Arm lymphedema secondary to breast cancer treatment most often develops gradually to a chronic disease giving an increase of adipose tissue in subcutis with a later in-growth of fibrosis probably due to the high protein concentration in the lymph stimulating the fibroblasts. Secondary lymphedema is a recognized complication of axillary node dissection, especially in combination with radio-therapy. Patients with arm lymphedema experience functional impairment, psychosocial maladjustment and increased psychological morbidity, the condition being lifestyle-compromising.

The assumption that untreated lymphedema is increasing in amount and grade with time has been verified by Casley-Smith. It was also found that the amount of arm lymphedema increased more rapidly than that of lower extremity lymphedema and the grades of secondary lymphedema increased more rapidly than primary ones. Accordingly, the purposes of treatment should aim to limit the increase of volume and to treat mild lymphedemas as soon as possible to avoid more serious sequelae and a chronic irreversible disorder.

Continuous compression using elastic sleeves is considered an important part of the treatment. Compression raises the interstitial pressure, limits blood capillary filtration and increases lymph flow. The effect of an elastic sleeve without any other treatment has been evaluated in breast cancer patients undergoing mastectomy and a decrease of 7-17% of the arm lymphedema, depending on how long the sleeve was administered (2 weeks - 6 months). Manual lymph drainage (MLD) combined with compression therapy is an effective treatment for lymphedema resulting in normalization of microlymphatic hypertension and an improvement of clinical appearance. Hutzchsenreuter et al. showed that MLD combined with low-stretch compression bandaging decreased arm lymphedema volume by 20%, and Johansson et al. found that MLD on its own reduced arm volume by 15%. Complex lymphedema therapy (CLT) is a combination of MLD, compression bandaging, exercises and skin care resulting in lymphedema reduction of about 60%. The volume-reducing effect of low-stretch bandaging alone has not previously been evaluated, although the clinical impression is that bandaging is the most effective volume-reducing factor in the CLT. There is a lack of agreement, however, whether the time-consuming MLD treatment adds any volume-reducing effect.

The purpose of this study was to examine the effect of CB or when combined with MLD on limb volume and the subjective feeling of heaviness, tension and pain in women with secondary arm lymphedema after previous treatment for breast cancer.

CLINICAL POPULATION

In this prospective study, 40 consecutive women, with unilateral arm lymphedema after breast cancer operation with axillary nodal dissection (level I and II), were included over a three-year period. They were all referred to the Lymphedema Unit, University Hospital, Lund, Sweden. Lymphedema was defined as > 10% difference in volume between the abnormal and normal (contralateral) arm (18) as measured by volumetry (19). After written and oral information and approval by the patients, they were allocated to either CB treatment alone (CB group) or to CB in combination with MLD (CB+ MLD group). The series was determined so that the patients were consecutively numbered and the patients with even numbers were included in the CB group and those with odd numbers in the CB+MLD group.

The study design (Fig. 1) included three weeks of treatment with low-stretch compression bandages for all patients. The bandages were changed every second day. After two weeks (Part I), MLD was added to the CB treatment in 17 of the patients for 5 days for another week (Part II), whereas the other 18 patients continued with CB alone. Exclusion criteria were previous contra-lateral breast diseases or intercurrent disease affecting the swollen arm, or difficulties in participating in the study such as dementia. Also, patients who had received any lymphedema treatment within six months prior to the study were excluded except for those who wore elastic sleeves not renewed during the six-month period. Only those patients...
from Part I who still had an arm lymphedema by definition >10% volume difference between the abnormal and normal arm were included in Part II. Two patients in the CB group were dropped during Part I; one because of feelings of numbness and weakness in the arm during bandaging and one who was unable to participate in serial measurements for practical reasons. The mean±SD (range) age of the remaining 38 women was 64±12 (37-83) years in the CB group (n=18) and 58±12(41-80) years in the CB+MLD group (n=20). Other characteristics of which there were no differences between the groups are presented in Table 1. Sixteen patients
had received different kinds of lymphedema treatment, but not within six months of the study and nine of them wore elastic sleeves. Three patients from the CB+MLD group were not included in Part II because of complete resolution of the arm edema after CB treatment in Part I.

The study was approved by the Lund University Research Ethics Committee.

**PHYSIOTHERAPEUTIC TREATMENT**

CB treatment was accomplished with low stretch bandages to ensure continuous pressure during work as well as during rest periods. The bandage was wrapped in proximal direction, beginning at the hand and ending at the extremity root with pressure gradually decreasing. The bandage was kept on until the next measurement was performed.

The CB+MLD treatment during Part II was performed at approximately the same time of the day for 45 min/day during five days. The CB and MLD treatments were performed mainly by one experienced physiotherapist specially trained in bandaging and in the MLD technique of Dr Vodder. The MLD involves gentle massage starting over the

**Table 1. Patient Characteristics**

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>CB Group n=17</th>
<th>CB+MLD n=18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edema beginning after op, months</td>
<td>median (q₁-q₃)</td>
<td>median (q₁-q₃)</td>
</tr>
<tr>
<td></td>
<td>19 (3.8-69)</td>
<td>10 (6-21)</td>
</tr>
<tr>
<td>Edema duration, months</td>
<td>6 (1-27.3)</td>
<td>4 (3-42.8)</td>
</tr>
<tr>
<td></td>
<td>number</td>
<td>number</td>
</tr>
<tr>
<td>Right/left arm lymphedema</td>
<td>11/7</td>
<td>13/7</td>
</tr>
<tr>
<td>Dominant arm lymphedema</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Partial mastectomy/mastectomy</td>
<td>4/14</td>
<td>5/15</td>
</tr>
<tr>
<td>Radiotherapy</td>
<td>15</td>
<td>18</td>
</tr>
</tbody>
</table>

CB = Compression Bandaging  
MLD = Manual Lymph Drainage
contralateral quadrant of the trunk free of lymphostasis followed by massage over the ipsilateral trunk and extremity in a proximal direction ending with the hand.

**MEASUREMENTS AND ASSESSMENTS**

The study design is illustrated in Figure 1. In Part II, with daily MLD treatments, all measurements were performed before treatment at test 2 and 3.

**Volume of the arm:** Each arm was submerged in a container with water and the volume displacement was measured in ml. The method has been described by Kettle (19), who found a standard deviation of 1.5% from the mean volume. Bednarczyk et al. carried out a validity test for the water displacement method with a computerized limb volume measurement system (CLEMS) and found a high correlation coefficient \((r=0.992)\). They also showed that measuring plaster figures, CLEMS had a high test-retest correlation \((r=0.999)\). The changes in lymphedema volume were obtained by comparing the difference in volume between the affected and unaffected arm. The changes are expressed both in ml and as percentage reduction in lymphedema. Percentage lymphedema reduction was calculated as follows:

\[
\text{diff test A} - \text{diff test B} \times 100
\]

\[
\text{diff test A}
\]

where \(\text{diff} = \text{affected arm volume minus unaffected arm volume (22)}\).

**Body weight** was registered at each volume assessment.

**Subjective assessment:** The experiences of pain, heaviness and tension of the affected arm were each scored by the patient on a 100 mm horizontal visual analogue scale (VAS). The endpoints were “worst imaginable” (0 mm) and “no discomfort” (100 mm). Each patient was asked to consider her subjective sensations before and after the three-week period of study. The initial scores at test 1 were made available to the patient at test 3 at the end of the study.

**STATISTICS**

Student’s t-test for paired samples was used to calculate differences within the total group during Part I and within the groups CB and CB+MLD in Part II. T-tests for independent samples were performed to calculate differences between the two groups CB and CB+MLD. Corresponding analyses employing Wilcoxon signed rank tests and Wilcoxon rank sum tests for paired and independent samples respectively also have been performed. The \(p=0.05\) significance level was chosen.

**RESULTS**

**Volume of the arm:** In the total group the mean±SD arm volume was 3049±484 ml on the affected side and 2355±355 ml on the unaffected side at test 1. The difference was significant \((p<0.001)\). The mean percentage volume difference between the abnormal and normal arm was 22±9%. The mean lymphedema volumes for the total group was 694±353 ml at test 1 and 507±247 ml at test 2. The mean arm volumes and the mean lymphedema volumes for the CB group and the CB+MLD group on the different test occasions are shown in Table II and Table III, respectively. There were no significant differences between the two groups at test 2.

**Table 2. Arm volume (mean±SD) in ml**

<table>
<thead>
<tr>
<th></th>
<th>At the three test occasions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CB</td>
</tr>
<tr>
<td>TEST 1</td>
<td>3073±602 *</td>
</tr>
<tr>
<td>TEST 2</td>
<td>2841±479</td>
</tr>
<tr>
<td>TEST 3</td>
<td>2823±474</td>
</tr>
</tbody>
</table>

\(\text{CB} = \text{Compression Bandaging}\)

\(\text{MLD} = \text{Manual Lymph Drainage}\)

\(* = n=18\)

\(** = n=20\)

**Table 3. Arm lymphedema volume (mean±SD) in ml (affected minus unaffected arm) at the three test occasions**

<table>
<thead>
<tr>
<th></th>
<th>At the three test occasions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CB</td>
</tr>
<tr>
<td>TEST 1</td>
<td>770±455 *</td>
</tr>
<tr>
<td>TEST 2</td>
<td>565±311</td>
</tr>
<tr>
<td>TEST 3</td>
<td>545±311</td>
</tr>
</tbody>
</table>

\(\text{CB} = \text{Compression Bandaging}\)

**DISCUSSION**

Continuous CB with low-stretch bandage is effective treatment for volume reduction of secondary arm lymphedema in women previously treated for breast cancer, especially during the first week of therapy. The period of two weeks (Part I) for CB treatment was chosen according to the outcome of a previous study with a treatment period of four weeks including massage, isometric exercises and wearing of elastic sleeve. The
results of that study showed that the greatest edema volume reduction occurred during the first week and gradually diminished over the course of the next three weeks. Similarly, in another study with two weeks of MLD treatment, the most significant decrease of volume occurred during the first week. In the present study, a further small edema reduction was noted during the second week, but by the third week, no further edema reduction was forthcoming, suggesting that bandaging was most effective when administered daily for two weeks. This outcome is also supported by Ko et al. in a study of 149 patients with upper-extremity lymphedema using CLT. They found a volume reduction of 59% after an average of 16 days of treatment, whereas in another study, Boris et al., also using CLT in 56 patients, found a similar edema reduction (62.6%) over a 30-day period.

The results from two independent studies emphasize the clinical impression that CLT is an effective combination of treatment for lymphedema encompassing MLD, CB, exercises and skin care. When CLT is administered for at least a two-week period, a volume reduction of about 60% can be expected. The efficiency of a treatment, however, also needs to be related to the economic resources available. MLD is time-consuming, whereas CB takes comparatively little time to perform and can even, with some training, be left to the patients to do on their own. Therefore, the purpose of this study was to examine whether MLD had additive volume-reducing effect. The results obtained support this assumption, although the amount of added edema reduction was small. Thus, an edema decrease of 26% in 14 days occurred with CB alone, but when MLD was added for five days, a further edema reduction of 11% was obtained for a total reduction of 37%. An unanswered question is whether the difference (approx. 20%) between the two treatment programs, CLT and CB+MLD, may have been less if MLD had been added from the outset, or if the differences observed are attributable to exercises and skin care. Another consideration is that the percentage decrease during Part I may have been greater if the nine patients who wore elastic sleeves before the start of Part I had been excluded as being already “treated.” On the other hand, separate analysis showed a similar reduction of arm edema for patients who had worn elastic sleeves compared with those who had not before inclusion in the trial study.

Continuous compression with elastic sleeves is considered an important part of the treatment, especially to maintain an arm volume reduction for a longer period after intensive daily therapy has ceased. With an average follow-up of nine months, Ko et al. found that edema improvement was maintained within 95% of the initial volume in 84% of the patients wearing compression sleeves during the day combined with bandaging at night and a daily exercise program. The volume-reducing effect of an elastic sleeve without any other treatment has been evaluated for a longer period by Swedborg and Bertelli et al. They showed a volume reduction of 8% and 18% respectively after six months. With gradual decrease of the size of the sleeve over a one-year period, Brorson et al. obtained a reduction of 47%. However, Casley-Smith found that lymphedema increased with time. Thus, it is important when lymphedema is first detected to offer effective treatment over a short period and CB, alone, seems to have the largest volume-reducing effect over a short period. If MLD can be added, the effect is only slightly greater.

In the present study, CB+MLD was administered to patients with slight and moderate lymphedema. Whereas there was no planned exclusion of severe edema, no such patients were referred to the Lymphedema Unit during the study. This might be due to the close follow-up program of breast cancer patients in Sweden, resulting in early detection of lymphedema. It might also be due to the possibility of treating severe lymphedema, often with a high degree of fat deposition, by liposuction with complete reduction of the edema. However, considering the physical and psychosocial ill effects for lymphedema patients, the first goal for treatment is to keep the lymphedema volume as low as possible and, thereby, avert reaching the stage of severe lymphedema.

The patients in this study were allocated consecutively (i.e., not randomly but alternatively) to the two treatment groups when they were referred to the Lymphedema Unit. The patients were referred from many different clinics and the severity or the incoming order sequence was not influenced by any referring doctor. Normally, there is a small change in arm volume over time, approximately 5%, documented by Swedborg et al. In this study, the mean±SD percentage volume variation of the unaffected arm was 1±2%. Concerning this low variation together with the steady body weight, we conclude that the reduction of the arm volume on the affected side after treatment represented a true reduction of lymphedema.

Asymmetry of arm volume occurs because the dominant arm is usually larger than the non-dominant one. However, in our study, there were no significant differences between the groups regarding side of operation or dominant arm. Thus, no correction for asymmetry was made.

We used the visual analogue scale (VAS) to evaluate changes in feelings of pain, heaviness and tension in the affected arm during the treatment period. There was no correlation between edema volume reduction and feelings of
heaviness and tension, perhaps because the patient population was small. However, such a correlation was previously demonstrated by Swedborg et al. using a Borgscale. The correlation between VAS and Borgscale was found to be good by Wilson et al., measuring dyspnoea during exercise. However, the validity of the correlation between edema volume reduction and reduction of feelings of heaviness and tension has not yet been verified using VAS.

In this study, we determined that compression wrapping with a low-stretch bandage is an effective treatment regarding volume reduction of slight or moderate arm lymphedema in women previously treated for breast cancer. This response is improved when manual lymph drainage is added. Patients' subjective feelings of heaviness and tension in the swollen arm were similarly decreased by either CB alone or CB combined with MLD.

**The Authors**

K. Johansson, RPT, BSc, Department of Physical Therapy, Lund University, S-220 05 Lund, Sweden; M. Albertsson, MD, PhD, Department of Oncology, Lund University Hospital, S-221 85 Lund, Sweden; C. Ingvar, MD, PhD, Department of Surgery, Lund University Hospital, S-221 85 Lund, Sweden; C. Ekdahl, RPT, PhD, Department of Physical Therapy, Lund University, S-220 05 Lund, Sweden

**Acknowledgments**

This study was supported by research grants from the Swedish Cancer Foundation.

**Correspondence to:**

Karin Johansson, RPT, BSc
Rörelseterapiavdelningen
Lund University Hospital
S-221 85 Lund, Sweden
E-mail: karin.johansson@skane.se

**References available upon request.**