

# SF-36 Shows Increased Quality of Life Following Complete Reduction of Postmastectomy Lymphedema with Liposuction

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## Abstracts

**Background:** Arm lymphedema after breast cancer surgery affects women both from physical and psychological points of view. Lymphedema leads to adipose tissue deposition. Liposuction and controlled compression therapy (CCT) reduces the lymphedema completely.

**Methods and Results:** Sixty female patients with arm lymphedema were followed for a 1-year period after surgery. The 36-item short-form health survey (SF-36) was used to assess health-related quality of life (HRQoL). Patients completed the SF-36 questionnaire before liposuction, and after 1, 3, 6, and 12 months. Preoperative excess arm volume was  $1365 \pm 73$  mL. Complete reduction was achieved after 3 months and was sustained during follow-up. The adipose tissue volume removed at surgery was  $1373 \pm 56$  mL. One month after liposuction, better scores were found in mental health. After 3 months, an increase in physical functioning, bodily pain, and vitality was detected. After 1 year, an increase was also seen for social functioning. The physical component score was higher at 3 months and thereafter, while the mental component score was improved at 3 and 12 months. Compared with SF-36 norm data for the Swedish population, only physical functioning showed lower values than the norm at baseline. After liposuction, general health, bodily pain, vitality, mental health, and social functioning showed higher values at various time points.

**Conclusions:** Liposuction of arm lymphedema in combination with CCT improves patients HRQoL as measured with SF-36. The treatment seems to target and improve both the physical and mental health domains.

**Keywords:** SF-36, quality of life, lymphedema, liposuction, breast cancer

## Introduction

ARM LYMPHEDEMA REMAINS a significant clinical problem, with an incidence of 20% in women developing the condition following treatment for breast cancer.<sup>1,2</sup> Despite recent sentinel node dissection in breast cancer treatment, 5.6% are still affected.<sup>1</sup> Lymphedema with a swollen and heavy limb introduces an additional burden for the patient.<sup>3-6</sup>

Traditionally, lymphedema has been viewed as a relatively unimportant and untreatable side effect of cancer treatment.<sup>7</sup>

This perception is changing and lymphedema is increasingly recognized as a significant and complex problem representing a considerable challenge to a person's health-related quality of life (HRQoL).<sup>8</sup>

Patients with a newly diagnosed lymphedema are traditionally first treated conservatively with combined decongestive therapy (CDT), which includes manual lymph drainage (MLD), bandaging, skin care, exercises, and compression garments.<sup>9,10</sup> Several studies have shown that MLD does not contribute to the volume reduction of the lymphedema and can therefore be omitted.<sup>10-15</sup>

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Chronic lymphedema contains large amounts of adipose tissue.<sup>16,17</sup> A slow lymph flow accelerates lipogenesis and fat deposition.<sup>18</sup> This process is enhanced by the transformation of macrophages into adipocytes.<sup>19,20</sup>

The edema reduction itself is an advantage in terms of reduced weight of the arm, but the perceived impact of treatment, liposuction, and controlled compression therapy (CCT) on HRQoL has to be investigated to evaluate the overall outcome of treatment.<sup>21</sup> Most studies have used generic measures without any attempt to validate them in chronic edema. However, Franks et al. examined leg lymphedema using the 36-item short-form health survey (SF-36) and concluded that it appeared to be the most appropriate tool for use in patients with lymphedema of the lower limb.<sup>22</sup>

Earlier studies have demonstrated that arm lymphedema following breast cancer surgery is associated with reduced HRQoL as analyzed with questionnaires such as SF-36.<sup>23–28</sup> Improved outcomes of CDT using SF-36 have been shown in several studies for both arm and leg lymphedema.<sup>13,22,29,30</sup>

SF-36 has not yet been used to evaluate the outcome of HRQoL parameters in breast cancer-related arm lymphedema treated with liposuction and CCT.

The aim of the present study is to test the hypothesis that liposuction improves HRQoL.

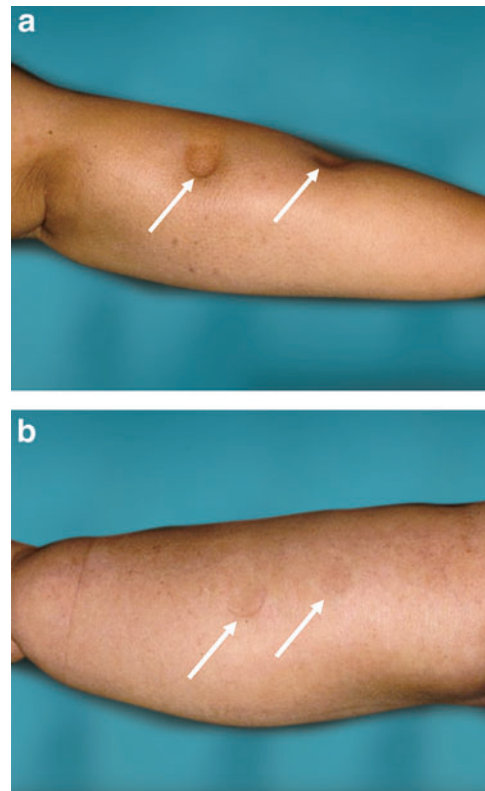
## Materials and Methods

### Patients

From 1999 to 2013, a consecutive cohort of 90 patients who attended our lymphedema center agreed to complete the SF-36 before and following liposuction at different time points; that is, before surgery and at 1, 3, 6, and 12 months thereafter. When responses to the surveys were analyzed, 30 patients had failed to answer one or more of the questionnaires at the different time points. This left 60 patients in the study cohort.

The lymphedema center maintains a registry of all patients who have been diagnosed with limb lymphedema and treated with liposuction and CCT. All data of patients eligible for surgery are entered into the registry at the first consultation and then at each follow-up. Data collected include, for example, type of breast cancer surgery, lymph node removal, postoperative chemotherapy, and irradiation; previous conservative treatment, pre- and postoperative bouts of erysipelas, type of compression garments, age at cancer surgery, age at lymphedema start, and at liposuction, onset (time from cancer surgery to lymphedema debut), duration (time from lymphedema start to liposuction). In addition, after oral and written instructions, each patient is asked to complete the SF-36 before surgery, and at follow-up. There is currently no gold standard for the definition of lymphedema, but a 10% difference in limb volume is a common definition.<sup>31</sup>

Patients who met the following inclusion criteria were recruited: (1) they had been diagnosed with secondary arm lymphedema following breast cancer treatment based on medical history and physical observations, (2) there was a significant excess volume (=the difference between the volume of the affected and nonaffected arm) where the affected arm was at least 10% larger than the unaffected one, and concomitant subjective discomfort, (3) previous conservative treatment had not been able to reduce the excess volume completely, and (4) the lymphedema showed no or minimal pitting (less than 5 mm); a sign of adipose tis-



**FIG. 1.** (a) Marked lymphedema of the arm after breast cancer treatment, showing pitting several centimeters (white arrows) in depth (stage I–II edema). The arm swelling is dominated by the presence of fluid, that is, the accumulation of lymph. (b) Pronounced arm lymphedema after breast cancer treatment (stage II–III edema). There is no pitting despite hard pressure by the thumb for 1 minute (white arrows). The “edema” is completely dominated by adipose tissue. The term “edema” is improper at this stage, as the swelling is dominated by hypertrophied adipose tissue and not by lymph. At this stage, the aspirate contains either no lymph or a minimal amount. Color images available online at [www.liebertpub.com/lrb](http://www.liebertpub.com/lrb)

sue hypertrophy (Fig. 1a, b).<sup>16,17</sup> Exclusion criteria were (1) generalized disease or local ulcers and (2) any doubts about undergoing continuous CCT after liposuction.

The study was approved by the Ethics of Human Investigation Committee at Lund University (LU 503/2006). All participants provided their written informed consent to participate. The procedures were in accordance with the 2008 Declaration of Helsinki.

### Liposuction and CCT

Our surgical technique has previously been described in detail.<sup>32,33</sup> In brief, liposuction was performed by making around 15, 4 mm-long, incisions and the hypertrophied fat was removed by vacuum aspiration as completely as possible.

CCT was instituted with a custom-made compression sleeve-and-glove garment (JOBST–Elvarex BSN Medical, Smith & Nephew, Mölndal, Sweden) with compression in the range 32–40 mmHg (class 2). Measurements for these garments were taken 2 weeks before surgery using the healthy arm as a template. The garments were renewed three to four times during the first year to compensate for the decrease in excess volume (=the difference between the volume of the

TABLE 1. CHARACTERISTICS OF THE STUDY POPULATION (MEAN  $\pm$  STANDARD ERROR OF THE MEAN)

	Study patients	Nonresponding patients
Number of patients	60	30
Age at breast cancer treatment, years	52 $\pm$ 1.3	49 $\pm$ 2.0
Age at liposuction, years	64 $\pm$ 1.3	60 $\pm$ 2.1
Onset (time from breast cancer operation to lymphedema start), years	2 $\pm$ 0.4	4 $\pm$ 1.1
Duration of lymphedema, years	10 $\pm$ 1.3	8 $\pm$ 1.2
Duration from breast cancer treatment to liposuction, years	12 $\pm$ 1.0	12 $\pm$ 1.5

There were no significant differences between the characteristics of the study group and the group of nonresponding patients.

affected and nonaffected arm). In addition, when needed, the garments were taken in at each visit using a sewing machine to compensate for loss of elasticity. The same staff, one physiotherapist and one occupational therapist, measured arm volumes before liposuction and after 1, 3, 6, and 12 months.

#### Arm volume measurement

Lymphedema volumes were recorded using the water displacement technique, which is considered the gold standard for volume measurements.<sup>33–35</sup> A container with a faucet was filled with water. The whole arm was then submerged until the fingertip reached the bottom of the container. In cases of short arms, a fixed ruler was used to define the arm position. The displaced water was collected and weighed on a balance to the nearest 5 g, corresponding to 5 mL. Both arms were always measured at each visit and the difference in volume between the two was designated the edema volume.<sup>33–35</sup> Our water displacement technique has previously been validated and showed a coefficient of variation of 0.609%.<sup>35</sup>

#### Volume of removed fat

Aspirate volumes were collected in graded 2000-mL canisters and the amount of removed fat was calculated with an accuracy of 10 mL.

#### Quality of life before and after liposuction

The SF-36 was used to assess HRQoL. This is a standardized questionnaire and is one of the most widely used measures of health related to HRQoL research. The Swedish version has been validated, and normative data for Swedish women are available.<sup>36,37</sup> Consequently, we asked patients to complete the SF-36 questionnaires before liposuction and after 1, 3, 6, and 12 months. All questionnaires were self-administered, that is, they were completed by the patients themselves at home and then sent back to the clinic.

The SF-36 consists of 36 items constituting 8 domains: physical functioning, role limitations as a result of physical problems, bodily pain, general health perception, vitality, social functioning, role limitations due to emotional problems, and mental health. The first three domains: physical function, role physical, and bodily pain measure physical well-being; and the last three domains: social function, role emotional, and mental health relate to emotional well-being. The two remaining domains, general health and vitality, are associated with both physical and emotional dimensions. All items relate to the situation during the 4 weeks before answering the questionnaire.

These eight domains can be aggregated into two summary measures: the physical and mental component score. General health and vitality are domains shared by the physical and mental component score. In addition, the physical component score encompasses physical function, role physical, and bodily pain, whereas the mental component score includes social function, role emotional, and mental health. A high score on the subscales signifies a higher level of function and HRQoL.

#### Statistical analyses

To compare data from our sample and the Swedish normative data, the sample was age standardized. The normative data were based on 4582 women from the age of 35 to 75+, divided into 5-year intervals.<sup>36</sup>

Data were entered in Microsoft Excel version 14.5.3 and all statistical analyses were carried out using IBM SPSS Statistics for Mac OSX (Version 22.0; SPSS, Inc.). The Shapiro–Wilk test was used to test sample distribution, which showed that only physical functioning before surgery,

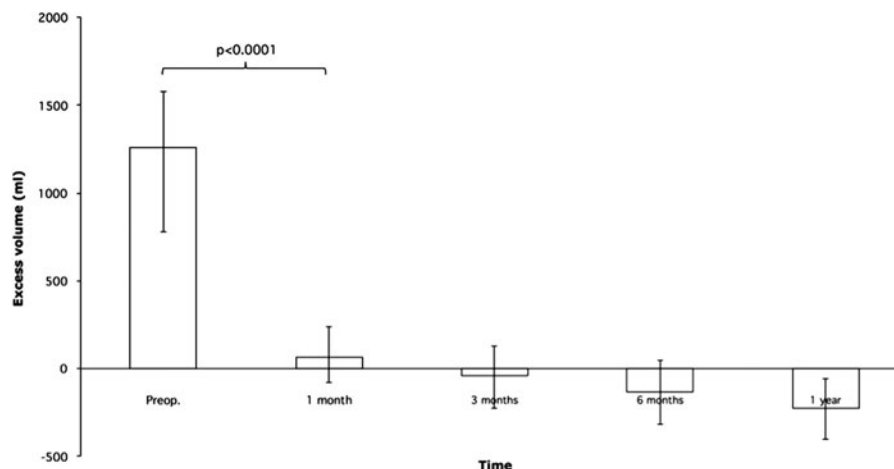


FIG. 2. Excess volumes before and after liposuction (mean  $\pm$  SEM). SEM, standard error of the mean.

general health, and vitality at 1 month after surgery showed normal distribution. In 2009, Torrance et al. stated that although scores in each of the eight domains of SF-36 rarely conform to a normal distribution SF-36 is most widely analyzed using simple parametric statistical techniques.<sup>38</sup> We therefore used a parametric test, the Student's *t*-test, to analyze the outcome. Our hypothesis was that liposuction improves HRQoL over time postoperatively, and given this *a priori* assumption, we chose to use uncorrected *p*-values.

SF-36 scores and excess volume values are presented as mean and standard error of the mean (SEM). The Student's

paired *t*-test, two tailed, was used to test changes over time. One sample *t*-test was used for statistical comparison of normative data. The outcome of the significance tests was considered to show exploratory results, and therefore, nominal *p*-values are presented without any adjustment for multiple comparisons. A *p*-value less than 0.05 was considered statistically significant.

## Results

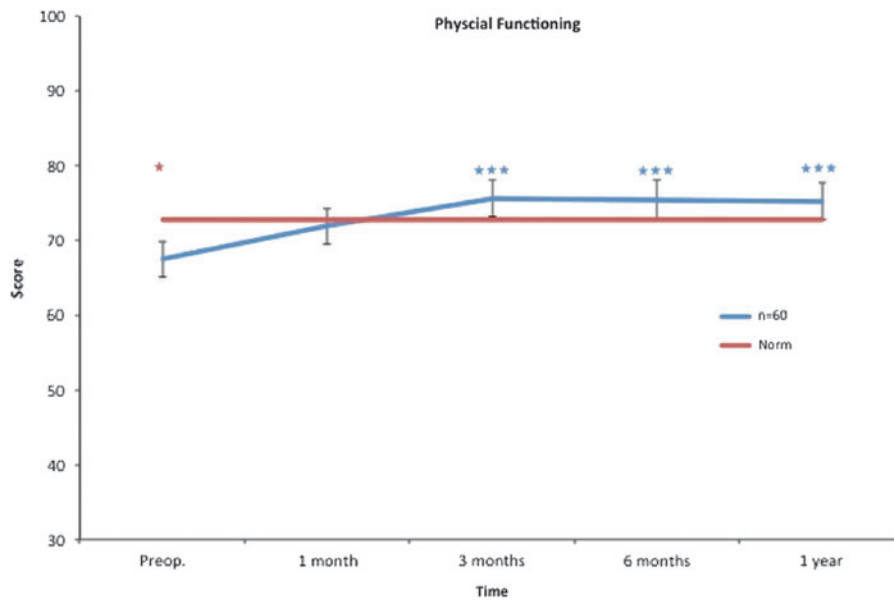
A total of 60 female patients with arm lymphedema participated in the study and were followed for a 1-year period.

TABLE 2. COMPARISON OF PRE- AND POSTOPERATIVE SF-36 SCORES WITHIN EACH SUBDOMAIN AND ITS RELATION TO SWEDISH REFERENCE DATA

Subdomain	Measurement	Preoperative	1 month	3 months	6 months	1 year
Physical functioning	Score	67 (2.4)	72 (2.4)	76 (2.4)	75 (2.7)	75 (2.5)
	<i>p</i> -value vs. preoperative	—	0.06	<b>0.001</b>	<b>0.001</b>	<b>0.001</b>
	Swedish reference score	73	73	73	73	73
	<i>p</i> -value vs. reference	<b>0.03</b>	0.72	0.24	0.34	0.31
Role physical	Score	65 (5.3)	42 (5.5)	61 (5.2)	64 (5.5)	67 (4.8)
	<i>p</i> -value vs. preoperative	—	<b>0.001</b>	0.43	0.79	0.68
	Swedish reference score	68	68	68	68	68
	<i>p</i> -value vs. reference	0.63	<b>0.001</b>	0.20	0.49	0.92
Bodily pain	Score	65 (3.4)	60 (2.9)	78 (2.8)	79 (3.2)	79 (3.2)
	<i>p</i> -value vs. preoperative	—	0.11	<b>0.001</b>	<b>0.001</b>	<b>0.001</b>
	Swedish reference score	66	66	66	66	66
	<i>p</i> -value vs. reference	0.80	<b>0.04</b>	<b>0.001</b>	<b>0.001</b>	<b>0.001</b>
Social functioning	Score	83 (3.2)	83 (2.4)	89 (2.5)	87 (2.5)	90 (2.3)
	<i>p</i> -value vs. preoperative	—	1.00	0.05	0.28	<b>0.01</b>
	Swedish reference score	84	84	84	84	84
	<i>p</i> -value vs. reference	0.71	0.63	0.07	0.40	<b>0.01</b>
Role emotional	Score	71 (5.1)	63 (5.5)	75 (4.9)	77 (4.8)	78 (4.7)
	<i>p</i> -value vs. preoperative	—	0.24	0.38	0.25	0.07
	Swedish reference score	77	77	77	77	77
	<i>p</i> -value vs. reference	0.21	<b>0.02</b>	0.69	0.95	0.78
Mental health	Score	74 (2.5)	80 (2.3)	82 (2.2)	81 (2.0)	82 (2.1)
	<i>p</i> -value vs. preoperative	—	<b>0.02</b>	<b>0.002</b>	<b>0.01</b>	<b>0.01</b>
	Swedish reference score	78	78	78	78	78
	<i>p</i> -value vs. reference	0.18	0.43	0.06	0.07	<b>0.03</b>
General health	Score	68 (2.9)	72 (2.5)	70 (2.6)	70 (0.35)	69 (2.7)
	<i>p</i> -value vs. preoperative	—	0.06	0.37	0.35	0.80
	Swedish reference score	66	66	66	66	66
	<i>p</i> -value vs. reference	0.44	<b>0.01</b>	0.08	0.07	0.28
Vitality	Score	66 (2.7)	68 (2.3)	73 (2.3)	73 (2.3)	72 (2.4)
	<i>p</i> -value vs. preoperative	—	0.55	<b>0.02</b>	<b>0.01</b>	<b>0.03</b>
	Swedish reference score	64	64	64	64	64
	<i>p</i> -value vs. reference	0.37	0.10	<b>0.001</b>	<b>0.001</b>	<b>0.001</b>
PCS	Score	43 (1.3)	41 (1.1)	45 (1.1)	45 (1.3)	45 (1.2)
	<i>p</i> -value vs. preoperative	—	0.09	<b>0.03</b>	<b>0.01</b>	<b>0.03</b>
	Swedish reference score	—	—	—	—	—
	<i>p</i> -value vs. reference	—	—	—	—	—
MCS	Score	49 (1.3)	50 (1.4)	51 (1.3)	51 (1.1)	52 (1.2)
	<i>p</i> -value vs. preoperative	—	0.52	<b>0.04</b>	0.07	<b>0.01</b>
	Swedish reference score	—	—	—	—	—
	<i>p</i> -value vs. reference	—	—	—	—	—

Swedish reference data for PCS and MCS are not available in the literature. Values are presented as mean (SEM). There are two *p*-values for each domain. One is for change over time within the study group for each subdomain and one is for comparison with Swedish reference data. Significant *p*-values ( $p < 0.005$ ) are presented in bold.

MCS, mental component score; PCS, physical component score; SEM, standard error of the mean.



**FIG. 3.** Physical functioning. All postoperative values are compared to preoperative ones. Pre- and postoperative scores within the group, and in comparison to the Swedish normative data. \* $p < 0.05$ , \*\*\* $p < 0.001$ . Color images available online at [www.liebertpub.com/lrb](http://www.liebertpub.com/lrb)

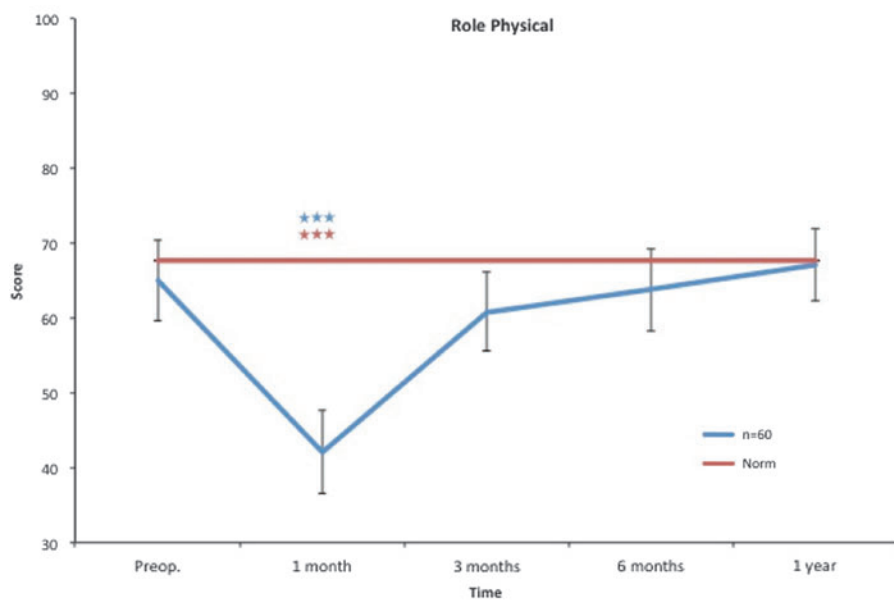
Nine missing answers on single questions were detected and were replaced with the values from the previous time point.

*Characteristics of the study population*

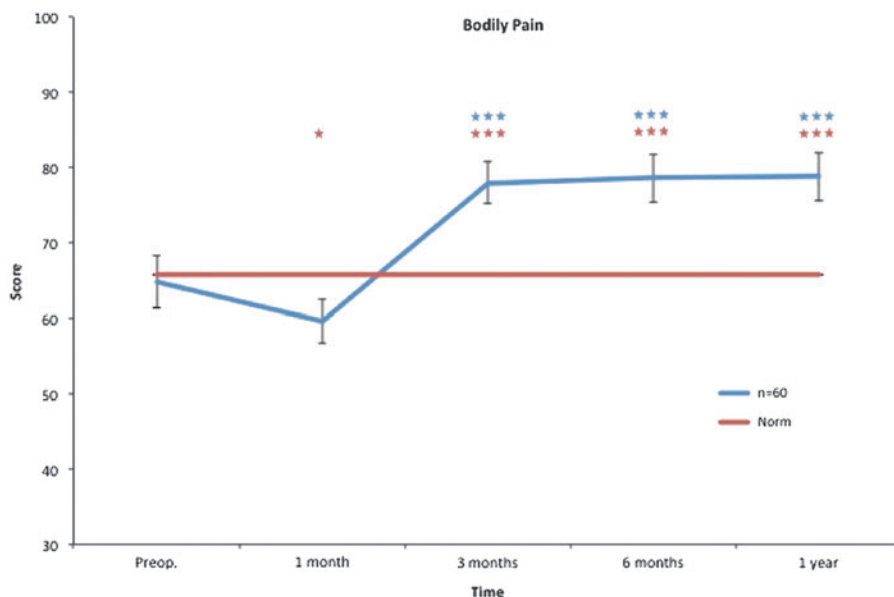
Thirty-six patients (60%) were older than 60 years. Table 1 shows age at the time of breast cancer treatment, onset (interval between breast cancer treatment and lymphedema start), duration of lymphedema (time from lymphedema start to liposuction), and duration from breast cancer treatment to liposuction.

*Volume reduction and aspirated fat*

The total aspirated volume was  $1361 \pm 66$  mL, of which the fat volume was  $1373 \pm 56$  mL. The mean  $\pm$  SEM preoperative excess volume was  $1365 \pm 73$  mL, rapidly declining to  $75 \pm 35$  mL at 1 month,  $-26 \pm 40$  mL at 3 months,  $-133 \pm 40$  mL at 6 months, and at 1 year  $-213 \pm 35$  mL; thus, the treated arm became somewhat smaller than the normal one (Fig. 2). Neither minor nor major complications to liposuction treatment were observed. In 49 patients (82%), the excess volume was reduced completely.



**FIG. 4.** Role physical. All postoperative values are compared to preoperative ones. Pre- and postoperative scores within the group, and in comparison to the Swedish normative data. \*\*\* $p < 0.001$ . Color images available online at [www.liebertpub.com/lrb](http://www.liebertpub.com/lrb)



**FIG. 5.** Bodily pain. All postoperative values are compared to preoperative ones. Pre- and postoperative scores within the group, and in comparison to the Swedish normative data. \* $p < 0.05$ , \*\*\* $p < 0.001$ . Color images available online at [www.liebertpub.com/lrb](http://www.liebertpub.com/lrb)

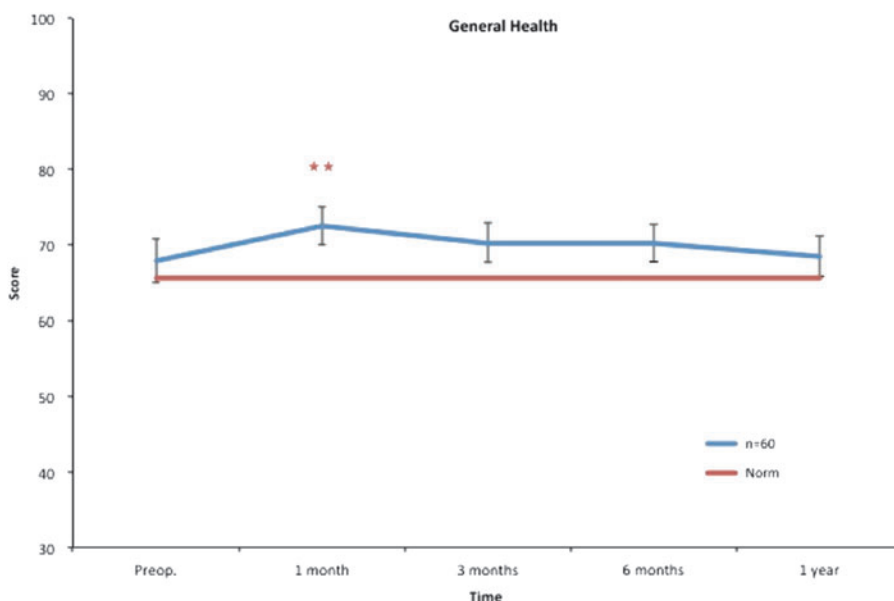
#### *Comparison between pre- and postoperative SF-36 scores within the group*

Mean and SEM for all SF-36 subscales are presented in Table 2. Already at 1 month after liposuction, significantly better values were seen in mental health that continued during the follow-up. At 3 months, physical functioning, bodily pain, and vitality showed significant improvements that continued throughout the study. At the 1-year follow-up, a significant increase was also seen for social functioning (Figs. 3–10).

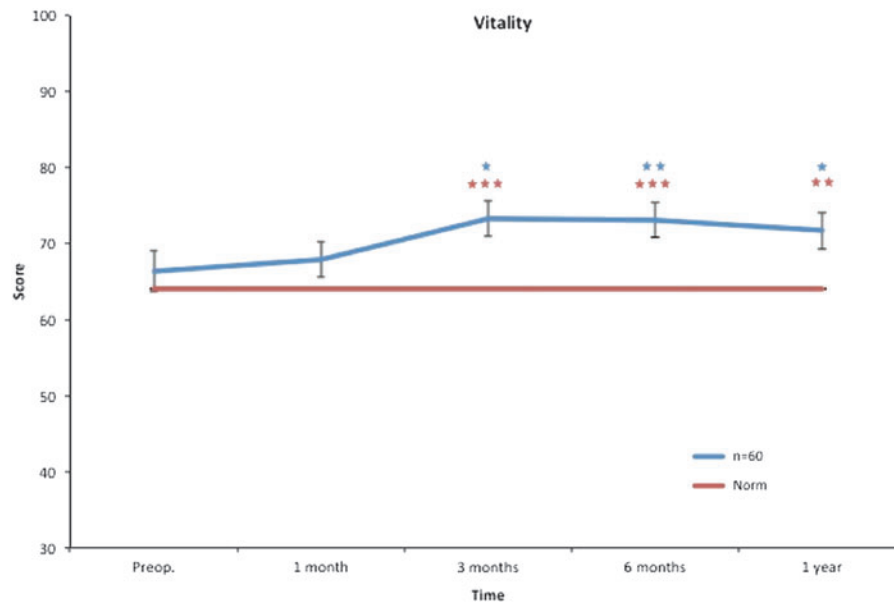
Similarly, the physical component score was significantly better at 3 months and thereafter. The mental component score was significantly improved at 3 months, and at 1 year after liposuction (Fig. 11).

#### *Comparison of pre- and postoperative SF-36 scores with Swedish reference population (norm)*

Only physical functioning showed a significant difference at baseline, with worse values than the norm. One month after



**FIG. 6.** General health. All postoperative values are compared to preoperative ones. Pre- and postoperative scores within the group, and in comparison to the Swedish normative data. \*\* $p < 0.01$ . Color images available online at [www.liebertpub.com/lrb](http://www.liebertpub.com/lrb)

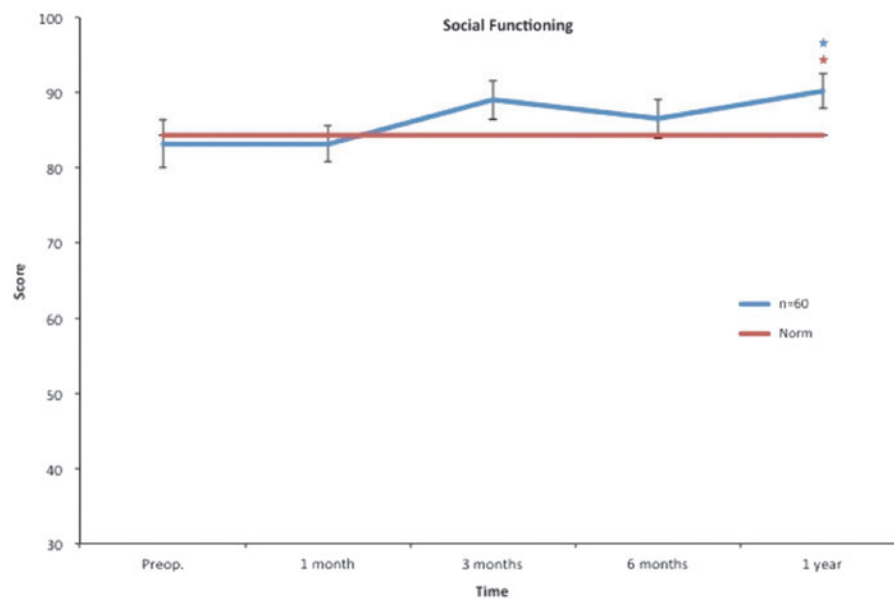


**FIG. 7.** Vitality. All postoperative values are compared to preoperative ones. Pre- and postoperative scores within the group, and in comparison to the Swedish normative data. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ . Color images available online at [www.liebertpub.com/lrb](http://www.liebertpub.com/lrb)

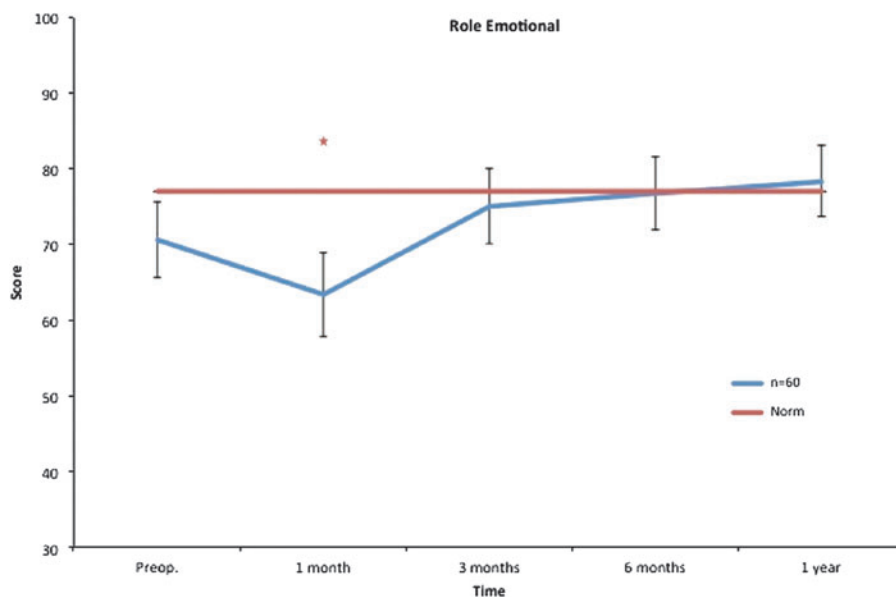
treatment, role physical, bodily pain, and role emotional showed significantly decreased scores, while general health showed significantly increased scores. Regarding bodily pain, significantly better values were seen at 3 months and thereafter, while no difference was seen in role physical, general health, and role emotional after 1 month. Vitality displayed better values at 3 months and thereafter. At the 1-year follow-up, mental health and social functioning also showed significantly better values (Figs. 3–10).

## Discussion

Lymphedema is a chronic, complex, and multifaceted condition that has major physical, psychological, and social implications for the HRQoL of patients. The World Health Organization defines health as a state of complete physical, mental, and social well-being and not merely as the absence of disease or infirmity. There is no single variable that can be used to describe health. Measurement of HRQoL requires



**FIG. 8.** Social functioning. All postoperative values are compared to preoperative ones. Pre- and postoperative scores within the group, and in comparison to the Swedish normative data. \* $p < 0.05$ . Color images available online at [www.liebertpub.com/lrb](http://www.liebertpub.com/lrb)



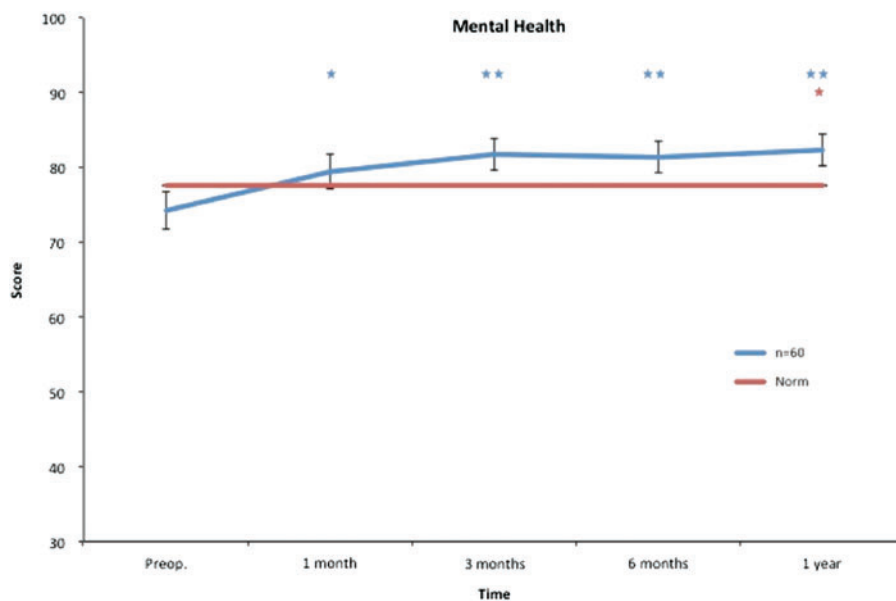
**FIG. 9.** Role emotional. All postoperative values are compared to preoperative ones. Pre- and postoperative scores within the group, and in comparison to the Swedish normative data. \* $p < 0.05$ . Color images available online at [www.liebertpub.com/lrb](http://www.liebertpub.com/lrb)

several steps and involves the evaluation of several health-related indicators. Consequently, it is essential to evaluate the reliability of health measures (i.e., how much random error is present in the measurement) and validity (i.e., whether the scores give us meaningful information about the respondent). In addition, there is no “gold standard” for HRQoL; therefore, it is a challenge to determine whether any HRQoL measure is tapping into the intended aspect of people’s experience. Such generic instruments are not developed to evaluate the specific issues of importance to lymphedema patients. As an example,

the SF-36 does not capture the specific symptoms such as difficulty in grasping or holding objects.<sup>39</sup>

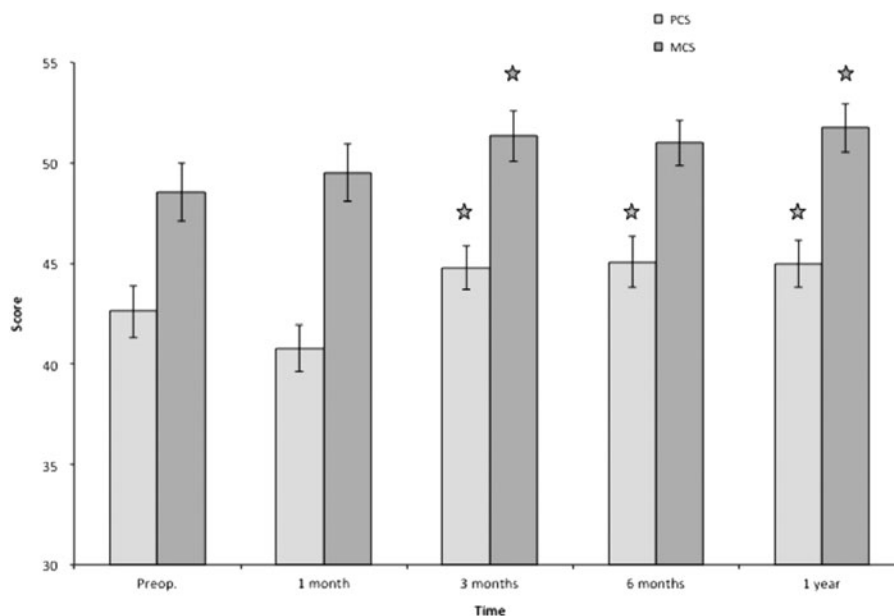
As yet there is no standard, routinely used, and disease-specific HRQoL tool for chronic lymphedema for either research or clinical purposes.<sup>40</sup> However, there are tools, some of which have been described and validated in the literature but not yet used in the clinical situation.<sup>40–42</sup>

In 2005, Haywood et al. conducted a structured review of 15 generic self-assessed health instruments. This review provided an extensive synthesis of evidence for 15 generic,



**FIG. 10.** Mental health. All postoperative values are compared to preoperative ones. Pre- and postoperative scores within the group, and in comparison to the Swedish normative data. \* $p < 0.05$ , \*\* $p < 0.01$ . Color images available online at [www.liebertpub.com/lrb](http://www.liebertpub.com/lrb)





**FIG. 11.** All postoperative values are compared to preoperative ones. Pre- and postoperative PCS and MCS. \* $p < 0.05$ . MCS, mental component score; PCS, physical component score.

multi-item measures of health following completion by older people (age  $>60$ ). The most extensive evidence was found for the SF-36 (i.e., reliability, validity, responsiveness).<sup>43</sup>

SF-36 has been widely used in HRQoL research.<sup>44</sup> A Swedish version has been validated and normative data for Swedish women are available.<sup>36</sup>

In the present study, we used the Swedish version of SF-36 to measure HRQoL after treatment of arm lymphedema with liposuction in combination with CCT. As in the study of Haywood et al., 60% ( $n = 36$ ) of our study group ( $n = 60$ ) were older than 60 years.

#### Characteristics of the study population

Table 1 shows the characteristics of the study group and the group of nonresponding patients. Although there is no significant difference between the groups, it shows that the onset (time from breast cancer operation to lymphedema start) in the study group and in the group of nonresponding patients is 2 and 4 years, respectively. Corresponding values for duration are 10 and 8 years, respectively. This might have had an influence on the outcomes of the study in terms of fewer symptoms in the nonresponding group compared to the studied group.

#### Comparison between pre- and postoperative SF-36 scores within the group

One year after liposuction, the scores were significantly improved for physical functioning, bodily pain, vitality, social functioning, and mental health (Table 2 and Figs. 3, 5, 7, 8, and 10).

The physical functioning subscale concerns problems in daily life caused by physical restraints. It includes items about everyday life activities, for example, things we normally do such as feeding ourselves, bathing, dressing, grooming, work, homemaking, and leisure. Three months

after treatment, physical functioning showed improvement, suggesting that liposuction (i.e., reduction of the excess volume of the arm) has an early impact on patients' physical restraints. This improvement was noted at each time point throughout the study period (Fig. 3).

The bodily pain subscale includes items about pain levels and to what extent pain has interfered with normal activities and work. One month after surgical treatment, we found no significant improvement; instead, we found significantly decreased scores that were probably due to postoperative pain and discomfort. After 3, 6, and 12 months, bodily pain significantly improved, suggesting reduced interference of pain with normal activities and work (Fig. 5).

The vitality subscale assesses patients' fatigue, which is known to affect patients with chronic diseases. Three months after liposuction, our patients already showed a significantly higher level of alertness compared to the preoperative state, and this continued throughout the study (Fig. 7).

The social functioning and mental health subscales include items such as interference with normal social life due to physical and emotional problems and also feelings of nervousness and depression. In our study, treatment with liposuction and CCT seemed to target these psychological restraints in a positive manner. Mental health improved significantly after only 1 month and continued to do so throughout the study. Social functioning showed a statistically significant improvement after 12 months (Figs. 8 and 10).

Three scales (physical functioning, role physical, bodily pain) correlate most highly with the physical component and contribute most to the scoring of the physical component score. The mental component correlates most highly with the mental health, role emotional, and social functioning scales, which also contribute most to the scoring of the mental component score. Three of the scales (vitality, general health, and social functioning) have correlations

with both components.<sup>37</sup> In terms of validity, subscales that load highest on the physical component are most responsive to treatments that change physical morbidity, whereas scales loading highest on the mental component respond most to drugs and therapies that target mental health.

In this study, both the physical component score and mental component score improved significantly after 3 months and continued during the 12-month follow-up, with the exception of mental component score, which was not significant at 6 months (Fig. 11). Other studies have shown that patients with arm lymphedema after breast cancer treatment suffer both from a physical and psychological point of view.<sup>5,6,45–47</sup> Therefore, it seems that liposuction followed by CCT improves these functions.

Liposuction in combination with CCT seems to have no impact on role limitations due to emotional problems. The role emotional subscale concerns problems in daily life caused by physiological restraints. It includes, for example, cutting down the amount of time spent on work or other activities. No significant changes were found for role emotional after treatment during the 12-month follow-up. This scale is work related and the outcome might be explained by the high mean age, 64 years, of the study participants, an age when many have retired.

#### *Comparison of preoperative and postoperative HRQoL with a Swedish reference population*

Only physical functioning showed impaired scores before surgery compared to the Swedish norm. This is most likely due to the heaviness of the arm. Even at 1 month after surgery, no significant difference could be detected between the study group and the Swedish norm. This finding remained during the whole follow-up.

The decrease in role physical, bodily pain, and role emotional at 1 month is probably an effect of the surgical procedure and concomitant postoperative pain, discomfort, and convalescence.

Accordingly, the study group presented better scores in vitality at 3 months than the Swedish norm, and this continued during the follow-up. At 12 months, social functioning and mental health also showed significantly higher scores than the Swedish norm (Figs. 3–10).

#### *Arm lymphedema and treatment*

Arm lymphedema is a well-known sequel of breast cancer treatment. Lymphedema eventually transforms into adipose tissue with varying elements of fibrosis,<sup>16,17,48–50</sup> and a surgical approach to remove the excess fat is rational in a non-pitting edema.

The increased volume/weight of the affected arm leads to substantial limitations in functioning. Also, the enlarged size of the arm may prevent patients from wearing ordinary clothing. Thus, if the lymphedema is untreated or undertreated, it might interfere with the patients' HRQoL. Also, arm lymphedema after breast cancer treatment is associated with additional psychological morbidity.<sup>51</sup>

Our findings are in par with an earlier study of patients with arm lymphedema treated with liposuction, whereas the present study shows even more pronounced positive effects on psychologically oriented domains.<sup>6</sup>

There are some limitations to this study. The number of patients was relatively small ( $n=60$ ), and using a generic questionnaire such as SF-36 causes a potential bias since it has been found that disease-specific questionnaires have an advantage over more global assessments of HRQoL. Despite this, we have shown that the treatment has beneficial effects on most of the outcome parameters.

#### **Conclusions**

Liposuction of arm lymphedema combined with CCT improves patients' HRQoL when measured with SF-36. The treatment seems to target both physical and mental health domains. Compared to the Swedish reference population, the study group showed the same, or even better HRQoL when analyzing specific subscales.

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No competing financial interests exist.

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