Lipedma

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Lipedema

Anatomical study, diagnostics and perioperative environment

In recent years, lipedema has received the greatest attention due to its unexpectedly frequent occurrence and the possibility of treating it with liposuction. It is assumed that globally approx. 5 % of the Caucasian female population suffer from this pathological, aggressive fat proliferation. Its inability to be classified in a conventional obesity concept, its fateful progression with reduced quality of life gives dynamic impetus to confront this clinical picture with the most modern research results concerning organ fat. The first therapeutic literature reports and current guidelines come from dermatosurgery and phlebology [10-13]. Only in Germany, Austria [14, 15] and the Netherlands [16] are there guidelines for the diagnosis and treatment of lipedema. Our group has operated on 415 patients with lipedema in the last 4 years.

All our patients were classified by means of duplex sonography with regard to phlebo- logical disease and fat layer assessment. In all of them, an additional impedance measurement (tani- ta scale) was carried out pre- and postoperatively to objectify the adipositas. In this way, the patients were also examined with regard to their metabolic diseases.

In many of these patients, stem cell examinations were carried out in collaboration with the Austrian Boltzmann Institute for Traumatology. Pre- and postoperative physiotherapeutic measures were also carried out. Finally, we conducted studies at the anatomical institute of the University of Graz on relevant lipedema preparations.

Anatomy

Anatomical teaching already had various functions in its primeval times for the organ fat, whereby primarily the storage fat and the structural fat (building fat) in the subcutaneous area were de- fined. Increased new formation of lipocytes is only possible under certain conditions, e.g. slowed blood flow (Virchow) and insufficiency of the lymphatic drainage ([1], Unna in [2]). The panniculus adiposus shows com- plete atrophy at certain points. This is called lipopho- bie of the tissues: no fat where there is no muscle under the skin but only bone, cartilage or ligaments. Examples are sternum, tibia, eyelids, male genitals, ears.

Lipoedema is characterised by hyperplasia and hypertrophy of the fatty tissue in the extremities, caused by congestion in the lymphatic system. Pretibial lipophobia is therefore lost (**Fig. 1**)!

In the normal case (**Fig. 1a**), the flash neck can be seen, above the medial

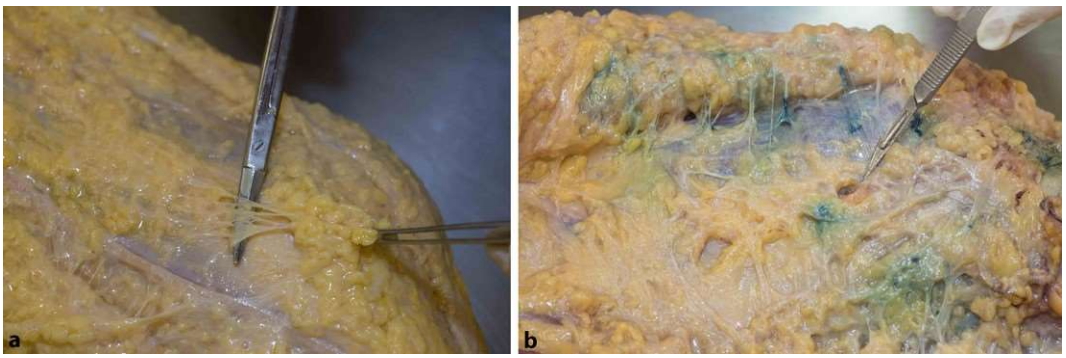

Fig. 1 **a** Anatomical preparation of the unifying lymphatic collectors in the medial knee region of a normal patient. **b** Attempt to prepair the lymphatic collectors. However, these can hardly be visualised due to the fibrosis in the fascia area. Image of fasciitis (© M. Sandhofer, with kind permission)

Fig. 2 8 Ultrasound examination of the confluent great saphenous vein. Compression in the thigh area is very painful! (© M. Sandhofer, with kind permission)

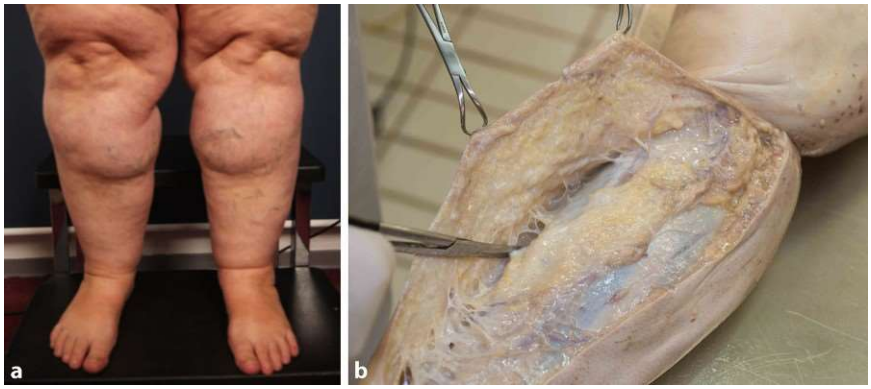

Fig. 3 8 **a** Full picture of the pretibial proximal bottle neck fat body in the late stage. **b** Dissection of the pretibial bottle fat body, macroscopically traversed by ectatic lymphatic vessels (© M. Sandhofer, with kind permission).

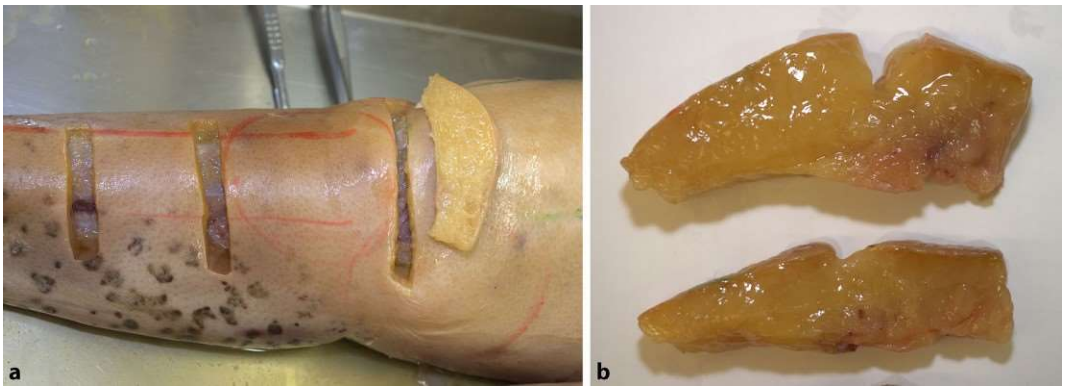

Fig. 4 9 **a** Pretibial excision of several cutaneous/subcutaneous structures up to the periosteum, proximally and distally. **b** Excision of pretibial with massively thickened subcutis, **a** over the tibia, **b** over the wa- de

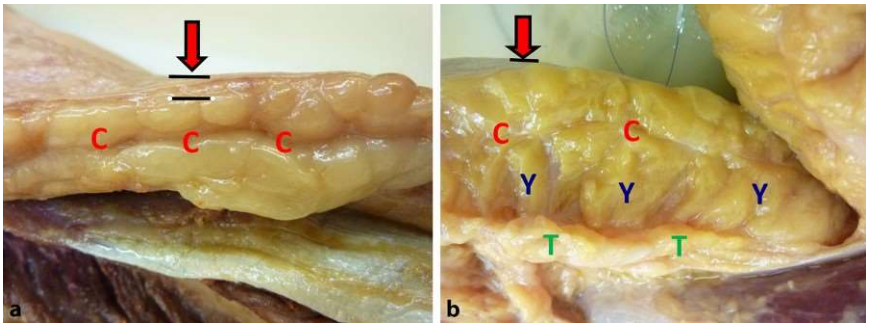

Fig. 5 8 **a** Normal structure of the subcutaneous fat of the upper arm with a normal dermis and an intermediate fascia (*C*). **b** Subcutaneous structures of a pronounced lipedema upper arm with extremely thinned dermis and pronounced three-layered fat compartments. Here
The function of the dermal fat (dWAT) in particular may be impaired [17, 19]. *C* Camper's fascia, *Y* sub-cutaneous fat layer, *T* fat layer above the triceps fascia (© M. Sandhofer, with kind

In the case of a lipoedema preparation (**Fig. 1b**), it is not possible to visualise them because the fibrotic changes with the inflammatory fascia wall up the collectors. This inflammatory phenomenon in the sense of fasciitis also explains the extreme tenderness along the saphenous vein on the inner thigh, which alone suggests the diagnosis of lipoedema (**Fig. 2**). We make these observations again and again in the course of routine phlebological duplex examinations.

The pretibial to medial lymphatic vessels constrict fla- schen-neck-like and thus form a lymphatic backwater, clinically manifested by the lymphatic congestion typical of the lip-

Infobox 1 Comorbidity of the 415 patients operated on (period: 2013-2017)

In 26 of these cases, a previous surgical varicose vein repair, mostly by stripping, had preceded.
In several cases, a unilateral increase in circumference was observed on operated legs.

The typical neck of the bottle fat body (- **Fig. 3a**).

Pretibially, we were also able to excessive fat thickening.
The dermis shows a strong thinning of the dermis, which is manifested macroscopically by a coarse lobular structure interspersed with dense connective tissue fibres (- **Fig. 4b**). The dermis is very thinned out.

» Lipedema is from Hyperplasia and hypertrophy of the adipose tissue on the extremities

Lipoedema also shows a clear thinning of the dermis with its increase in stage, as can be seen in our upper arm preparations (- **Fig. 5a, b**).

In addition, we have in our anatomical studies the effectiveness of different suction cannulae. On the right, we see the result of an aggressive suction with a vacuum system on the preparation of the median abdominal fat layer (- **Fig. 6**), where all lymphatic collectors on the rectus fascia were no longer detectable. On the left, the lymphatic structures are visible after suction with the MicroAir system (PAL, AFS Medical GmbH - Medizinprodukte-handel, Teesdorf) has been preserved. We have therefore used this lymph-preserving suction system exclusively for all our treatments of lipoedema. In our opinion, the application of energy, as is the case with laser lipolysis or radiofrequency-assisted liposuction, is contraindicated in lipedema [4, 18].

Summary - Abstract

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Lipoedema. Anatomical study, diagnostics and perioperative environment

Summary

Lipedema is a very complex condition, unsuspectedly frequent occurrence of the disease. the fat system of the extremities. It a lymphologic disease pattern, whereby especially the building fat as are affected. Only in a few cases is it also vulnerability associated with metabolic symptoms. explained.
Lipedema is a special form of adipose, which is neither in medicine nor in of the population as exercise- and diet-responsive. perceived as ins- sistent. The people concerned Patients are extremely distressed in their emotional equilibrium. have a lasting effect. On the basis of our anatomical examinations, one can quite of a serious, progressive Disease of the subcutaneous fat tissue and of the neighbouring, associated structures speak. It is not only the clinic, but also the duplex sonographic evaluation. and impedance analytic exploration are for diagnosisfindings and for postoperative follow-up is necessary. It also confirms the a special behaviour of the stem cells of the pathomechanism. Due to thinning, this is of the dermis and loss of elastic fibres dermatological problems such Dryness, tendency to infection, and tendency to ecchymosis can be
In this case, the function of the dermal fat is impaired. From our observations Observations show that obesity is especially the early surgical therapy Liposuction can for patients in the early stages and the patients a significant improvement in the quality of life.

Keywords

Liposuction - Duplex sonography - Stoff metabolic disease - lipophobia - Impedance measurement

Lipedema. Anatomical study, diagnosis, and perioperative setting

Abstract

Lipedema is a very complex, unexpectedly is confirmed by a particular behavior of frequently occurring disease of the fat system the stem cells. Dermatological problems of the extremities. It is a lymphologic disease such as dryness, infections, vulnerability, that especially affects abdominal fat. In a and tendency toward ecchymosis can be
few cases is it also associated with metabolic explained by the thinning of the dermis and symptoms. Lipedema is a special form of loss of elastic fiber. Here, the function of obesity that is not recognized by medicine or dermal fat may be impaired. It is apparent the population as being resistant to exercise from our observations that, in particular, early and diet. The mental burden for these patients surgical therapy by means of liposuction has is extreme. On the basis of our anatomical a lasting value for patients in the early stage investigations, one may well speak of a and brings a significant improvement in the serious, progressive disease of subcutaneous quality of life to the patient.
adipose tissue and neighboring, associated structures. Not only is a clinical examination required, but also duplex sonographic Meta- evaluations and impedance measurements bolic disease - Lipophobia - Impedance are necessary for diagnosis and postoperative measurements

Keywords

Liposuction - Duplex sonography -

Phlebology

Of our 415 operated patients, 99 had a relevant phlebological history (- **Infobox 1**).

Among the types of varicose veins, there is a higher incidence of truncal of the profunda perforans type according to Hach [3] (- **Tab. 1**).

Since anatomically the main lymphatic collectors on the thigh partially cross the great saphenous vein, a lymph-sparing procedure is necessary, especially in **lipedema** (- **Fig. 7**).

Fig. 6 8 Suction of abdominal fat over the rectus fascia. On the right with an aggressive suction cannula and on the left with the vibrating Micro Aire Cannula (PAL) (© M. Sandhofer, with kind

Fig. 7 8 Anatomical preparation of the great saphenous vein on the thigh with crossing lymphatic collectors (© M. Sandhofer, with kind permission).

Fig. 8 8 65-year-old lipoedema patient with truncal varicosis of the great saphenous vein known for 30 years. Type Hach stage 4 3] (© M. Sandhofer, with kind permission)

For this reason, radial stripping methods should also be avoided. We generally prefer endolumi- nal obliteration techniques with radio waves (VNUS Closure fast) or chamber-assisted foam sclerotherapy. Peripherally, primarily sclerotherapy should be used, especially as extensive surgical measures cause massive haemorrhage and swelling, particularly in lipoedema, and thus also a prolongation of the postoperative follow-up period.

After we had clarified all our patients by duplex sonography, it was surprising that in individual cases persistent unilateral swelling of the lower leg could be observed occurred. After duplex sonographic clarification, we were able to verificate new perforating varicose veins of the Cockett type. The loss of pressure from the thick, suctioned hypertrophic fat layer could explain this postoperative phenomenon. In these few individual cases, active follow-up by means of sclerotherapy or perforant dissection was required.

» Radical stripping methods should be avoided

We routinely treat the existing varicose veins at least 2 months before the therapeutic liposuction of the lipoedema. First and foremost, the existing phlebolymphedema and the associated adipogenesis must be eliminated. On the other hand, a varicose vein can easily be injured during liposuction, which can lead to a dramatic complication of bleeding. **Fig. 8** shows the increased lymphological pathomecha- nism of decompensated varicose veins, especially as extreme leg circumference diffe- rences can result from increased fat hyperplasia (**Fig. 8**).

Diagnostics

Currently, the existing guidelines for the presence of lipoedema in Germany and the Netherlands do not include the Parameters such as morphology, haematoma and swelling tendency, and painfulnessevidential.

Duplex sonography

Due to the specific changes in the fatty tissue, duplex examination is indispensable in lipedema. The pretibial fat deposits are decisive, as the physiological lipophobia of this zone is lost in almost all types of lipoedema. At the same time, sonography is used to determine the phlebological status with possible varicose veins as well as the extent of so-called lipo- olymphoedema (**Fig. 9**), and in lipoedema the duplex shows the classic image of a snowdrift. Sonographically, there is a homogeneous spreading of the subcutis with uniformly increased echogenicity and an accentuated presentation of echo-rich septa. The thickness of the layer in the lower extremity can also be objectified anatomically by the deep position of the truncal veins, especially as they run with their shallow tunnels on the fascia cruralis and femoralis (**Fig. 10**).

Impedance measurement

We performed a bioelectrical impedance measurement (BIA) for the analysis of body fat (Tanita scales) in all 415 operated patients pre- and postoperatively. In 186 patients

Tab. 1 Variceal types

Truncal varicosis of the saphenous vein ma- gna	39
Truncal varicosis V. saphena parva	3
Profunda-perforans-Hach-varicosis	7
Isolated side branch varicose	11
Isolated perforator varicosities	8
Postoperative new perfo- rans varicosis (Cockett)	5
Already pre-operated patients out- side	26

Tab. 3 Comorbidity of 415 lipoedema patients

	N = 415	%
Veins	99	23,9
Hypothyroidis	91	21,9
Depressive mood	42	10,1
Movement restriction	38	9,2
Hypertonus	23	5,5
Div. coagulation	17	4,1
Neurological disease	17	4,1
Hormonal disorder	13	3,1
Bariatric patients	12	2,9
Skin disease	11	2,7
Cardiological disease	11	2,7
Factor V	9	2,2
Hyperlipidaemi	4	1,0
Diabetes	3	0,7

Comorbidity lipedema

showed obesity (body mass index [BMI] over 30), which made it necessary to assess the obesity with all its metabolic risks (- **Tab. 2**). Surprisingly, of these many obese patients, only 3 patients had diabetes mellitus (0.7%) (- **Tab. 3**).

We would like to explain the diagnostic benefit of bioelectrical impedance measurement in lipedema on the basis of the following case histories:

Fig. 11 shows that a patient with extreme overweight and bariatric therapy lost a lot of weight (96 kg). What has not improved

Tab. 2 Comparison of lipedema patients vs. the average female population in the German-speaking world [20].

	Lipedema patients *N* = 415	**Average population**
Weight (kg) (average)	86,73	67
Body mass index (average)	30,65	26,1
Fat content (%) (average)	37,25	- –
Fat percentage (kg) (average)	32,25	- –
Obesity (people)	186	- –
Obesity (in %) (average)	44,82	23,9
Visceral fat (average) (Pathological over 13 units)	7,54	- –
Extracted fat (net litres) (average)	8,98	- –

However, the pronounced lipoedema, so that one must assume that lipoedema is not a metabolically storing fat.

Since lipoedema itself is considered to be resistant to diet and exercise, the

for us the Questi Whether Impedance Measurement of mesenchymal structures using Tanita scales about the value of lymph-sparing liposuction. In the 27-year-old patient shown in - **Fig. 12a, b,** we were able to document a favourable course over a period of 1 year on the basis of the following parameters (- **Fig. 12c**). A total of 9 litres of pure fat were removed in 2 sessions. The original weight was reduced by 4 kg after 2 months and by 16 kg after 1 year. The fat mass was also reduced from 27 kg to 15 kg within one year. The water retention was still high after 2 months, corresponding to the water retention of the large wound surface. Interestingly, there was also a significant reduction in muscle mass, whereby it can be assumed that the original subcutaneous lymph congestion also extended into the muscles of the extremities. The basal metabolic rate, which was usually significantly reduced for lipedema, returned to normal values after 1 year. The values listed here can usually be achieved in young patients with stage 1 to 2 and with a BMI that is not significantly increased. When the hyperplastic, hypertrophic lipoedema fat is removed and a normal lymphfluss is achieved, effective control of fat dynamics via the hypothalamus is possible again, i.e. a transformation to physiological fat metabolism takes place again. The resistance to movement and diet of lipoedema is lost with therapeutic liposuction.

The physiological, hormonel- change situations such as puberty, Pregnancy and menopause have a major influence on the development of lipoedema [5]. In the same way, hormonal contraception has a negative effect on lipoedema. In - **Fig. 13a-c** we have documented a patient pre- and postoperatively, whereby 2 months after the surgical intervention a normal response, as also described in - **Fig. 12. The control after six months** was normal. The check-up after six months was again accompanied by clinical complaints in the sense of lipoedema (bruises, pressure and rest pain). All values in the impedance analysis (- **Fig. 13d**) had worsened. The patient received a so-called "3-month injection" for contraception. Since several patients on the pill were unable to observe any significant clinical improvement after liposuction, which we were also able to determine by means of impedance measurement, it is obligatory for us to radically discontinue any hormonal therapy pre- and postoperatively.

Lipedema is not only resistant to active sports,

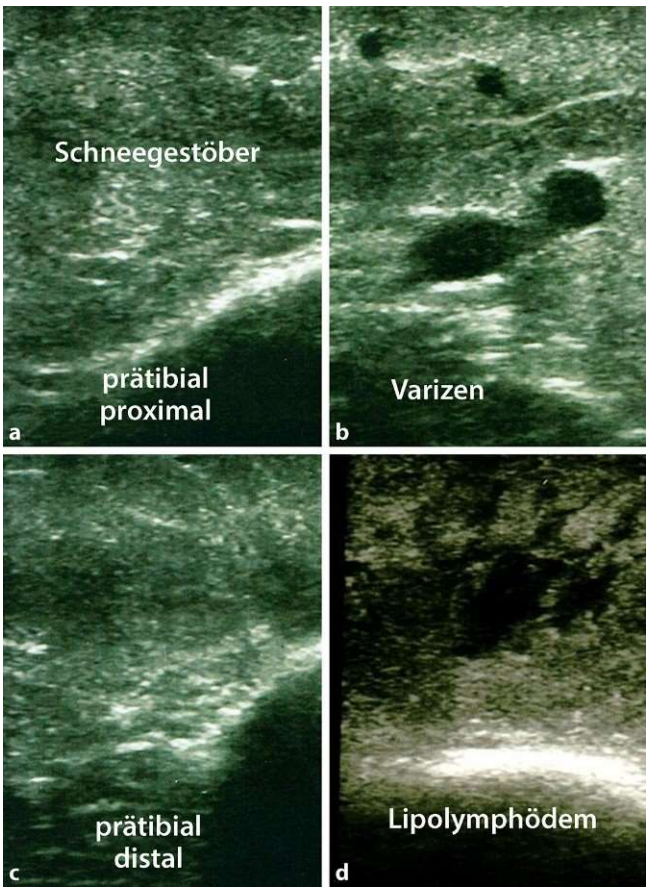

Fig. 9 9 Thickened pretibial fat deposits, **a** 3 cm thick proximally pretibially; **c** pretibially distally 2 cm thick. **b** Varix convolutes. **d** Seroma-like, echo-poor lymph accumulation - lipolymphoedema. In the first 3 so-called snow piles (pattern of fat distribution) (© M.

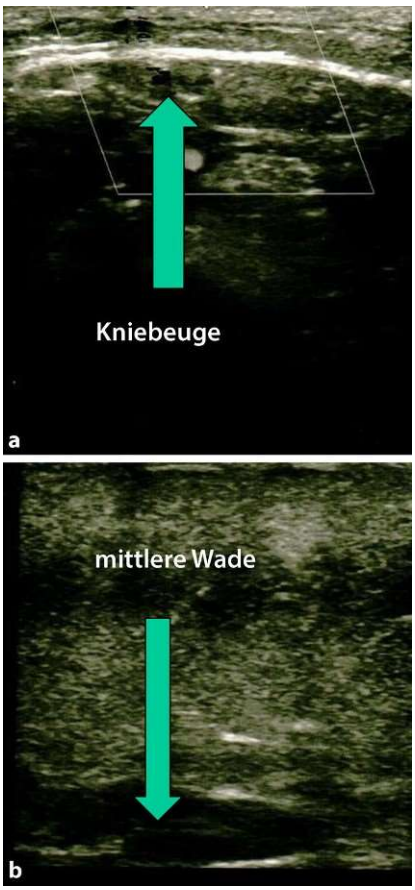

Fig. 10 8 **a** Subdermal saphenous vein in the bend of the knee. **b** 4 cm deep saphenous vein in the area of the mid-calf (© M. Sandhofer, with kind permission).

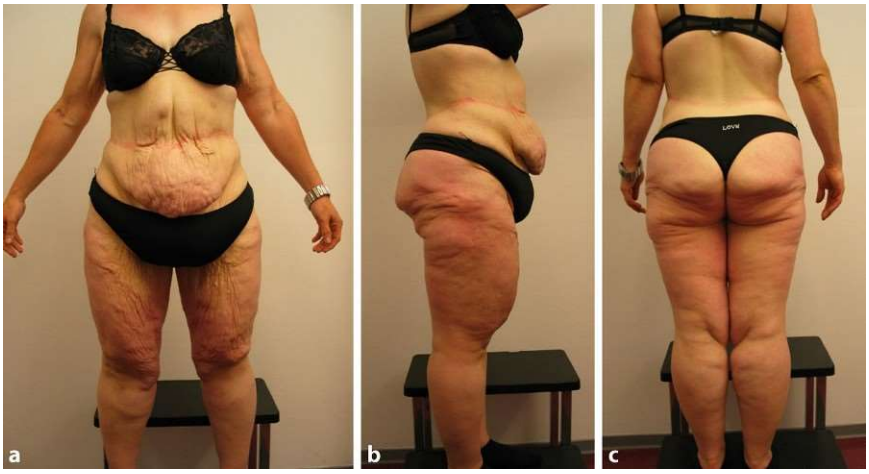

Fig. 11a-c 8 Lipoedema patient after gastric bypass surgery and weight loss of 96 kg (© M. Sandhofer, with kind permission)

but in the case of extreme athletic stress, there is a radical deterioration, as we have been able to document in **Fig. 14a**, **b.** The 23-year-old sports student weighed 79 kg at the initial examination, with typical values for lipoedema. After refusing the proposed surgery and undergoing a radical sports programme, she was 1 year, there was a weight gain of 9 kg, a significant increase in fat mass, BMI, visceral fat and a significant decrease in basal metabolic rate (**Fig. 14c**). The extreme circulation of the extremities through sport with normal return transport of 90 % venous and 10 % lymph strains the already

The result was that the subcutaneous lymphatic system became even more congested, which led to increased adipogenesis.

The dynamics of lipedema and the associated therapeutic options are further objectified by the documentation of a 53-year-old mother and her 24-year-old daughter (**Fig. 15a, b**). The mother (**Fig. 15a**) had the same weight 30 years ago as her daughter now. She currently has 143 kg, 79 kg fat mass, a visceral fat of 23 and a BMI of 56 and a significantly reduced basal circumstance. Anamnestically, she had bleeding fibroids, received ongoing hor- mon therapies for this and is currently borderline immobile. The daughter is 23 years old and weighs 81 kg, has a fat mass of 31 kg and a BMI of 31. Her visceral fat is far below the norm and her basal metabolic rate is

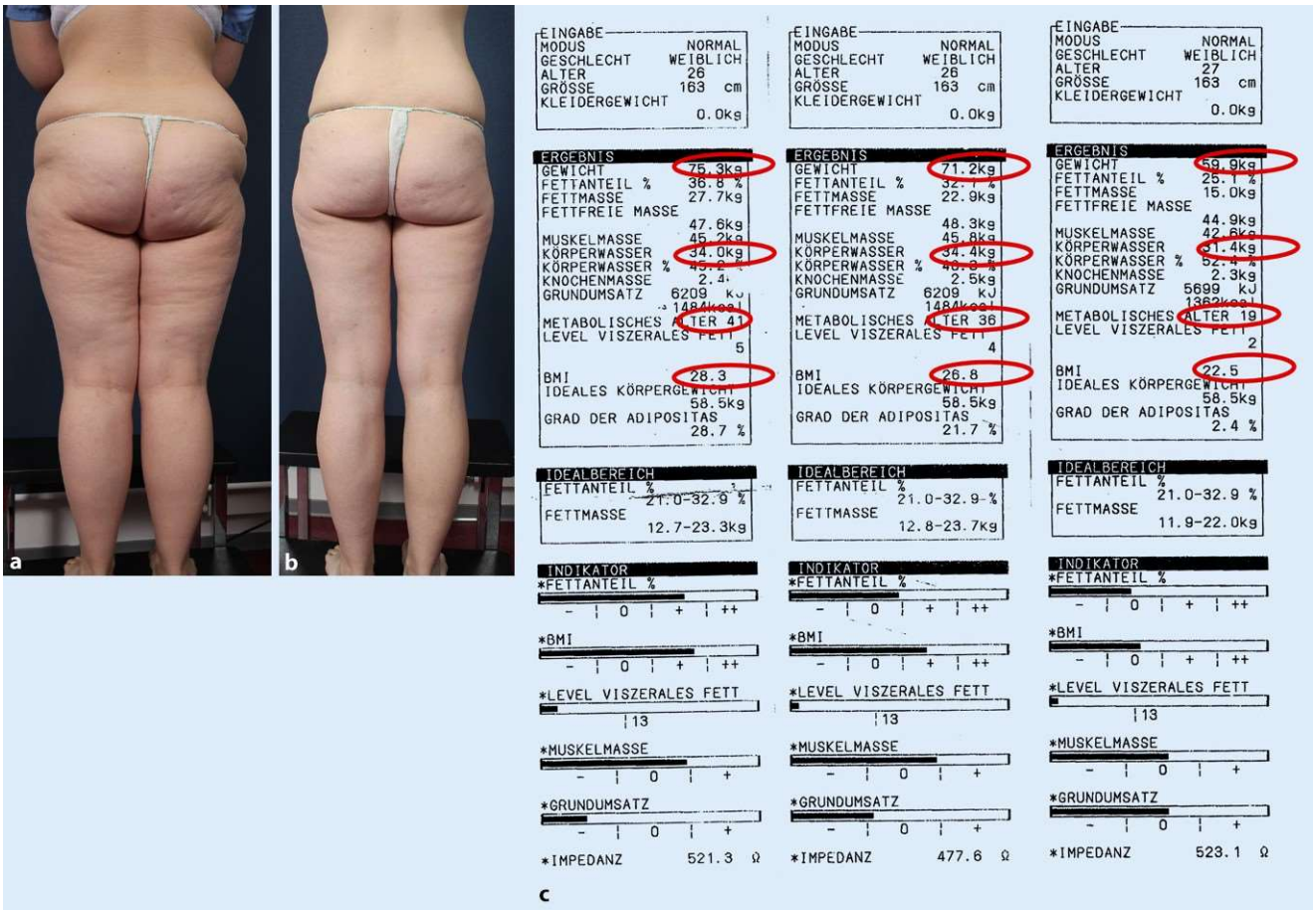

Fig. 12 8 Lipoedema patient before and 1.5 years after lipoedema surgery (© M. Sandhofer, with kind permission)

Fig. 13 8 Lipoedema patient before (**a**) and 2 (**b**) or 7 months (**c**) after lipoedema surgery (© M. Sandhofer, with kind permission)

Mother/Daught the following results: The daughter will soon be treated by liposuction and has a good prognosis. The mother's fibroids must first be removed and hormone replacement must be discontinued. Subsequently, a bariatric-metabolic therapy in the sense of a tube stomach would be necessary, and only then can the lipoedema be cured surgically by means of lymph-sparing liposuction. In this case, straightening operations are probably also necessary. If one compares the morbidity and cost factors of the daughter and the mother, the mother's probably outweighs the other by a factor of 10.

Stem cells

We have performed stem cell studies on lipedema (stromal vascular fraction) [6]. Thereby we found twice the number of stem cells

Fig. 14a,b 9 Sports student with lipoedema, before and after one year of intensive sporting activity (© M. Sandhofer, with kind

Fig. 15a-c 9 Mother and daughter, data of the impe- dance analysis (© M. Sandho- fer, with kind permission)

compared to healthy patients. The viability and the energy content of the cells were the same, whereby the adipogenesis was reduced compared to the healthy person. The regenerative process is clearly increased in lipedema, accompanied, however, by an increased degradation (degeneration) of the adipocytes. We were able to document this through biopsies from lipedema fat: There were clear degradation processes poCytes with different large, partly nucleus-less adipocytes and an increased phagocytosis activity with so-called "phagocytosis".
"crown like structures" (histological

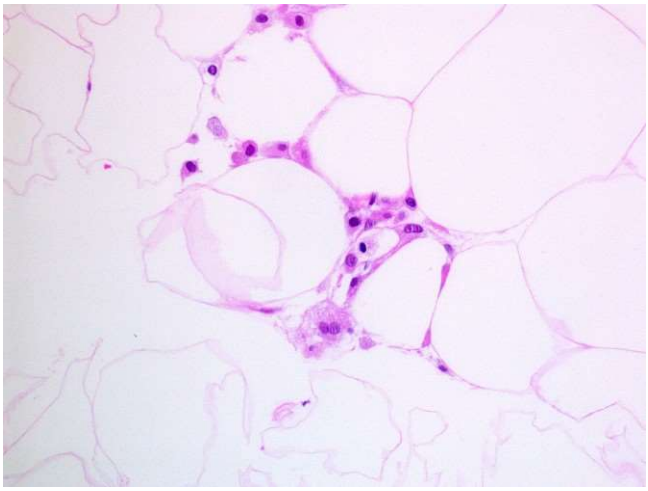

Fig. 16 9 Histology: Sample excision from the subcutaneous fat of a lipoedema patient (© M. Sandhofer, with kind permission).

Physicotherapy

Conservative therapy pursues 2 goals: Improvement of the symptoms and/or the dysproportion. The main therapeutic measures are compression, manual lymphatic drainage (MLD) and intermittent compression (AIK). The same applies to the reduction of haematoma tendency. We routinely use LDM ultrasound therapy [7] against inflammatory processes pre- and postoperatively. With regard to postoperative indurations, the lymph drainage effect of the radial shock wave is recommended [8]. Forced walking with activation of the muscle pump and additional exercise therapy in water have an excellent therapeutic effect. Already half a metre under water, a pressure in the sense of a compression class 2 comes into effect. The more subcutaneous fat develops, the more the dermis thins out. With the progression of subcutaneous adiposity, there is also a loss of elastic fibres in the dermis. Thus, the cohesive force of the dermis is largely lost, leading to stages 2 and 3 of lipedema [9]. This cohesive deficit can only be compensated for with flach-knitted compression material.

This means that compression treatment is still possible in stage 1 with round-knitted compression stockings, but in stage 2 and even more so in stage 2 with compression stockings.

Stage 3 flach-knitted compression stockings are indicated pre- and postoperatively. The physiotherapeutic measures are necessary for life in mild cases that do not necessarily require surgery. Thinning of the skin also leads to atrophy of the skin appendages, which can also manifest itself in dehydration and hairlessness of the affected areas. As a result, appropriate indifferent care measures are also required perioperatively.

Preoperatively, total decongestion must be ensured, especially in patients with lipolymphoedema; postoperatively, appropriate compression girdles/stockings must also be applied. Often the lower legs may require prolonged compression treatment by means of waist stockings. In some patients, residual post-operative symptoms are always present again, so that physical therapy measures are also necessary here. This is especially true for patients with a long history of illness without any diagnosis or therapy.

» Physicotherapeutic Measures are for cases that are not to be operated on, necessary for life

A reduction of the pathologically increasing fatty tissue with elimination of the dysproportion, but also of the The treatment of these complaints is currently not possible through physical measures. Pre-operative spa stays are also not absolutely necessary in most of our cases. This is especially true for early stages.

Conclusion for the

- **Lipoedema is a complex disease of the fatty system of the extremities and is a special form of obesity.**
- **In addition to clinical examinations, duplex sonographic evaluation and impedance-analytical explorationalso necessary for diagnosis and postoperative follow-up.**
- **A special behaviour of the stem cells confirms the pathomechanism. Due to thinning of the dermis and loss of the elastic fibres, dermatological problem areas are such as dryness, infectious nevi The main reasons for this are the ageing, vulnerability and tendency to ecchymosis.**
- **Especially the early surgical therapy by means of liposuction has sustainable value for patients in the early stages.**

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Compliance with ethical

Conflict of interest. M. Sandhofer, P. Schauer, M. Sandhofer and F. Anderhuber state that there is no conflict of interest.

This article does not include any studies on humans or animals conducted by the authors. All patients who are identifiable through images or other information in the manuscript have given their written consent. In the case of patients who have not reached the age of majority, the consent of a parent or legally appointed guardian is given.

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