, this was not statistically significant.

Mean inguinal uptake before minus after tumescent liposuction of the groin was also slightly improved, 0.02 ( $p = 0.02$ ). This is statistically significant (Table 3).

The clearance and inguinal uptake correlation coefficient 2 h post injection of radioactive protein between right and left after tumescent liposuction were 0.51 versus 0.47.

## Discussion

Lipoedema is a very common disease and a burden for the patient and the medical profession. Weight reduction is not of great value due to the disturbed metabolism of the lipocytes at the specific regions (legs, buttocks and arms but never the abdomen<sup>6</sup>) where lipoedema is present. Nevertheless, it is true that a significant part of the lipoedema patients also has obesity. As weight and by this BMI are not realistic parameters to determine obesity, only abdominal circumference can diagnose the obesity factor in lipoedema patients. A good treatment for lipoedema is therefore a combination of obtaining a normal abdominal circumference (women < 90 cm), exercising and specific treatment for the areas of lipoedema.

Tumescent liposuction is the only available treatment for lipoedema with good and long lasting results.<sup>28</sup> However, this technique could theoretically destruct the lymphatic vessels, which will lead to lymph transport stasis and thus to lymphoedema. Although in lipoedema stasis of lymph in the adipose tissue septa plays a role, this is uncorrelated to the function of the major transporting lymph vessels of the extremities. This means that lipoedema is not a complication with lymphoedema. This is clearly visible in the patients because in lymphoedema the feet are first and always swollen but in lipoedema the feet are never touched by the pathological process. To

investigate the potential risk of lymphoedema due to tumescent liposuction for lipoedema, we started this protective study.

Lymphoscintigraphy, a well established objective instrument to measure the lymph drainage of extremities, has been performed since the 1950s and is still currently the recommended technique for the examination of lymphoedema.<sup>29–33</sup>

We examined the lymphatic outflow of a group of 117 lipoedema patients. This study showed that most of our lipoedema patients had a delayed leg lymph transport as both clearance (disappearance from the depot) and inguinal uptake were disturbed 2 h post injection of radioactive protein. Whether the primary factor is the growing adipocyte or an intrinsic problem in the interstitial space or microlymphatic pathway is still under discussion. However, the major lymph vessels were normal in function. This corresponds with the observation of Stutz<sup>34</sup> and Schmeller et al.<sup>35</sup>

Also the clearance and inguinal correlation coefficient (n = 117) 2 h post injection of radioactive protein between right and left were both 0.39. This means that there is a moderate correlation of lymphatic function in lipoedema patients between both legs according to Dancey and Reidy's correlation. In conclusion this means that lymphatic function was rather symmetrical.

We also investigated whether the function of the lymphatic system in 50 lipoedema patients was different after tumescent liposuction by comparing the values of clearance and inguinal uptake 2 h post injection. This study shows clearly that tumescent liposuction did not damage the lymphatic function as both mean clearance and mean inguinal uptake before minus after tumescent liposuction were slightly improved.

The clearance and inguinal uptake correlation coefficient 2 h post injection of radioactive protein between right and left after tumescent liposuction (n = 50) were 0.51 versus 0.47. This means a moderate correlation of lymphatic function in both legs in lipoedema patients according to Dancey and Reidy's correlation. Also here lymphatic function was rather symmetrical.

Tumescent liposuction gave minimal improvement in the lymphatic system but this was only statistically significant for the inguinal uptake. Most important is that our study proved that tumescent liposuction will not damage the lymph vessels in lipoedema patients.

**Table 2.** Inguinal uptake groin 2 h post injection.

	Frequency (in numbers)	Per cent (in %)
Inguinal uptake right leg 2 h post injection		
Disturbed ( $\leq 10\%$ )	70	60.3
Normal ( $> 10\%$ )	46	39.7
Total	116 (1 missing)	100
Inguinal uptake left leg 2 h post injection		
Abnormal ( $\leq 10\%$ )	75	64.7
Normal ( $> 10\%$ )	41	35.3
Total	116 (1 missing)	100

**Table 3.** Mean clearance feet and inguinal uptake groin before and minus after tumescent liposuction.

	Mean (before–after liposuction)	Sig. (two-tailed)	95% CI of the difference: Lower	95% CI of the difference: Upper
ClearanceFeetBefore–ClearanceFeetAfter	–0.01	0.37	–0.04292	0.01612
InguinalUptakeGroinBefore–InguinalUptakeGroinAfter	–0.02	0.02	–0.03723	–0.0042



The outflow of lymph even increased after liposuction. Also lipoedema patients have less lymph transport capacity than healthy volunteers but this does not lead to lymphoedema. We definitely need a bigger study to have our data confirmed.

## Conclusion

Lymphatic insufficiency plays a significant role in the pathophysiology of lipoedema.

Tumescent liposuction does not diminish the lymphatic function in lipoedema patients.

## Declaration of Conflicting Interests

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## Ethical approval

Conducted according to the World Medical Association Declaration of Helsinki.

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CBP.


## Contributorship

Chantalle van de Pas was involved in leading the trial, researched the literature, did the write-up and submission. Robert Boonen was involved in recruitment of the lipoedema patients and executed the protocol. Shaula Stevens assisted in this process. Sten Willemsen led the analysis. Roelf Valkema reviewed the technical and trial design output. Martino Neumann was the overall senior academic and lead for the trial, he reviewed the write-up and submission. Martino was consulted throughout the trial development and write-up. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

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## ORCID iD

Chantalle B van de Pas  <https://orcid.org/0000-0001-6409-9554>

## References

1. Allen EV and Hines EAJ. Lipedema of the legs: a syndrome characterised by fat legs and orthostatic edema. *Proc Staff Meet Mayo Clin* 1940; 15: 184–187.
2. Schmeller W and Meier-Vollrath I. Lipödem: Ein update. [Lipedema: an update] *Lymphol Forsch Prax* 2005; 9: 10–20.
3. Wold LE, Hines EA Jr and Allen EV. Lipedema of the legs; a syndrome characterized by fat legs and edema. *Ann Intern Med* 1951; 34: 1243–1250.
4. Langendoen SI, Habbema L, Nijsten TEC, et al. Lipoedema: from clinical presentation to therapy. A review of the literature. *Br J Dermatol* 2009; 161: 980–986.
5. Damstra RJ. *Diagnostic and therapeutical aspects of lymphedema – second edition*, chapter 15. Rabe Verlag Medical Publishing, 2013.
6. Foldi M and Foldi E. *Lehrbuch der lymphologie für mediziner und physiotherapeuten*. Jena: Urban und Fischer Verlag, 2005.
7. Herpertz U. [Lipedema]. *Z Lymphol* 1995; 19: 1–11.
8. Weissleder H, Brauer JW, Schuchhardt C, et al. [Value of functional lymphoscintigraphy and indirect lymphangiography in lipedema syndrome]. *Z Lymphol* 1995; 19: 38–41.
9. Partsch H, Stoberl C, Urbanek A, et al. Clinical use of indirect lymphography in different forms of leg edema. *Lymphology* 1988; 21: 152–160.
10. Tiedjen KU, Heimann KD, Tiedjen-Kraft U, et al. Indirect xerolymphography in lymphedema, lipedema and venous insufficiency. *Phlebologie* 1992; 92: 396–398.
11. Bollinger A. Microlymphatics of human skin. *Int J Microcirc Clin Exp* 1993; 12: 1–15.
12. Amann-Vesti BR, Franzeck UK and Bollinger A. Microlymphatic aneurysms in patients with lipedema. *Lymphology* 2001; 34: 170–175.
13. Stoberl C, Partsch H and Wruhs M. [Diagnostic value and assessment criteria of indirect lymphography in lymphedema]. *Vasa* 1990; 19: 212–217.
14. Boursier V, Pecking A and Vignes S. [Comparative analysis of lymphoscintigraphy between lipedema and lower limb lymphedema]. *J Mal Vasc* 2004; 29: 257–261.
15. van Geest AJ, Esten SCAM, Cambier J-PRA, et al. Lymphatic disturbances in lipoedema. *Phlebologie* 2003; 32: 138–142.
16. Brauer WJ and Brauer VS. Altersabhängigkeit des lymphtransportes beim lipodem und lipolymphodem. *Lymph Forsch* 2005; 9: 6–9.
17. Brauer WJ and Weissleder H. Methodik und ergebnisse der funktionslymphszintigraphie: erfahrungen bei 924 patienten. *Phlebologie* 2002; 31: 118–125.
18. Ryan T. Lymphatics and adipose tissue. *Clin Dermatol* 1995; 13: 493–498.
19. Bilancini S, Lucchi M, Tucci S, et al. Functional lymphatic alterations in patients suffering from lipedema. *Angiology* 1995; 46: 333–339.
20. Fife CE, Maus EA and Carter MJ. Lipedema: a frequently misdiagnosed and misunderstood fatty deposition syndrome. *Adv Skin Wound Care* 2010; 23: 81–92.
21. Harwood CA, Bull RH, Evans J, et al. Lymphatic and venous function in lipoedema. *Br J Dermatol* 1996; 134: 1–6.
22. Klein JA. The tumescent technique: anesthesia and modified liposuction technique. *Dermatol Clin* 1990; 8: 425–437.

23. Hoffmann JN, Fertmann JP, Baumeister RGH, et al. Tumescant and dry liposuction of lower extremities: differences in lymph vessel injury. *Plast Reconstr Surg* 2003; 113: 718–724.
24. Habbema L. Safety of liposuction using exclusively tumescant local anesthesia in 3240 consecutive cases. *Dermatol Surg* 2009; 35: 1728–1735.
25. Partsch H. Assessment of abnormal lymph drainage for the diagnosis of lymphedema by isotopic lymphangiography and by indirect lymphography. *Clin Dermatol* 1995; 13: 445–450.
26. Kroonenburgh MJPG van. Lymfscintigrafie. In: Neumann HAM and Tazelaar DI (eds) *Leerboek flebologie*. Utrecht: Lemma, 2003, pp.137–144.
27. Jensen MD, Simonsen L, Karl Smark T, et al. Lymphoedema of the lower extremities-background, pathophysiology and diagnostic considerations. *Clin Physiol Funct Imaging* 2010; 30: 389–398.
28. Schmeller W, Hueppe M and Meier-Vollrath I. Tumescant liposuction in lipoedema yields good long-term results. *Br J Dermatol* 2012; 166: 161–168.
29. Szuba A, Shin WS, Strauss HW, et al. The third circulation: radionuclide lymphoscintigraphy in the evaluation of lymphedema. *J Nucl Med* 2003; 44: 43–57.
30. Lymphoedema Framework. Best practice for the management of lymphedema. In: *International consensus*. London: MEP Ltd, 2006.
31. Warren AG, Brorson H, Borud LJ, et al. Lymphedema: a comprehensive review. *Ann Plast Surg* 2007; 59: 464–472.
32. Rockson SG. Diagnosis and management of lymphatic vascular disease. *JACC* 2008; 52: 799–806.
33. Piller N and Carati C. The diagnosis and treatment of peripheral lymphedema. *Lymphology* 2009; 42: 146–147.
34. Stutz JJ and Krah D. Water-jet assisted liposuction for patients with lipoedema: histologic and immunohistologic analysis of the aspirates of 30 lipoedema patients. *Aesthetic Plast Surg* 2009; 33: 153–162.
35. Schmeller W, Tronnier M and Kayserling E. Lymphgefassschadigung durch Liposuktion? Eine immunhistologische Untersuchung 2007; 19: 55–59.