Tumescent microcannular (laser-assisted) liposuction in painful lipedema

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Background: Painful lipedema (PL) is a chronic progressive disorder of adult females. Conservative treatment, although often considered as therapeutic standard, is of limited efficacy.

Objective: To evaluate the role of liposuction in a cohort of patients with PL compared with conservative complex decongestive treatment (CDT).

Methods: 24 lipedema and 2 Dercum's disease patients were included (mean age 47.3 ± 18.9 years) with CDT. Eighteen patients were further treated by microcannular tumescent liposuction (MTL) (43 sessions) or by 980 nm diode laser-assisted tumescent liposuction (LATL) (12 patients, 22 sessions).

Results: In contrast to CDT, MTL reduced adipose tissue, pain and improved mobility. The total amount of lipoaspirate was 3,200 mL to 12,000 mL. MLT and LATL improved pain and mobility. We did not observe any signs of lymphedema development after liposuction.

Conclusion: Liposuction is a more effective treatment option in patients with advanced painful lipedema as compared to CDT.

KEYWORDS:

ABSTRACT

INTRODUCTION

Painful lipedema and Dercum’s disease are disabling disorders affecting females. Lipedema is characterized by a combination of symmetrical lipodystrophy of legs with a characteristic cuffing at ankles with spontaneous pain and pain after

CORRESPONDENCE

Disclosures

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minor pressure. Dercum’s disease is characterized by adiposity and painful adipose tissue. Further symptoms that have been described for the two diseases include bruising and hematomas after minor blunt trauma and tenderness and depression. Without treatment the disease is progressive leading to significant impairment.1-5
The prevalence of lipedema in adult women has been estimated between 4.8 to 9.7% in southern Germany.6 The prevalence of Dercum’s disease is unknown.5 Most patients report first symptoms developing after puberty, often worsened after pregnancy. The diagnoses are based on typical clinical findings but underdiagnosis and misdiagnosis commonly lead to a marked delay in diagnosis and treatment.4, 7 There is no clear demarcation between the two conditions.5
The etiology of lipedema and Dercum’s disease is unknown. Recent investigations in patients with lipedema indicated the combination of necrotizing adipocytes surrounded by macrophages and the proliferation of Ki67+/CD34+ adipose-derived stem cells. The findings argue for an increased adipogenesis in affected adipose tissue that can lead to hypoxia and macrophage recruitment.8 In obesity aquaporin-7 is overexpressed.9 There is no data available for Dercum’s disease.
In both Dercum’s disease and lipedema increased obesity due to impaired mobility can aggravate the disease and symptoms. Patients with morbid obesity may develop secondary mechanical insufficiency of the lymphatic system, producing a secondary lipolymphedema.4 Lipedema can be classified into three major stages. In stage I the skin surface is smooth by there is a lipohypertrophy. In stage II skin becomes uneven and nodules can be felt in subcutaneous adipose tissue layers. Stage III goes on with tumor-like bulging protrusions of adipose tissue with significant adverse effects on knee mobility.2, 7, 10 Dercum’s disease can be classified into type I – juxtaarticular, type II – diffuse-generalised and type III – nodular.5
Conservative treatment is widely used as a treatment for lipedema despite the lack of scientific evidence. The central part is complex decongestive physiotherapy according to Földi, which has been developed for treatment of lymphedema.11 The only effects that are documented in lipedema are temporary minor reduction of leg volume and decrease of capillary fragility.12 The effects are somewhat better when lipedema is complicated by secondary lymphedema of course, i.e. lipo-lymphedema. There are no reports on conservative treatment of Dercum’s disease. In the present study we investigated effects and safety profile of microcannular tumescent liposuction13 including the first application of laser-assisted liposuction versus conservative decongestive therapy in patients with advanced lipedema and Dercum’s disease.

PATIENTS AND METHODS

Patients

Twenty-six consecutive adult female patients with painful lipedema (n= 24) or Dercum’s disease (n = 2) were treated between 2005 and 2011. The mean age was (47.3 ±
18.9) years (range, 21-78) (Table 1). The diagnosis of lipedema and Dercum’s disease was made according to clinical criteria. The severity of lipedema was classified according to Strößenreuther (2001) and Meyer-Vollrath and Schmeller (2004) into grade I (mild) to III (most severe) (Figure 1). Six patients had been presented in a

<table>
<thead>
<tr>
<th>Patient’s demographics and staging of disease</th>
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<tr>
<td>Age (years)</td>
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<td>Patient 1</td>
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<td>Patient 25</td>
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<td>Patient 26</td>
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*) Patients with Dercum’s disease, staging according to Hansson 2011.
**FIGURE 1.** Classification of lipedema according to Meier-Vollrath and Schmeller (2004). (a) Grad I with even skin surface but characteristic adipose tissue hypertrophy. (b) Grade II with an uneven surface. (c, d) Grade III with bulging subcutaneous adipose tissue and a “tumor-like” growth. (c) This leads to severe complications of knee joints and loss of mobility.
previous publication, but all patients were reevaluated. Our patients presented with predominant lipedema of the upper legs but less pronounced involvement of lower legs. An additional involvement of the arms was observed in 6 patients. Lipedema patients were classified according to severity of the lipedema into class I (n=1), class II (n=9), and class III (n=11). The two patients with Dercum's disease suffered from the nodular type III. Two other patients previously classified as Dercum's disease have been re-classified as lipedema. The duration of complaints before confirmation of diagnosis was 14.5 ± 18.9 years.

Before treatment all patients had at least two appointments for clinical examination, discussion of the procedures and care after surgery. Photos were taken and a laboratory examination was performed (basics included blood count, glucose-6-phosphatase, met-hemoglobin, and clotting analysis). All patients got an individualized compression garment (trousers) and had been advised to wear the compression at least for six months. Patients were informed that with increasing age skin laxity after liposuction might occur and additional surgical procedures could become necessary to improve the aesthetic outcome. Pre-operative exclusion criteria were history of deep venous thrombosis, other thrombotic events or embolism, active phlebitis, untreated cancer and connective tissue disease.

Comorbidities

The patients’ history was analyzed for comorbidities and complications of lipedema and Dercum’s disease.

Satisfaction and pain

The patients’ satisfaction was scored from unsatisfied, unchanged, medium, high to very high. Furthermore, the pain was assessed using the visual analogue pain scale (0, no pain; 100, maximum pain).

Histology

Histology specimens were regularly taken from the aspirate and processed for routine hematoxylin-eosin stains.

Complex Decongestive Therapy (CDT)

All 26 patients with grade II or higher lipedema or Dercum’s disease underwent ambulatory complex decongestive therapy (CDT) from 3 months to 5 years. These 26 patients underwent an intense standardized CDT with daily manual lymphdrainage (at least 30 min), individualized compression garments and mobilization by physiotherapists for 10 days in the inpatients department.

Liposuction

Initially all patients who underwent liposuction were treated by microcannular tumescent liposuction (MTL) (n=14 patients) with a total of 43 liposuction sessions. Later-on we introduced laser-assisted liposuction. In 12 patients 22 laser-assisted tumescent liposuction (LATL) sessions were performed. Six of them had only LATL, another five had classi-
All patients received a single dose of intravenous ascorbic acid (1 g) before surgery to reduce the risk of met-haemoglobin formation. Perioperative antibiotics were not regularly used. Postoperatively blood counts and met-hemoglobin was monitored in all patients until normalization. Met-hemoglobulinemia was treated with toluidine blue solution.

Those patients who had experience with both liposuction procedures were asked to compare their experience considering invasiveness, pain during liposuction and post-surgical complaints.

**MCL**

Twenty-nine MTL were performed using tumescent anesthesia, i.e. a solution containing 0.1% prilocarpine solution (1mL of 1:1,000 adrenaline, 50mL of prilocarpine, 1,000mL of Ringer solution) using an infusion pump with a speed of 100mL per minute. The maximum volume of tumescence solution was 5 L. During surgery pulse oximetry was initially used for monitoring but found to be of useless to control met-hemoglobinemia. Liposuction was performed in a longitudinal direction with blunt cannula (diameter 2 to 3 mm, in two cases 5 mm depending on the anatomical situation). After removal of deeper parts of the adipose tissue with the larger canulas, smaller ones were used for finer sculpturing. Suction was achieved with the Mentor Contour Genesis device (Mentor Corp., Santa Barbara, CA) with a negative pressure of 350 mm Hg. During liposuction, manual pressure from outside was applied when superficial liposuction was performed. Incisions were sutured with polyamide sutures (3-0 Ethilon, Ethicon). No drains were needed. Patients used compression bandages for 24 to 48 hours, then replaced by individualized compression garments (trousers). Liposuction was performed in series from one to four sessions to avoid the need for larger volumes of tumescence solution.

**LATS**

LATS was performed under tumescent anesthesia exactly as MCL. A 980 nm diode laser was used in continuous emission mode (15-35 W; mostly 15-25 W) (Biolitec, Jena, Germany). The laser was connected by a 600 µm bare fiber to the tip of blunt 3 mm microcannula. The microcannula has been specifically been designed so that its distal end is in one level with the laser fiber tip. The tip was cooled using Ringer’s solution. Protective eye-glasses need to be used for patients and staff.

Postoperative compression (MTL and LATL) Patients were advice to wear compression trousers regularly for at least 3 months. The trousers had to be adopted repeatedly during sequential liposuction procedures to ensure sufficient compression.

**Statistics**

Values are given as mean and standard deviation. Differences between groups of patients have been analyzed by two-tailed Mann-Whitney U-test. A p value > 0.05 was
considered to indicate a statistically significant difference.

RESULTS (Table 2)

Comorbidities
The most common comorbidity observed was arterial hypertension (n=13) followed by chronic venous insufficiency (n=9). Central body obesity was evident in four patients. The body mass index ranged from 22.9 to 61.8 (mean ± standard deviation: 35.3 ± 10.1).

Skin diseases like psoriasis or atopic dermatitis were noted in six patients, five were treated for hypothyreosis, three suffered from cardiac arrhythmia (one with a pacemaker). Six patients suffered from go-narthrosis including three with total knee endoprothesis. Four patients had a longer history of vertebral pain syndrome. Psychological complaints were reported by 50% of patients, five of them had psychiatric or psychological treatment (panic attacks, depression, eating disorder, anxiety).

Conservative treatment
All patients had tried several courses of various diets and physical activities (fitness studio, water gymnastics, Nordic walking etc.). All but one patient had experience with outpatient CDT before surgery. With intensified CDT 17 patients achieved a reduction in leg circumferences, most obtained up to 2 cm to 3 cm reduction in lower (1.1 ± 0.7 cm) and upper leg (2.5 ± 1.2 cm).
cm) (measured 20 cm above the knee for thighs and 10 cm below the knee for calves). Tenderness of the legs decreased in 18 of 26 patients. There was no improvement in patients with Dercum’s disease. A reduction of bruising was reported by two lipedema patients. One lipedema patient could not tolerate compression garments because of pain. The conservative approach with strongly motivated patients, however, had not reduced any of the more severe symptoms of lipedema, i.e. spontaneous and pressure induced pain, lipomatosis of legs and/or arms, or problems with joint mobility (mostly knees) among these patients.

**MTL**

Liposuction was well tolerated by all patients. Between 900 mL and 3,100 mL lipoaspirate was removed per session. The mean total amount was 4,200 mL (range, 3,200-7,900 mL) (Figure 2). The mean surgery time per session was one hour (1 to 1.5 hours). The mean reduction in body weight was 7.8 kg. The mean time of stay in hospital was 4.4±2.3 days per procedure (2-5 days). The total number of procedures was one to four. In two patients additional surgery was done: one thigh lift and one resection of pendulous abdomen.

**LATL**

In 12 patients 22 sessions with LATL were performed. The treatment energy varied between 6,617 – 28,626 J per session (mean 9.758± 6.334). The lipoaspirate volume was...
between 900 to 3,000 mL per session (mean 2,600 ± 1,250). The mean surgery time was (1.0 ± 0.3) hours (range 1-1.5 hours). The mean time of hospital stay was 1.8±1.3 days (range 1-3 days). Despite the fact that the mean age in this group of patients was 47 years skin tightening was obvious even in older patients (Figure 3). Nevertheless, the skin tightening effect was better in patients younger than 40 years of age compared to those older than 50 years of age.

**Satisfaction and pain after liposuction**
The patients’ satisfaction was “medium” in a single patient and “high” or better in the other 18 patients. Of those patients who had experience with both liposuction procedures 5 of 6 patients preferred LATL since it was considered to be “less invasive”, “less painful”, “less bruising”, and showed a shorter healing time.
Pain scores decreased after the first liposuction session. There was no difference in between the two liposuction methods. The mean scores dropped from 78±27 (mean ± SD) before liposuction to 30±17 after the procedure. Eight women had no spontaneous or pressure induced pain two weeks after completing the treatment. The mobility (like knee bending) improved in 16 of 17 patients.

**Histology**
Histology revealed large lobules of mature adipose tissue. Laser-assisted liposuction produced more lipolytic changes like ruptured adipocyte cell membranes (Figure 4).

**Adverse events**
There was one case of varicose vein bleeding with standard liposuction. The procedure was interrupted but compression bandages stopped the bleeding.
During immediate post-surgery monitoring, 16 of 18 patients showed a significant increase of their met-hemoglobin levels. The kinetics of that was highly variable with a peak reached with 12 to 72 hours. Among

**FIGURE 3.** Laser-assisted tumescent liposuction. The subdermal laser produced a marked skin tightening effect on thighs. (a) Before treatment and (b) about 8 weeks after the procedure.
those patients who had at least two sessions of liposuction the amount of met-hemoglobin formation varied remarkably. There was no clear relationship to the amount of tumescence solution either. Met-hemoglobin levels between 20% and 31% have been observed 8 times the same day after liposuction and 2 times the next day. Intravenous toluidine blue injection was rapidly effective in all cases of symptomatic met-hemoglobulinemia. Nausea and vomiting was observed once after toluidine blue injection.

Bruising was seen in 23 of 29 MTL sessions, none of them needed any surgical intervention. After 6 of 22 sessions of LATL liposuction bruising was observed, but less pronounced compared to standard liposuction. There was no skin burning by laser-assisted liposuction. Six patients experienced temporary leukocytosis within 24 h. Two patients developed a raised body temperature of 38.2 and 38.5 °C controlled by oral antibiotics. None of the patients had a clinically significant decrease in hemoglobin and hematocrit levels during the procedure. Headache was reported by two patients, temporary post-operative pain in four patients. We did not observe any signs of lymphedema during a mean observation time of 18 ± 26 months (range, 5 months to 5 years) following liposuction.

**DISCUSSION**

Painful lipedema runs a progressive course. Conservative treatment with CDT is widely accepted as standard.\(^\text{14}\) It may reduce tenderness but has no effect on adipose tissue itself. The improvement of lymphatic transport by CDT is well established in lymphedema. In lipedema, however, lymphatic drainage is not primarily disturbed.\(^\text{15, 16}\) Due to increased pain sensations in lipedema, medical elastic compression stockings are

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**FIGURE 4.** Histology of adipose tissue after tumescent liposuction (Hematoxylin-eosin stain; x 40). (a) Classical tumescent liposuction and (b) laser-assisted liposuction. The tissue shows a better preservation with laser-assisted procedure, in particular less connective tissue is removed. In the right upper corner a laser-induced lipolysis can be seen with disruption of adipocyte cell membranes.
not always tolerated.\textsuperscript{7}

Lipectomies are of limited success and bear the risk of lymphatic damage according to some authors\textsuperscript{2,7} In recent years, however, MTL has greatly changed therapeutic options for lipedema.\textsuperscript{17-19} This method allows minimally invasive body sculpturing although it is not useful for body weight normalization.\textsuperscript{13,17} The mean reduction in body weight in this study was 7.8 kg. Hospitalization was useful to monitor laboratory changes and ensure frequent sterile wound dressing changes in particular in those patients of older age and with multiple co-morbidities.

Published studies on tumescent liposuction in lipedema and Dercum’s disease are summarized in Table 3. As far as long-term follow-up is available, the outcome after tumescent liposuction remains stable at least seven years.\textsuperscript{20} The procedure leads to significant improvement of body shape, decreased pain and bruising, and improved quality of life.\textsuperscript{2,13,20-24} An important issue is that by early liposuction joint damage can be prevented.\textsuperscript{24} In case of advanced lipedema fat bulges of the knees can be removed correcting the “knock knee”.\textsuperscript{13,20-24} This is the first report on laser-assisted liposuction in lipedema and Dercum’s disease. We employed a 980 nm diode laser with a continuous emission mode. Laser-assisted liposuction is a new technology in aesthetic medicine. Histopathologic investigations demonstrate adipolysis by adipocyte membrane disruption and small vessel coagulation.\textsuperscript{25,26} There is much evidence that subdermal 980 nm diode laser as 1064 nm Nd:YAG laser induce connective tissue remodelling during the procedure resulting in a skin tightening effect.\textsuperscript{27,28} The ideal candidate for skin tightening and body sculpture in aesthetic medicine, however, is young, healthy and not obese.\textsuperscript{29} Therefore, surgical techniques of skin tightening like thigh lift or arm lift might become necessary after liposuction for elderly patients. Nevertheless several patients demonstrated a significant skin tightening effect after laser-assisted liposuction (Figure 3).

As shown in experimental setting, continuous wave mode of laser application achieves a greater and more uniform volumetric heating and reduces peak temperature rise.\textsuperscript{30} The combination with a cooling of the fiber tip in our case offers a greater safety for the patient reducing the risk of skin burning.

An interesting observation is the reduction of pain by liposuction (Table 3). The adipose tissue is innervated by sympathetic nerves. The pain in lipedema and Dercum’s disease is thought to be generated from abnormal connections between peripheral autonomic and sensory nerves.\textsuperscript{31} Liposuction does interrupt the abnormal peripheral nerve circuits but does not affect the thermal and vibratory thresholds in Dercum’s disease.\textsuperscript{32,33} The results indicate that the laser-assisted liposuction is a safe and convenient technology not only in aesthetic surgery but also in the treatment of lipedema and Dercum’s disease. Furthermore, the mean age of our patients of 46.6 years is much higher than most of published data on lipedema and the severity of the disease is high. The patients suffered from numerous comorbidities which have to be considered in individ-
### TABLE 3.

**Tumescent liposuction in lipedema (LE) Dercum’s disease (DD)**

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Number of patients</th>
<th>Age (mean, years)</th>
<th>Lipomatosis stage</th>
<th>Follow-up (months)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berntorp et al. 1998</td>
<td>53 (DD)</td>
<td>52</td>
<td></td>
<td></td>
<td>Significant reduction of body weight*</td>
</tr>
<tr>
<td>Schmeller &amp; Meier-Vollrath 2006</td>
<td>28 (LE)</td>
<td>37.7</td>
<td>I-II</td>
<td>1-26</td>
<td>Normalization of body proportions, less pain and bruising</td>
</tr>
<tr>
<td>Stutz &amp; Krahl 2009</td>
<td>30 (LE)</td>
<td>36</td>
<td>III</td>
<td>n.d.</td>
<td>No significant change of lymphatic vessels</td>
</tr>
<tr>
<td>Schmeller et al. 2010</td>
<td>112 (LE)</td>
<td>38.8</td>
<td>I-III</td>
<td>8-82</td>
<td>Significant improvement of pain, edema, bruising, joint mobility, and quality of life, 22.4% without any treatment after liposuction</td>
</tr>
<tr>
<td>Wollina et al. 2010</td>
<td>6 (LE and DD)</td>
<td>55.7</td>
<td>II-III</td>
<td>≥6</td>
<td>Improved body proportions and mobility, less pain</td>
</tr>
<tr>
<td>Rapprich et al. 2011</td>
<td>25 (LE)</td>
<td>34</td>
<td>n.d.</td>
<td>6</td>
<td>Normalization of body proportions, less pain, improved quality of life</td>
</tr>
<tr>
<td>Hansson et al. 2011</td>
<td>53 (DD)</td>
<td>52</td>
<td></td>
<td>60</td>
<td>Decrease of pain, amelioration of pain up to 5 years after liposuction **</td>
</tr>
<tr>
<td>Present study</td>
<td>17 (LE and DD)</td>
<td>47.5</td>
<td>I-III</td>
<td>3-60</td>
<td>Normalization of body contour, reduction of pain, improvement of mobility, high patient satisfaction</td>
</tr>
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Legend:
- n.d., not done.
- * Here, dry – not tumescent - liposuction was performed in general anesthesia.  ** This is the only prospective trial.
ualized treatment. Nevertheless, even in very long-standing disease and advanced stage improvement by tumescent liposuction is a realistic option.

In conclusion, tumescent liposuction is an effective and safe treatment option for patients with advanced painful lipedema and Dercum’s disease, with higher efficacy than conservative treatment. LATL was found to be less stressful for patients and the surgeon compared with the MTL but larger studies are needed. In further trials the role of early treatment (stage I lipedema) to prevent comorbidities needs to be analyzed.

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REFERENCES


