Original communication

Volume reduction in leg lymphedema after comprehensive inpatient rehabilitation

A naturalistic prospective cohort study

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https://econtent.hogrefe.com/doi/pdf/10.1024/0301-1526/a001268 - Wednesday, March 25, 2026 6:07:22 PM - IP Address:1.123.231.1

Summary: *Background:* Data on volume changes after complex decongestive therapy (CDT) for leg lymphedema are sparse. This naturalistic prospective cohort study aimed to quantify the intraindividual changes of leg volume after comprehensive inpatient rehabilitation, focusing on intensive CDT, and to relate these changes to health-related quality of life (HRQOL). *Patients and methods:* Limb volume of patients with leg lymphedema (n = 101; 75 women) were measured between entry and discharge (3 weeks later) by the 4 cm measurement method according to Kuhnke and the Perometer® method. Changes were also expressed as standardised response means (SRM). The change on the Freiburg Quality of Life Assessment for lymphatic disorders, short version (FLQA-lk) total score was predicted using multivariate linear regression analysis with volume data adjusted for various confounders. *Results:* The overall mean volume decrease on the 4 cm/Perometer® method for both legs combined was 1.94/1.31 l for all patients, corresponding to SRMs of 1.04/0.86. In the lymphedema-affected limbs, the decreases ranged between 1.03 and 1.40 l/0.77 and 0.99 l (SRMs 0.70–1.72/0.67–1.28). The total volume loss (4 cm) of both legs of all n = 101 patients correlated by 0.240 (bivariate, p = .010) and by 0.216 (multivariate, adjusted, p = .045). *Conclusions*: After multidisciplinary rehabilitation focusing on intensive CDT, moderate to large effects on reducing limb volume were observed. Volume reduction was positively associated with improvement in HRQOL.

Keywords: Lymphedema, limb volume, rehabilitation, complex decongestive therapy, health-related quality of life

Introduction

Lymphedema of the legs is a chronic, debilitating disease with symptoms that include functional limitations and psychosocial consequences, such as altered body image. These symptoms significantly impair the health-related quality of life (HRQOL) of those affected [1, 2, 3]. Primary lymphedema is characterised by an intrauterine malformation or genetic disorder of the lymphatic system. Secondary lymphedema may have different etiopatholic reasons; typical is the interruption of the lymphatic vessels due to trauma, cancer, surgical therapy, or chronic infections. In both forms, reduced lymphatic transport accumulates interstitial fluid, leading to chronic swelling and, over time, remodeling of the interstitial tissue in the affected limb or drainage region. A patient's medical history and clinical findings are usually sufficient for diagnosing lymphedema [1, 3]. Currently, there is no specific diagnostic test or curative treatment for lymphedema.

Complex decongestive therapy (CDT) and rehabilitative interventions that reduce the functional and psychosocial consequences of lymphedema, helping patients to cope, are well-established clinical approaches to improving health-related quality of life (HRQOL). However, scientific evidence supporting CDT is limited. A review of 168 studies found that single therapy modalities are relatively ineffective, but combined treatment programs that reduce limb volume lead to greater improvements [4]. This aligns with our multidisciplinary rehabilitation setting, which focuses on intensive CDT. In this setting, the observed effects were corrected for waiting time effects [5]. Effect sizes up to 0.767 could be causally attributed to the 3-week inpatient intervention (n = 67 leg lymphedema).

In the most recent and important reviews, almost all studies on the effectiveness of conservative management report findings for lymphedema of the arm [6, 7, 8]. Data on volume reduction in lymphedema of the leg are scarce. And among those, very few report absolute volume data instead of (to the unaffected leg) relative volume data [8, 9]. Other important reviews summarised only settings with exercise interventions not with CDT [10].

The first aim was to quantify the absolute baseline and change in leg volume within individuals between the start and end of a 3-week comprehensive inpatient rehabilitation program, focusing on intensive CDT. The second aim was to examine the association between volume change and change in HRQOL.

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Materials and methods

Patients

Patients were consecutively referred by their family physicians, internists, or angiologists to the angiology department of our rehabilitation clinic for inpatient treatment [5]. Health insurance companies reimbursed inpatient rehabilitation on the condition that patients still suffered from symptoms requiring further treatment despite having already received at least 6 months of outpatient physiotherapy and CDT, the quality of which was often unknown. The study was approved by the local ethics committee, and written informed consent was obtained from all participants.

The inclusion criteria were as follows: (1) Age between 18 and 90 years. (2) A confirmed diagnosis of primary or secondary lymphedema of stage II according to Földi/International Society of Lymphology (ISL; edema with secondary vessel changes and pitting; limb elevation alone rarely reduces tissue swelling) or stage III (hard edema and trophic skin alterations with lobuli, former "elephantiasis") by the head of the angiology department (last author) [1, 3, 11]. Excluded were edema with a predominantly nonlymphatic component, i.e., lipedema, venous, cardiac, renal, liver-related edema as well as persons with BMI > 50.0 reflecting severe, morbid obesity, which has a major impact on the levels of health and quality of life dimensions in contrast to the lymphedema alone.

Intervention

The entire 3-week intervention has been described in detail in our first report (Angst 2023 [5]; see also Table I). Patients participated in two CDT sessions on 5 days per week, on Saturdays only in the morning CDT session. This therapy intensity corresponds to a phase I intervention according to the guidelines [3]. Before the morning CDT session, participants underwent an aquatic group session with removed bandages (in water at 28°C, with exercises such as gymnastics and aquatic-jogging).

The morning CDT session consisted of meticulous skin care, manual central and peripheral lymphatic drainage, and application of a three-to-four layer compression bandage to the affected limb and, if necessary, to other extremities: (1) a gauze stocking (tube gauze), (2) a foam or cotton bandage, (3) a short stretch compression bandage, and (4) additionally optional a long stretch bandage above the short one. The afternoon CDT session consisted of central manual lymph drainage, checking the compression bandage, and, if necessary, correcting or reapplying it for the night.

The therapy program included individual physiotherapy three times a week to treat lymphedema-related issues, such as muscular imbalance, on a case-by-case basis and three times a week walking group with the bandage. Additionally, daily guided individual medical training therapy (MTT) and compression stocking usage instruction were provided. Optional individual psychotherapy

Table I. Sociodemographic and disease-relevant data at entry and the FLQA-lk total scores at entry and discharge (n = 101)

Characteristic	Bilateral	Unilateral right	Unilateral left	Total
n	47	20	34	101
Female	33 = 70%	15 = 75%	27 = 79%	75 = 74%
Educational attainment level (%)				
Basic school (8–9 years)	6	0	12	7
Vocational training	60	65	56	59
College/high school/university	34	35	32	34
Comorbidities (%)				
None	4	0	12	6
1	9	25	12	13
2	6	15	21	13
3	23	15	24	22
≥4	57	45	32	47
Secondary lymphedema	32 = 46%	17 = 85%	21 = 62%	70 = 69%
BMI (kg/m^2): M (SD)	31.6 (8.2)	25.7 (5.6)	29.6 (7.5)	29.7 (7.8)
Age (years): M (SD)	62.1 (15.2)	61.3 (12.0)	57.9 (14.6)	60.5 (14.4)
FLQA-lk total entry: M (SD)	65.7 (13.7)	70.1 (17.6)	66.9 (17.7)	66.3 (15.9)
FLQA-lk total discharge: M (SD)	73.6 (13.9)	77.0 (18.4)	75.5 (13.9)	74.5 (15.0)
FLQA-lk total change: M (SD)	7.9 (10.0)	6.9 (9.1)	8.7 (9.4)	8.2 (9.7)
FLQA-lk total SRM: M (SE)	0.79 (0.15)	0.76 (0.22)	0.92 (0.17)	0.85 (0.10)

Notes. BMI: body mass index; FLQA-lk total: Freiburg Quality of Life Assessment for lymphatic disorders, Short Version Total score (0 = worst, 100 = best); M: arithmetic mean; SE: standard error; SRM: standardised response mean.

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was another element of the program. Nutrition counselling received every participant. Compression stockings adapted to reduced volumes were ordered and delivered upon discharge, and their fit was checked during the discharge measurement.

Measures

Volumetry was performed at entry and discharge using two methods, both of which were always administered by one of the same two therapists: (1) the 4 cm circumference volume measurement method after Kuhnke, and (2) the optoelectronic Perometer® technique [12, 13].

The Kuhnke method measures the circumference at right angles to the leg. This method is simple and possible in almost every clinical situation, as it only requires a measuring tape. Leg volumes were calculated for each 4 cm of leg length from 8 cm above the ground to the crotch and added together using the cylinder volume formula by the measured leg circumferences. Oblique measurements from the crotch allow determination of leg volume beyond the crotch (e.g., buttocks, partial breeches), at least for comparison purposes with subsequent measurements. In our clinic, the measurement was performed by three trained individuals who periodically checked each other's technique. Standardised foot positioning improved reliability. A right-angled heel rail was used to standardise the position of the leg. The measuring tape was tensioned using standardised 100g weights attached to its end.

The Perometer® device is an optical body scanner [14, 15]. As the frame moves over the limb, LED light barriers and measuring sensors scan the leg and take circumference measurements approximately every 4.7 mm. These measurements are used to calculate the volume. Measurements are taken from 53 mm above the ground up to the "stop" in the crotch area. Due to the rigid measuring frame, however, measurements can usually only be taken up to approximately 10 cm below the crotch, depending on the contour of the thigh. Each volume calculation is compared with previous measurements and adjusted to the lowest measurement height for long-term comparisons. Previous comparative measurements are adjusted downward. Therefore, it is important to raise the measuring frame as high as possible each time.

The Perometer® method requires that patients must be able to stand safely and cannot exceed a body weight of 130 kg (written information in the owner's manual of "Pero-Systems"). The 4 cm method is taken with the patient lying down and can therefore always be carried out, even with bedridden patients. This led to a difference in the number of examined subjects. Examination was completed by photographs of all four sides of the body in a standardised position. Both measurement methods enable an assessment of the volume progression as an objective criterion of the clinical situation and the volume progression. Due to the different measuring heights (from foot to crotch), the measured values are not identical, but nevertheless allow a comparison and control of the measurements taken. Further measurement characteristics of both methods are outlined and discussed later in the discussion.

The Freiburg Quality of Life Assessment for Lymphatic Disorders (short version; FLQA-lk) is the only validated, disease-specific German questionnaire that measures health and quality of life (QOL) [16]. It is composed of the following scales: physical symptoms, daily and professional life, social life, mental health, lymphatic disorder therapy, and satisfaction. The sum of all 33 items builds the FLQA-lk total score, which is used to relate to leg volume change in this study.

Analysis

For all limbs, the volume differences between entry and discharge (3-week stay) were measured in ml = cm^3 by both techniques and described using distribution-dependent and -independent parameters to depict potential asymmetries in the frequency distributions. By the fact that a person has a system of lymph vessel drainage in both legs that confluences with the central lymphatic system, the volumes of both legs even if not affected, were summed for part of the analyses.

The standardised response mean (SRM) is the volume/score difference between entry and discharge divided by the SD of the differences. It is also known as "Cohen's delta" and is a standardised measure of effect size [17, 18]. SRMs ≥ 0.80 reflect large effects, and SRMs ≥ 0.50 reflect moderate effects [17]. A positive SRM reflects improvement, i.e., volume loss. Linear regression modeling was used to relate the volume difference (entry minus discharge) to the FLQA-lk Health and QOL scale via bivariate correlations (zero order), and adjusting for sex, age, education, number of comorbidities, BMI, baseline volume, and baseline FLQA-lk total score (see Table I) via partial correlations. All those variables are potential confounders that may influence HRQOL (FLQA-lk total score) and leg volume and their changes after therapy.

Results

Patients, sociodemographics, and HRQOL

Of the 290 admissions from August 2015 to March 2024, 82 (28.3%) were excluded because they had a different primary diagnosis, 27 (9.3%) were excluded due to morbid obesity (BMI > 50), and 14 (4.8%) were excluded due to advanced age (>90 years; Figure 1). A further 62 participants (21.7%) were unable to participate due to language, adherence, or other problems, and four had incomplete volume data (e.g., because of premature discharge due to acute illness).

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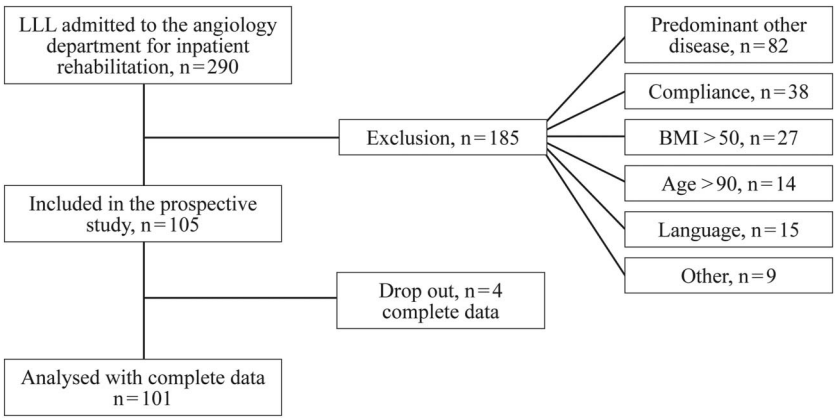

Figure 1. Flow chart of study participants. BMI: body mass index (kg/m2); LLL: lower limb lymphedema; n: number of subjects.

The typical participant with complete data (n = 101, 4 cm method) was female (74%), aged 60.5 years, not obese (mean BMI = 29.7), with an education level of vocational training (59%), with three (median) comorbidities, and with a mean FLQA-lk total score of 66.3 (100 = best; Table I). The smallest subsample, with 20 participants, was unilateral right and showed the best health, i.e., fewer comorbidities and a higher FLQA-lk total score. The bilateral (n = 47) and unilateral left (n = 34) data were comparable. The FLQA-lk total score showed that lymphedema-specific health and quality of life improved by large effect sizes (SRMs) ranging from 0.76 to 0.92 (all $p < .001$, different from zero).

Secondary leg lymphedema was present in n = 70 = 69% cases of which 50 (71%) occurred after cancer surgery. Prostate was the most frequent localisation of the cancer in males (n = 10/26 = 38%) and uterus/ovary/cervix (n = 48/75 = 64%) in females.

Volume data

Examining the volume data per person using the 4 cm method, the total volume of both legs decreased from a mean of 24.3 l at entry to 22.4 l at discharge. This reflects a change of −1.9 l (range −12.6 to +0.5) for the entire sample

Table II. Volume data (ml) per person (sum of both limbs)

	4 cm	Kuhnke	Method	Perometer®		Method
	Entry	Discharge	Change	Entry	Discharge	Change
Bilateral			(n = 47)			(n = 39)
M	**25,867**	**23,500**	**−2,367**	**21,653**	**20,022**	**−1,631**
SD	7,037	5,755	2,446	5,850	5,015	2,024
Minimum	14,624	13,896	−12,627	12,544	12,163	−10,282
Mdn	24,921	23,881	−1,580	20,291	19,287	−799
Maximum	42,781	38,874	493	36,661	32,580	482
SRM (SE)			**0.97** (0.15)			**0.81** (0.16)
Unilateral			(n = 54)			(n = 50)
M	**22,954**	**21,384**	**−1,570**	**19,421**	**18,367**	**−1,054**
SD	5,424	4,983	1,067	4,790	4,534	902
Minimum	13,242	13,186	−5,797	12,481	11,846	−3,676
Mdn	22,018	20,269	−1,463	18,120	17,321	−918
Maximum	37,192	35,779	466	33,177	33,671	790
SRM (SE)			**1.47** (0.14)			**1.17** (0.14)
Total			(n = 101)			(n = 89)
M	**24,310**	**22,369**	**−1,941**	**20,399**	**19,092**	**−1,306**
SD	6,365	5,433	1,875	5,366	4,795	1,518
Minimum	13,242	13,186	−12,627	12,481	11,846	−10,282
Mdn	22,650	21,593	−1,561	19,434	18,196	−860
Maximum	42,781	38,874	493	36,661	33,671	790
SRM (SE)			**1.04** (0.10)			**0.86** (0.11)

Notes. SE: standard error; SRM: standardised response mean. Bold are the means and the SRMs as the main results.

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Table III. Linear modeling of improvement on FLQA-lk Total score (entry to discharge) by leg volume reduction (sum of both legs in ml, 4 cm method) and other confounding factors (n = 101)

		Regression			Bivariate		Adjusted	
Explained variance: 26.6%	Standardised β	β	SE	*t*	Correlation	p	Correlation	p
Constant		18.454	8.761	2.106				.038
Sex	0.075	1.581	2.172	0.728	0.109	.148	0.079	.468
Age	−0.097	−0.062	0.075	−0.825	−0.125	.115	−0.089	.412
Education	0.094	0.679	0.708	0.959	0.080	.222	0.103	.340
Comorbidities	−0.116	−0.459	0.459	−0.999	−0.059	.286	−0.108	.321
BMI	0.330	0.393	0.208	1.895	0.178	.043	0.201	.061
FLQA-lk total entry	−0.368	−0.215	0.057	−3.754	−0.412	<.001	−0.377	<.001
Volume (4 cm) entry	−0.279	−0.00041	0.00029	−1.419	0.145	.081	−0.152	.159
Volume (4 cm) change	−0.258	−0.001	0.001	−2.036	**−0.240**	**.010**	**−0.216**	**.045**

Notes. BMI: body mass index; FLQA-lk Total: Freiburg Quality of Life Assessment for lymphatic disorders; short version health total score; N: number of; SE: standard error of β: Student's distribution *t*-value. A negative correlation means that a decrease is positively associated with improvement on the FLQA-lk Total score, p = two-sided type I error that the correlations is different from zero. Bold are the means and the SRMs as the main results.

(n = 101), corresponding to an SRM of 1.04 – a large effect (Table II). The corresponding results were 24.3–22.4 l, with an SRM of 0.97, for the bilateral cases (n = 47), and 23.0–22.4 l, with an SRM of 1.47, for the unilateral cases (n = 54).

The analogue data on the Perometer® method showed a decrease from 20.4 to 19.1 l, reflecting a change of −1.3 l (range −10.2 to +0.8, n = 89), corresponding to an SRM = 0.86 – a large effect (Table II). The bilateral cases (n = 39) experienced a decrease from 21.6 to 20.0 l (SRM = 0.81) and the unilateral persons from 19.4 to 18.4 (SRM = 1.17).

Detailed volume data for each leg of each subgroup are listed in Appendices 1 and 2, which use the 4 cm and Perometer methods, respectively. Before therapy, the affected legs had average volumes between 12.1 and 13.7 l (unaffected: 9.3 and 10.2 l). After the intervention, the affected legs lost an average of 1.1–1.5 l (unaffected: 0.3–0.2 l), corresponding to SRMs between 0.70 and 1.72 (unaffected: 0.56 and 0.87) on the 4 cm measurement (see Appendix 1).

Analogue Perometer® data showed lower volumes that changed in the same direction (see Appendix 2): the affected leg decreased by an average of 0.8–1.1 l (unaffected: 0.2–0.3 l) from 10.0 to 11.8 l (unaffected: 8.0–8.7 l). The SRMs were 0.67–1.28 (unaffected: 0.18–0.77). Pearson correlations of the 4 cm and Perometer® volume changes were 0.900 and 0.944, respectively, for the right and left limbs (p < .001 for both).

Association volume reduction to HRQOL improvement

In the bivariate, unadjusted association, the loss of total volume (4 cm method) in both legs (n = 101) correlated with improvement in the FLQA-lk total score (dependent variable) by 0.240 (p = .010). This correlation remained stable after adjusting for confounders in the linear model (Table III) by 0.216 (multivariate, partial correlation, p = .045). Poor baseline health was the most important predictor of higher improvement on the FLQA-lk total score (adjusted correlation: 0.377, p < .001). All other potential confounders showed no statistically significant associations. Higher BMI (adjusted correlation: 0.201; p = .061) and lower baseline volume (adjusted correlation: 0.153; p = .159) were slightly associated with health improvement after therapy.

Discussion

We observed the effects of the intensive phase (phase I) of complex decongestive therapy in a standardised 3-week inpatient rehabilitation program for lymphedema of the lower extremities. The overall mean volume decrease, measured by the 4 cm method according to Kuhnke, was 1.94 l for both legs combined. This decrease was 2.37 l for bilaterally affected patients (n = 47) and 1.57 l for unilaterally affected patients (n = 54). The volume decreases on the lymphedema-affected limbs ranged from 1.03 to 1.40 l, and the corresponding Perometer data ranged from 0.77 to 0.99 l.

The volume loss was statistically significantly associated with improvements in overall health and quality of life (QOL) on the FLQA-lk, with bivariate and adjusted correlations of 0.240 and 0.216, respectively. This association explained more than half (13.5%) of the model's total explained variance (26.6%). The low total explained variance and the weak but statistically significant association mean that leg volume and its change did not substantially affect subjective health experience but that possibly many other not assessed cofactors may influence HRQOL. It further confirms the observation that persons with LLL cope very well with the edema and its consequences. On the Short Form 36 (SF-36), the levels of physical function, role physical, social functioning, and role emotional were comparable to those of the general population after our rehabilitation program [5]. Pain, general health, vitality, and mental health were even

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statistically significantly better than expected by the norm at that follow-up.

These volume losses result in standardised response means (SRMs) between 0.67 and 1.72, which express moderate (≥0.50) to very large (≥1.20) observed effects [17]. The crude SRMs in our study ranged from 0.76 to 0.95 on the FLQA-lk total score, which is comparable to the SRM of 0.904 in our effect study with a partial sample of n = 67 [5]. On the FLQA-lk, waiting-time effects reduced the crude observed effects by 26.9–42.1% to obtain the effects causally attributable to the intervention [5]. Extrapolating to the volume loss data, we can conservatively estimate the therapy-attributable volume losses to be between 0.39 and 1.00, reflecting moderate to large effects. As with the maintenance of intervention effects on the FLQA-lk, volume loss effects may stabilise during the subsequent outpatient maintenance phase of the CDT with the regular use of compression stockings and manual lymphatic drainage [19].

The study of Do et al. was found to be the unique reporting absolute volume data [20]. The affected legs volume (4 cm method) were 8.8 l, i.e., the lymphedema were smaller than ours (12.1–13.7 l). In the outpatient intervention group (n = 20) having received CDT together with "complex" rehabilitation, the affected legs lost 576 ml (SRM = 0.61) and 639 ml (SRM = 0.65) in the control group (n = 20) after CDT alone. This means that both the absolute and relative effects were lower than ours, partly explained to the lower disease severity. The volume effects were not significantly different between the two groups. The therapy program of that setting has not been specified in detail and may differ from ours.

A comparable intervention to ours was administered to 14 primary and 31 secondary cases of leg lymphedema, the report of Noh et al. [9]. The intervention consisted of ten sessions of 90 min CDT and comprehensive education on bandage technique, remedial exercise, and skin care. This means elements, which were all also comprised in our rehabilitation program; further special focus of our program was on active physiotherapy and MTT. The post-CDT Perometer® volume reductions relative to the unaffected leg were 6.0% (primary) and 5.6% (secondary), compared to our calculated levels of 8.9% (unilateral right) and 4.8% (unilateral left; see Appendix 2).

Comprehensive clinical assessment of changes in lymphedema of the leg due to interventions is challenging and subjective. On the one hand, the degree of fibrosis, tissue condition, skin trophism, and other qualities are not standardised, but rather are subjective and based on the clinical experience of the examiner. On the other hand, quantitative leg volumetry is highly objective and characterised by high validity and reliability. The original study showed that the Perometer® method provides accurate volume data comparable to that of the water displacement method, the accepted "gold" standard [13, 15]. The Kuhnke 4 cm spring tape method, or the "disk model" method, reveals a constant but not proportional bias [21]. Both techniques are characterised by very high intra- and interobserver reliability with intraclass correlation coefficients (ICCs) between 0.937 and 0.997 [15, 21, 22, 23]. In our study, the two volume measurement methods revealed consistent, highly correlated results.

The most important strength of this study is that it presents the largest worldwide sample of absolute leg volume data. Volume changes were measured by two valid methods, resulting in highly consistent, correlated data. Patient selection, therapy, and volume measurement were performed under standardised criteria and conditions by a small group of well-trained therapists [5]. Volume reduction was associated with a significant improvement in HRQOL, independent of various potential confounders.

Limitations

The most important limitation is the absence of a control group for comparison, which hinders the ability to attribute volume loss causally to therapy. However, it is difficult to imagine a placebo intervention for CDT. Both, the monocentric design of a setting in one single clinic and the short-term follow-up limit generalizability. Furthermore, 2–5 patients' volume of the affected leg(s) increased after rehabilitation. This may be explained by the fact that a standardised therapy program administered in the same way for all patients cannot meet the needs of every individual patient. They may have been better satisfied by the individually tailored outpatient management before entry to the clinic resulting in the baseline volume.

Conclusions

A substantial volume loss was observed after a comprehensive 3-week inpatient rehabilitation program for patients with a primary or secondary lymphedema of the leg, focusing on CDT, corresponding to moderate to large, standardised effects. The absolute volume data presented from two independent and valid methods allow for comparisons to other settings. The volume reduction was positively associated with improvement in lymphedema-specific HRQOL, independent of confounding factors. As with our HRQOL data, the volume loss can partly be attributed to the intervention. Future controlled studies should refine this quantification.

Highlights

- Multidisciplinary rehabilitation focusing on CDT attained large effects of limb volume reduction.
- Volume loss was positively associated with improvement on HRQOL.
- The study presents the largest worldwide sample of absolute leg volume data.

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History
Received September 30, 2025
Revision received November 18, 2025
Accepted January 10, 2026
Published online March 11, 2026

Acknowledgments
We thank all patients for their voluntary participation in the study. We further thank Elizabeth Kyrke for the linguistic editing of the text.

Conflict of interest
The authors declare that there are no conflicts of interest.

Funding
This study was supported by the Zurzach Rehabilitation Foundation SPA, Bad Zurzach, Switzerland.

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Appendix 1. Volume data (ml) per limb by the 4 cm measurement method

Bilateral	Entry right	Discharge (n = 47)	Change	Entry left	Discharge (n = 47)	Change
Mean	13,436	12,104	−1,333	12,431	11,397	−1,034
SD	3,731	3,167	1,270	3,879	2,905	1,469
Minimum	6,189	5,896	−5,867	7,721	7,195	−6,760
Median	12,769	12,030	−969	11,562	11,014	−574
Maximum	23,080	21,483	620	24,423	19,396	336
SRM (SE)			**1.05** (0.15)			**0.70** (0.15)
Unilat right	**Right**	**n = 20**		**Left**	**n = 20**	
Mean	12,077	10,966	**−1,111**	9,259	9,060	**−199**
Sttdev	3,102	2,230	1,216	1,655	1,513	355
Minimum	6,971	6,818	−5,656	6,271	6,368	−1,176
Median	11,800	10,796	−879	8,614	8,676	−134
Maximum	20,821	15,165	272	13,232	13,091	272
SRM (SE)			**0.91** (0.22)			**0.56** (0.22)
Unilat left	**Right**	**n = 34**		**Left**	**n = 34**	
Mean	10,174	9,855	−319	13,733	12,329	−1,404
SD	2,467	2,434	369	3,586	3,279	816
Minimum	7,140	6,798	−1,375	7,198	6,503	−3,141
Median	9,574	9,288	−344	13,005	11,910	−1,437
Maximum	16,969	16,903	288	21,209	20,302	163
SRM (se)			**0.87** (0.17)			**1.72** (0.17)

Appendix 2. Volume data (ml) per limb by the Perometer® method

Bilateral	Entry right	Discharge (n = 37)	Change	Entry left	Discharge (n = 37)	Change
Mean	11,033	10,173	−860	10,619	9,849	−770
Sttdev	3,060	2,700	1,074	3,232	2,600	1,153
Minimum	5,354	5,175	−5,003	6,435	6,416	−5,279
Median	10,412	9,962	−406	9,782	9,482	−306
Maximum	17,677	16,540	385	20,917	17,169	304
SRM (se)			**0.80** (0.16)			**0.67** (0.16)
Unilat right	**Right**	**n = 20**		**Left**	**n = 20**	
Mean	9,967	9,198	**−769**	7,999	7,950	**−49**
Sttdev	2,139	1,512	843	1,614	1,693	277
Minimum	7,373	7,355	−3,640	4,965	4,576	−415
Median	9,510	9,200	−567	7,715	7,714	−86
Maximum	15,382	12,401	283	12,667	12,631	748
SRM (se)			**0.91** (0.22)			**0.18** (0.22)
Unilat left	**Right**	**n = 31**		**Left**	**n = 31**	
Mean	8,747	8,531	−216	11,763	10,772	−991
Sttdev	2,313	2,351	281	3,416	3,156	772
Minimum	4,616	4,564	−671	6,486	6,138	−3,013
Median	8,364	7,959	−213	11,101	10,041	−921
Maximum	14,966	14,932	646	18,211	18,739	528
SRM (se)			**0.77** (0.18)			**1.28** (0.18)

Notes. SE, standard error; SRM, standardised response mean; unilat, unilateral.

https://econtent.hogrefe.com/doi/pdf/10.1024/0301-1526/a001268 - Wednesday, March 25, 2026 6:07:22 PM - IP Address:1.123.231.1

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