Lymphoedema and Breast Cancer. A Physiotherapeutic Approach.

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A Physiotherapeutic Approach

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Thesis 2002

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To my mother, Berit,
and her sister, Britt, my godmother,
who has arm lymphoedema after
breast cancer treatment.

Till min mor, Berit,
och hennes syster, Britt, min gudmoder,
som har armlymfödem efter
bröstcancerbehandling.

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List of publications

This thesis is based on the following studies, which are referred to in the text by their Roman numerals:

I. Johansson K, Ingvar C, Albertsson M, Ekdahl C. Arm lymphoedema, shoulder mobility and muscle strength after breast cancer treatment. A prospective 2-year study. Advances in Physiotherapy 2001; 3: 55–66.

II. Johansson K, Ohlsson K, Albertsson M, Ingvar C, Ekdahl C. Factors associated with the development of arm lymphedema following breast cancer treatment: A match pair case- control study. Lymphology (Accepted 2001)

III. Johansson K, Lie E, Ekdahl C, Lindfeldt J. A randomized study comparing manual lymph drainage with sequential pneumatic compression for treatment of postoperative arm lymphedema. Lymphology 1998; 31: 56–64.

IV. Johansson K, Albertsson M, Ingvar C, Ekdahl C. Effects of compression bandaging with or without manual lymph drainage treatment in patients with postoperative arm lymphedema. Lymphology 1999; 32: 103–110.

V. Johansson K, Holmström H, Nilsson I, Albertsson M, Ingvar C, Ekdahl C. Breast cancer patients' experiences of lymphedema. (Submitted).

Some additional data, not previously published, have been included in Results.

Abbreviations

ART	Radiotherapy treatment both to breast- and axilla area including fossae supra- and infraclavicularis
BMI	Body mass index: Body weight (kg) divided with body length (m) in square.
BRT	Radiotherapy treatment only to the breast area
CB	Compression bandaging
CMF	Cyklofosfamid, methotrexat and 5-flourouracil, (chemotherapy)
FEC	Fluorouracil, epirubicin and cyclofosfamid, (chemo-herapy)
Gy	Grey, radiotherapy dose
MLD	Manual lymph drainage
NRT	No radiotherapy treatment
ROM	Range of motion
SPC	Sequential pneumatic compression
VAS	Visual analogue scale

Definitions

Arm lymphoedema: The affected arm is ≥ 10% greater in volume than the non-affected arm (Stillwell 1969).

Axillary dissection: Surgical term meaning dissection of lymphatic nodes in the axilla lateral of (level I) and behind (level II) the pectoralis minor muscle (Bundred 2000).

Axillary sampling: Surgical term meaning dissection of four separate lymph nodes in the axilla (Bundred 2000).

Coping: Constantly changing cognitive and behavioural efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person (Lazarus & Folkman 1984).

Chronic disease: Permanent deviation from the normal, caused by unaltered pathological changes (Cameron & Gregor 1987).

Pitting oedema: By pressing a finger hard into the oedema for about 30 seconds a depression in the tissue will occur demonstrating that there are relatively free extra fluid in the tissue that can be pressed aside.

Introduction

Breast cancer

Incidence

Breast cancer is the most common malignancy in women in the world with 1 million new cases each year (McPherson et al. 2000). In Sweden 29% of the cancer diagnosis in women is breast cancer and 10% of the female population will be diagnosed with breast cancer during their lifetime. The incidence in Sweden has slowly increased since the ‘60s when registration started and the yearly age standardised increase is estimated at 1.4% (Swedish Cancer Registry, 1999). The survival rate during 1960–1995 in the South Sweden Health Care Region has also increased slowly and the current 5-year survival is about 85%.

Diagnosis

Assessment of invasive breast cancer is made by triple approach combining mammography and ultrasound with clinical examination and fine needle biopsy (Dixon & Mansel 2000). When results of all diagnostic procedures are available, they are discussed at the multidisciplinary breast conference. The extent of the disease is assessed at the postoperative conference where special considerations are taken to if the tumour is radical excised, the histopathological type and grade, multifocality, hormonal receptor status, lymphovascular invasion, lymph node involvement and periglandual growth.

Treatment

Most patients will have a combination of treatments to control the disease locally where surgery is often combined with radiotherapy. Systemic treatments, including antihormonal and cytotoxic treatment, are given to control for any micrometastatic disease. In a physiotherapeutic perspective, the interest is focused on morbidity related to surgery and radiotherapy.

Nowadays breast conservation is the most common way to treat breast cancer in Sweden. The tumour is excised with surrounding normal breast tissue

(Gage et al. 1996). Breast cancer unsuitable for treatment with breast conservation can be treated by mastectomy with removal of the breast tissue from the chest wall muscles (pectoralis major, rectus abdominus and serratus anterior) which are left intact (Veronesi et al. 1990). Common complications after mastectomy include seroma, infections and flap necrosis (Sainsbury et al. 2000). The wound surface is relatively large and the fibrotic tissue developed during wound healing has been related to occlusion of the remaining lymphatic channels (Thompson et al. 1995). The fibrotic tissue may also contribute to decreased shoulder mobility.

Radiotherapy is given in order to prevent recurrent cancer. Following breast conservation surgery radiotherapy is given tangentially to the remaining breast tissue. When axillary metastases are present, locoregional lymphnodes can be included (Bundred et al. 2000). Postoperative radiotherapy to the axilla has been reported to contribute to lymphoedema (Swedborg et al. 1981, Kissin et al. 1986, Christensen & Lundgren 1989), decreased shoulder mobility (Aitken et al.1989, Höjris et al. 2000) and muscle strength (Nikkanen et al. 1978, Aitken et al. 1989). Increasing fibrotic tissue in the shoulder area may also cause nerve entrapment (Olsen et al. 1993). At two to ten months after large single doses given to muscles of various species of animals, progressive muscle injury has been reported. Vascular lesions resulting in loss of capillaries and increased collagen formation probably cause these injuries. It was supposed that the fibrosis occurring might be mediated additionally by inflammation that accompanies vessel damage (Gillette et al. 1995). Fibrinous exudate caused by inflammation can be found months to many years after exposure of radiotherapy (Fajardo 1992).

Lymphoedema

The lymphatic system

The lymphatic system moves fluid, macromolecules and formed elements from within the interstitial spaces into the lymphatics in the form of lymph. The walls of the initial lymphatics consist of a single layer of endothelial cells allowing openings for fluid and macromolecules to enter the system (Castenholz 1991). The walls are directly connected to the tissue fibers by “anchoring filaments” (Leak et al. 1966, Leak 1971) providing support for the structures and they may also act as pathways for the transport of pre-lymphatic fluid (Ryan 1989). From the *initial lymphatics* the lymph is transported to the *precollectors* which in addition have collagenous and elastic fibers, and in bigger vessels mus-

cular elements, to form an outer vascular wall. They have valves and in some vessels they are already arranged in regular intervals. The precollectors communicate with *collecting lymphatics* comprising vessels with various diameters and their walls are similar to larger blood vessels (Castenholz 1991). All vessels possess valves and each segment between two valves represent a unit called lymphangion (Mislin 1961). The lymphangions are richly provided with nerve structures belonging to the autonomic nervous system. This system and the muscular elements in the walls of the angions generate contractions and this "pumping" activity is one of the most important mechanisms for generating lymph flow. The lymph is also propelled through numerous lymph nodes and finally returned to the blood system and into the subclavian veins (Gashev & Zawieja 2001).

Olszewski et al. (Olszewski 1980) measured the contraction frequency and flow in healthy lymphatic vessels in legs. In horizontal resting position the mean frequency was 2.4±1.8/min and the mean flow 0.3 ml/h. At massage with 30 compressions/min or at flexion of the foot in horizontal position frequency (4.4±2.0/min) and lymph flow (0.6±0.02ml/h) was observed to be at almost the same level. On the other hand, in upright position with rising toe the frequency rose to 5.5±1.0/min and lymph flow to 0.7 ml/h.

Lymphatic drainage of the arm is primarily accomplished through lymph vessels that pass through the axilla. Secondary passages, such as through the brachio-cephalic chain outside the axilla aid in removal of lymph and there may also exist alternative systems, such as lympho-venous anastomoses (Threefoot & Kossover 1966, Jonsson et al. 1982).

Pathophysiology

Lymphoedema can be defined as the tissue fluid accumulation that arises as a consequence of impaired lymphatic drainage (Szuba & Rockson 1998). "True" lymphoedema is not due to overproduction of lymph by increased capillary filtration (high output lymphoedema) but strictly occurs as a result of failure of lymph drainage (low output lymphoedema) (Olszewski 1991, Mortimer 1998). The transport capacity of the lymphatic system is less than the lymphload. The expression "transport capacity" is defined by the highest possible lymphflow per units of time (Földi et al. 1989).

Lymphoedema arises when an intrinsic fault develops within the lymph-conducting pathways (primary lymphoedema) or when damage occurs from one or more factors originating outside the lymphatic system, such as surgical removal of lymph nodes (secondary lymphoedema) (Mortimer 1998). Routes of drain-

age are decreased, resulting in reduced lymph transport capacity. Földi et al. (1989) has described mechanisms compensating this reduction:

1. Lymphatics spared by surgery and radiotherapy increase their capacity (Stanton et al. 2001)
2. Collateral lymphatic flow develops through axilloaxillary, axilloinguinal and other lympholymphatic anastomoses.
3. Protein-rich tissue fluid trickles out of the lymphatic area through connective tissue channels and superficial dermal lymphatic plexus void of valves into the border trunk possessing healthy lymphatics.
4. Lymphovenous anastomoses establish new connections between veins and lymphatics (Aboul-Enein et al. 1983)

However, in breast cancer related arm lymphoedema, Svensson et al. (1994) demonstrated with Doppler technique a significant higher proportion of patients with increased arterial flow in 50 breast cancer patients with arm oedema compared to 26 breast cancer patients with no swelling. The authors suggested that this might depend on neurological deficit with loss of vasoconstrictor control. In another study the same authors showed (Svensson et al. 1994) that 70% of 81 patients had abnormal venous outflow. This was supported by Bates et al. (1994) who found higher venous blood pressure in the oedematous arm compared to the control group. Neither could their measurements of the colloid osmotic pressure in the interstitial fluid support the traditional view of "high-protein" oedema (Földi et al. 1983, Reed & Aukland 1991) due to reduced axillary lymph drainage. In conclusion, they stated that "the pathophysiology of postmastectomy oedema involves additional mechanisms besides lymphatic damage".

The early phase of arm lymphoedema is characterised by palpable increasing thickness (Brodin 1971) particularly in subcutis (Raines et al. 1977, Göltner et al.1988, Brennan et al. 1996) and the patients' subjective feeling of increased tension in the tissue (Swedborg 1981). As long as the lymphoedema is in a reversible stage, pitting can be found and volume is reduced by limb elevation. At this stage, response to conservative treatment is very good (Brennan et al. 1996). However, as time passes, the lymphoedema loses its pitting character probably due to hypertrophy of the adipose tissue (Ryan & Curri 1995) and later fibrosis (Gaffney & Casley-Smith 1981). At this stage, surgery i.e. liposuction is preferable (Brorson & Svensson 1997). When not treated, secondary arm lymphoedema, such as occurs after breast cancer treatment, develop faster

in amount than other lymphoedema, such as leg lymphoedema or primary lymphoedema (Casley-Smith 1995).

Arm lymphoedema following breast cancer treatment

Incidence

The reported incidence or prevalence of arm lymphoedema varies a lot mainly due to different definitions, lack of standardisation of assessment techniques and different breast cancer treatments. A review of articles describing incidence is presented in Table 1. Only studies measuring volume with methods tested for validity (Bednarczyk et al. 1992, Airaksinen et al. 1991) and reliability (Swedborg 1977, Woods 1994) and where lymphoedema was defined were included. The prevalence increases with time. This is demonstrated by Kiel & Rademacker (1996) up to 3 years after breast cancer treatment and by Ivens et al. (1992) up to 4 years, who also found a decrease after that time.

Conservative treatments

Compression therapy, manual lymph drainage and intermittent pneumatic compression are the most commonly used conservative treatments for arm lymphoedema following breast cancer treatment in Sweden. A review of studies evaluating these treatments, alone or in combination, is presented in Table 2. Only studies measuring volume with methods tested for validity (Bednarczyk et al. 1992, Airaksinen et al. 1991, Stanton et al. 1997) and reliability (Swedborg 1977, Woods 1994) were included. Further were only studies expressing reduction of oedema in percentage (Bernas 1996) included in order to make comparison between results of different studies possible.

Compression therapy

Compressive bandages were already mentioned in the 19th century as an important part of lymphoedema treatment (Mackenzie 1880, Winiwarter 1892). Van der Molen & Toth (1974) described the most aggressive compression treatment where the extremity was tightly wrapped with elastic bandages. They remained in place until the patient started to express pain and were then quickly removed. This procedure was repeated 2-4 times. Custom-made compression

Table 1. Longitudinal (LO) or cross-sectional (CS) studies of lympoedema incidence/prevalence following breast cancer treatment. Only studies measuring volume with methods tested for validity and reliability and where lymphoedema has been defined were included.

Author(s) and year of publication	Time after surgery and study design	Definition of arm volume difference	RT	Breast cancer treatment*	Lymph-oedema incidence	Number of patients
Swedborg & Wallgren, 1981	mean 49 mo CS	> 10% volumetry	45 Gy 5 weeks	AD AD+preopART AD+ART	10% 16% 18%	144 163 168
Kissin et al. 1986	1-5 years (50%) 5-10 years (30%) >10 years (20%) CS	>200 ml volumetry	not described	No ax.treatm. RT AS AS+ART AD AD+ART	0% 8% 0% 9% 7% 38%	8 12 17 22 94 47
Christensen & Lundgren, 1989	1 year LO	>10% volumetry	mean 43 Gy 4-5 weeks	AD AD+ART AS AS+ART	10% 44% 0% 0%	20 27 23 25
Segerström et al., 1991	mean 42 mo CS	>150ml volumetry	45 Gy 3 weeks	AD AD+ART AD+BRT	21% 60% 17%	43 36 57
Hoe et al. 1992	mean 23 mo (at least 6 mo) CS	> 200ml volumetry	no RT	AD	8%	118
Thompson et al., 1995	1 year LO	>200 ml volumetry	45 Gy 4 weeks	AS+BRT AS+ART AD+ART	21% 30% 54%	28 61 13
Höjris et al. 2000	mean 9 years range(6-10yr) CS	>200 ml circumference	50 Gy 5 weeks	AD AD+ART	3% 14%	42 42
Tengrup et al., 2000	5 years LO	>10% volumetry	50 Gy 5 weeks	AD AD+BRT	12% 17%	35 75
Duff et al. 2001	2 years LO	> 200 ml optoelectr.	no RT	AD	19%	42

AD - Axillary dissection
ART - Breast and axillary radiotherapy
AS - Axillary sampling
BRT - Breast radiotherapy
Gy - Grey
RT - Radiotheraphy

Table 2. Overview of arm lymphoedema treatments with compression bandaging (CB) or sleeve, manual lymph drainage (MLD) and pneumatic compression (PC) where volume was measured with methods tested for reliability and validity, and where reduction of oedema volume was expressed in percentage.

Author(s) and year of publication	Measure-ments	Definition of arm vol. difference	Number of patients	Treatments	Length of study	Mean reduc-tion %
Swedborg 1977	Volumetry	No def.	7	PC	6 hours/ 10 days	RV 2.3%
Swedborg 1980	Volumetry	> 10%	22 54	Sleeve PC	6 mo 6 hours/ 10 days	RV 8% RV 18%
Hutzschenreuter et al. 1991	Circ. 4 cm intervals	No def.	62	MLD+CB	3 weeks	20%
Morgan et al. 1992	Circ. 10 cm intervals	ISL	78	MLD+CB	4 weeks	61%
Bunce et al. 1994	Circ. 10 cm intervals	No def.	25	MLD+PC+ CB+exercises	4 weeks	44%
Boris et al. 1997	Circ. 10 cm intervals	ISL	56	Skin care+MLD +CB+exercises	30 days	63%
Brorson & Svensson, 1998	Volumetry	No def.	14	Comp.sleeve was regularly taken in	1 year	47%
Ko et al. 1998	Circ. 7 locations	No def.	146	Skin care+MLD +CB+exercises	mean 16 days	59%

Circ. - circumference measurements
ISL - according to criteria of the International Society of Lymphology (Casley-Smith et al. 1985)
RV - relative volume

sleeves were developed during the first half of the twentieth century and first described in detail in an article by Nelson in 1966. It has been used as only treatment (Bertelli et al. 1992, Brorson & Svensson 1998) or in combination with manual lymph drainage or pneumatic compression (Swedborg 1980, Zanolla et al. 1984). The supply of different materials and shapes of the compression sleeves has improved constantly and a European standard has been set for different classes of compression (European Committee for Standardisation 2001).

Manual lymph drainage

Manual lymph drainage is a massage technique comprising slow and gentle circling or pumping strokes. The massage movements of manual lymph drainage are considered to mechanically stretch underlying epifascial lymph collectors (Mislin 1983), giving a higher frequency of angion contractions (Olszewski & Engeset 1980) and increased pressure in the lymph collectors (Hutzschenreuter & Bruemmer 1988), thus resulting in increased lymph transport capacity (Földi 1983, Hutzschenreuter 1991).

The massage technique was already introduced 1892 by Winiwarter, a surgeon, who applied the classical massage techniques introduced in the early 19th century by "the father of Swedish physiotherapy", Per Henrik Ling (Asdonk 1995). Winiwarter stressed the importance of beginning the massage at the root of the swollen extremity (Winiwarter 1892). He also recommended "careful cleanliness, massage and remedial exercises". This technique was forgotten for some decades. Perhaps this was due to the fact that compression garments, essential to maintaining the reduction caused by massage, were of poor quality and the massage had to be repeated very often. In the early '30s Vodder rediscovered the massage technique and further developed it into manual lymph drainage (Vodder 1936, 1957, 1966). The recommendation from Winiwarter concerning skin care, compression and remedial exercises was also renewed and complemented with compression sleeves in the '70s. This treatment program was introduced by Földi as "complex decongestive physiotherapy" (Földi & Földi 1981).

Intermittent pneumatic compression

The first report on treatment with intermittent pneumatic compression pumps was published in the '50s (Stillwell 1959). Britton & Nelson (1962) described further the method consisting of a machine designed to pump air into an inflatable sleeve fitting over the limb. The sleeve was inflated to a certain pressure (not specified) and deflated in a cycle for around 6 hours. In 1969 Godfrey described a segmented sleeve. The pressure was applied to each segment in a sequential fashion, from distal to proximal. Both kinds of devices are still used in the treatment of lymphoedema.

The recommended time for each treatment session seems to vary considerably from 30 minutes (Berlin et al. 1999) to 40 hours (Zelikovski et al. 1980). Also the pressure applied varies widely from Zeissler et al. (1972) using 30

mmHg to Zelikovski et al. (1980) using 120-160 mmHg. The great variation might be explained by the limited knowledge of the lymphoedema reducing mechanisms of the pumps. In 1980 Olszewski & Engeset proved the systolic pressure in superficial lymphatics in the leg to reach a mean level of 37.9 mmHg and one year later Miller & Seale (1981) published experiments with different pressure on lymphatic vessels in dogs showing that closing pressure was observed to be 60 mmHg. This seems to have influenced a few studies applying 40-60 mmHg (Swedborg 1984, Bertelli 1992). However, studies are still presented with high-pressure treatments (Berlin et al. 1999) without any rational physiological explanation.

Psychosocial aspects

As early as 1966 Nelson evaluated the use of compression sleeves among patients with lymphoedema using a questionnaire. Comments from the patients were presented in an article revealing both positive and negative experiences. Tobin et al. (1993) also using questionnaires found that breast cancer patients with arm lymphoedema experienced greater psychological morbidity and impaired adjustment to illness than those without lymphoedema. Velanovich & Szymanski (1999) compared quality of life in similar groups revealing influence in the domains of emotion and pain for patients with arm lymphoedema. This was supported by Dennis (1993) showing that depression and pain interfered with some lymphoedema patients' ability to comply with oedema treatment. However, Mirolo et al. (1995) stated that intensive conservative treatment followed by a self-management phase showed higher quality of life assessment compared to that before treatment in a one-year follow-up. Carter (1997) interviewed 10 breast cancer patients with arm lymphoedema. Using a phenomenological analysis she found that some women experienced depression, anxiety and impairments related to their work, social relationships and intimate.

Decreased shoulder mobility and muscle strength

Several studies report limited shoulder range of motion (ROM) following breast cancer treatment (Nikkanen et al. 1978, Aitken et al. 1989, Ivens et al. 1992, Maunsell et al. 1993, Paci et al. 1996) as well as reduced muscle strength (Nikkanen et al. 1978, Ivens 1992). Hladiuk et al. (1992) found that 12% of 57 patients reported decreased shoulder mobility one year after axillary node

dissection for breast cancer. Most of the reduction occurred within 6 months after surgery. These observations are consistent with the results of a Swedish exploratory study of 28 breast cancer patients (Johansson 1993). Both studies also pointed out that postoperative measurement at one and two years respectively showed small changes from the measurements at six months.

Objectives

General

The general aim of this thesis was to identify risk factors and onset, evaluate treatments and explore, in a physiotherapeutic perspective, the experiences of patients with arm lymph oedema following breast cancer treatment.

Specific

- To closely follow and describe arm volume differences, shoulder ROM and muscle strength of the shoulder and hand up to two years after breast cancer treatment in order to identify onset and patients at risk of impairments (I).
- To explore factors that may be related to early decreased shoulder ROM (I) following breast cancer treatment.
- To examine factors, including specific mode of therapy, patient occupation and lifestyle, associated with the development of arm lymphoedema following breast cancer treatment (II).
- To examine the effects of treatment with MLD and SPC (III).
- To examine the effects of treatment with CB alone or when combined with MLD (IV).
- To explore employed women's experiences of light or moderate arm lymphoedema following breast cancer treatment in order to gain a deeper understanding of this phenomenon (V).

Subjects

Since the early 1980's, when breast-conserving therapy was introduced in the South Sweden Health Care Region, this method has increased at the cost of modified radical mastectomy and in 1995 the division was about 75% and 25%, respectively. Axillary node dissection was performed to all subjects in Papers I-V. The aim of the dissection, according to the recommendations of the "Care Program for Breast Cancer" in the southern Sweden, is to remove tumour-infiltrated nodes. If no such nodes are seen or felt, eight to ten nodes are removed for staging of the breast cancer disease (South Swedish Breast Cancer Group 1995). The operation involves the nodes below and medial to the axillary vein (level I and II) (Fig.1) (Hermanek & Sobin 1987) saving the long thoracic and the thoracodorsal nerves but dividing nervous intercostobrachialis.

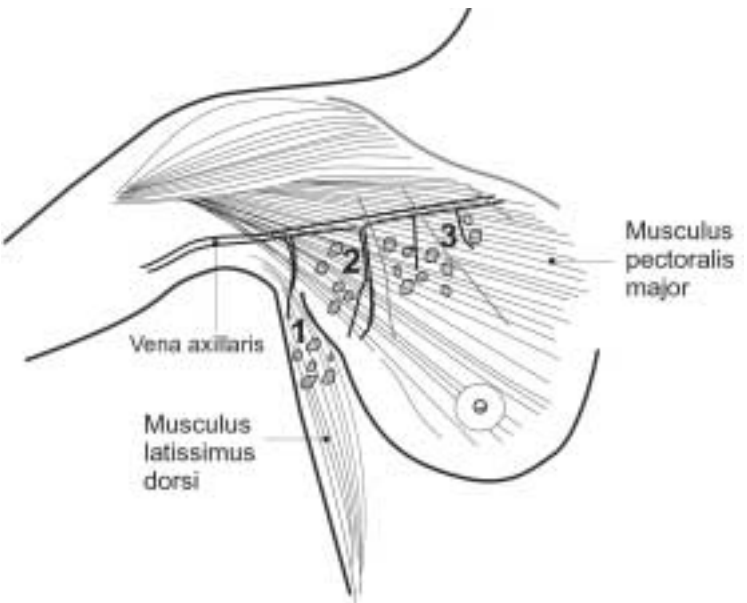

Figure 1. Axillary dissection involves the nodes below and medial to the axillary vein (level I and II).

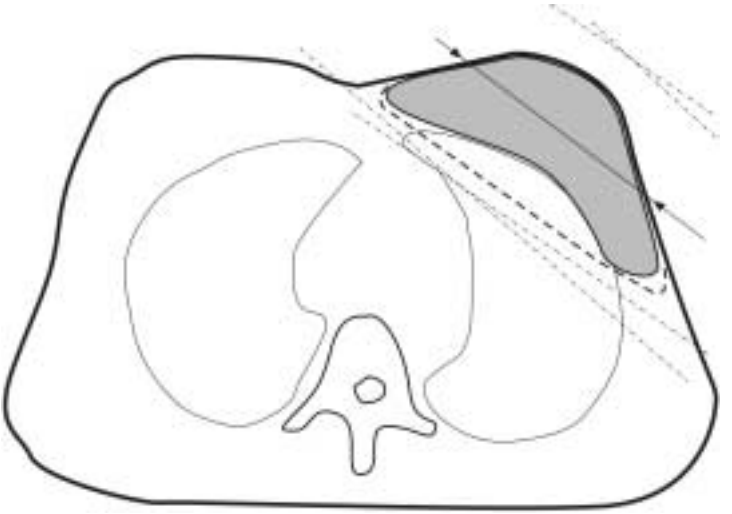

Figure 2. Following breast conservation radiotherapy is given tangentially to the remaining breast tissue.

Following breast conservation, radiotherapy is given tangentially to the remaining breast tissue (Fig. 2). In the case of axillary metastases radiotherapy is given to the thoracic wall and to lymph nodes in axilla and fossae supra- and infraclavicularis, and sometimes to the sternum nodes (Fig. 3). The upper limit is the

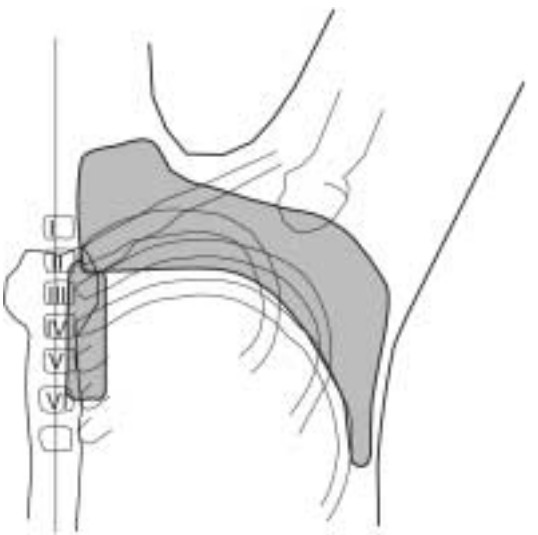

Figure 3. By axillary metastases radiotherapy is given to the thoracic wall and to lymph nodes in axilla and fossae supra- and infraclavicularis, and sometimes to the sternum nodes.

Table 3. Basic data for patients in paper I-IV.

	Paper I	Paper II		Paper III	Paper IV	Paper V
Number	61	71	71*	24	38	12
Age (mean±SD) years	56±10	58±11	58±9	60±13	64±12	50±6
Surgery						
Site, right/left, number	39/22	33/38	30/41	13/11	24/14	-
Side, dominant/nondominant/ ambidex., number	38/21/2	36/34/1	40/28/3	12/12/0	24/14/0	-
Type, partial/mastectomy number	35/26	29/42	36/35	3/21	9/29	-
Adjuvant treatment						
Radiotherapy, ART/ BRT/ NRT, number	19/16/26	40/19/12	40/24/7		30/3/5	-
Chemotherapy, number	15	22	27	1	16	
Tamoxifen, number	15	28	20	12	10	-
Lymphoedema						
Start after operation (mean±SD) months	-	-	-	31±48	27±47	-
Duration, months	-	-	-	37±62	27±47	44±17
Arm volume difference in %	-	-	-	24±14	22±9	19±6

* controls without lymphoedema

acromioclavicular joint and 2/3 of caput humeri. The radiotherapy dose given is 50 Gy in fractions 2 Gy/day over 5 weeks (South Swedish Breast Cancer Group 1997).

Basic data for patients in paper I-V can be seen in Table 3

Methods

Measurements

Volume (Paper I, III, IV)

Arm volume was measured with the water displacement method (Archimedes principle, Fig. 4) which has been used as the golden standard of limb volume measurements (Bernas et al. 1996). The method has been described by Kettle (1958), who found a standard deviation of 1.5% from the mean volume. In a study by Swedborg (1977) the test-retest reliability on the same method showed a mean difference of 0.5%. Bednarczyk et al. (1992) carried out a validity test for the water displacement method with a computerised 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).

Each arm was submerged in a container with water and the volume displacement was measured in ml (Fig. 4). The contralateral arm was used as control at

Figure 4. The arm volume was measured with the water displacement method (Archimedes principle). The arm was submerged in a container with water and the displaced volume was weighed.

each occasion. Arm lymphoedema, was defined as an increase in volume of at least 10% compared to the contralateral arm (Stillwell 1969) using the following formula:

$$\frac{\text{Vol. lymphoedema arm} - \text{vol. contralateral arm}}{\text{vol. contralateral arm}} \quad X \quad 100$$

The lymphoedema volume was obtained by calculating the difference in volume between the lymphoedema arm and the contralateral arm. The changes in lymphoedema volume was expressed both in millilitres as percentage reduction and was calculated as follows:

$$\frac{\text{diff test A} - \text{diff test B}}{\text{diff test A}} \quad X \quad 100$$

where diff = affected arm volume minus unaffected arm volume (Casley-Smith 1994, Sitzia et al. 1997). A correction for the natural asymmetry of the arms was performed with 1.6% for right-handed and 1.4% for left-handed (Godal & Swedborg 1982).

Body weight (Paper I, II, III and IV)

In Paper I, III and IV the body weight was registered in order to verify arm volume changes due to changes in weight. In Paper II body weight was obtained from the medical records at time for surgery and from the questionnaire at time for the study and Body Mass Index (BMI) was calculated.

Range of motion (ROM) (Paper I and III))

In a supine position, in the same order, passive abduction, flexion, internal and external rotation of the shoulder (Paper I+III) and elbow (Paper III) on the operated side were measured with a goniometer. Internal and external rotation were measured with the arm in 90° abduction or, if this position could not be reached, in maximal abduction. The ROMs were expressed in degrees as recommended by the American Academy of Orthopaedic Surgeons (1985).

In a prior pilot study (n=12) the test-retest reliability of the above ROM measurements was evaluated by one physiotherapist (KJ). Results showed a mean

absolute difference of 4.0±3.6°(abduction), 4.4±2.1° (flexion), 5.4±3.0° (internal rotation), and 5.6±3.2° (external rotation) between two test occasions performed again within a maximum of three days.

The limit for reduced mobility was set at ≥ 5% for flexion and abduction, and ≥ 10% for internal and external rotation. The percentages 5% and 10% were chosen to represent approximately 10 degrees of reference values (Am Academy Ort Surg 1985)) for each range of motion, to avoid measurement errors. Whenever this limit for reduced ROM, compared to the preoperative measurements, was exceeded, the patients perceived and expressed a feeling of stiffness in the tissue. With the arm still in the limited position, the patient guided the physiotherapist to palpate and identify the area mainly associated with the reduction of the ROM.

The involvement of increased muscle tension was examined by measuring the ROMs before and immediately after performing the hold-relax technique (Tanigawa 1972) in the different ranges. At the two-year follow-up the glenohumeral joint involvement was tested by passive abduction of the arm up to 90° with a stabilised scapula (Am Academy Ort Surg 1985). Any movement of the scapula within 90° abduction was noted.

Muscle strength (Paper I and III)

Isometric shoulder muscle strength was measured with a hand-held spring dynamometer with a range of 1-25 kp (10-250 N) and a precision of 0.5 kp. The flexors, extensors, adductors, abductors and internal rotators of the shoulder on the operated side were measured with the patient in a supine position. The device was placed just proximal to wrist joint with the arm straight in 90° flexion of the shoulder, except for internal rotators where the arm was held close to the body with a 90° flexion of the elbow. A breaking force technique was employed. The method is highly reliable with significant correlation's ($p<0.01$) for repeated measurements (Bohannon 1986). The gripping force of the hand on the operated side was measured with a Jamar-dynamometer (Medema, Bromma, Sweden), the patient sitting with the arm held closely to the body with a 90° flexion of the elbow. The highest value of three was registered for each test.

Visual analogue scale (Paper III and IV)

The experiences of pain, heaviness, tension (Paper III+IV), paresthesia and function (Paper III) 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) (Scott & Huskisson 1976). 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 (Scott & Huskisson 1979).

Questionnaire (Paper II)

A questionnaire was constructed including questions concerning occupational workload, housework, exercise, hobbies, body weight, smoking habits and stressful events. The questions concerning occupational workload were derived from The Scandinavian Occupational Classification questionnaire (1978) and the rest from clinical experiences. In a pilot study, the questionnaire was tested for relevance of questions in 15 breast cancer treated women with arm lymphoedema. The women were asked to complete the questionnaire and report if any question was unclear or not relevant. Results revealed data making it possible to change opened questions into closed ones within the fields of housework, exercise and hobbies.

Classification of workload (Paper II)

The workload of the different occupations represented in Paper II was classified according to a previously used model (Jacobsson et al. 1992). Five items were assessed concerning the upper extremity. The items were: (1) lifting (practical nurse, child minder); (2) repetitive and/or static work (telephone operator, factory worker); (3) awkward working posture with respect to the neck and shoulder (medical secretary, hairdresser); (4) heavy work with hands and/or forearms (shop assistant, cleaner); (5) exposure to hand vibrations (bus driver, farmer). Each item was rated on a four point scale (0-3), with 3 as maximum exposure. Examples of occupations given the rating 2 are given above within parentheses. The classification was performed blindly, that is, without knowledge of the subject's life-style.

An intra-reliability test for each of the 5 items was performed in 20 subjects randomly selected from the main 38 pairs. This test was performed two months

after the first assessments were made in order to assure that no details from the first assessment might be remembered. The test showed good correlation (at least Spearman's r_s =0.919, p<0.001).

Phenomenological method

Qualitative research methods have been suggested as being useful for psychosocial research on chronic illness (Charmaz 1990). The phrase qualitative method refers in the broadest sense to research that produces descriptive data (Taylor & Bogdan 1984). By "descriptive" is meant an approach that aims at answering the questions what and how things are, rather than why (Karlsson 1993). The qualitative research is based on the concept that the individual forms her own opinion of life and reality. Thus, this experienced knowledge of life and the knowledge itself is related to each other and mutually dependent (Guba 1990). The collection and analysis of the women's stories in paper V were guided by a phenomenological perspective, tracing the structure or the essential components, entailed in the experience. The aim of phenomenology is to describe lived experience i.e. how phenomena appear to people in their experience (Husserl 1931). The interest was not focused on the facts presented, but rather the meaning imbued in these facts (Karlsson 1995).

Interviews (Paper V)

The respondents were informed of the purpose of the study, the procedure and the rules of confidentiality. Two physiotherapists, without previous contact with the women, performed the interviews. All interviews took place in an undisturbed place, nine of them at the hospital, two in the women's homes and one at her place at work. One physiotherapist was present at all interviews and both were present at seven, due to practical reasons. The interviews lasted 25-50 minutes and were tape-recorded. An interview guide was used as a memory aid, including areas of concern derived from clinical practice and literature review.

Critical incident (Paper V)

The critical incident method was described by Flanagan (1954). It is based on registration of observed incidents connected to special fields or questions of interest. In paper V the special field examined was incidents differing from normal daily life. The incidents were observed and registered by the women them-

selves. They were instructed to choose incidents differing from normal daily life and it was stressed that there could be no incident of such low or high importance that it could not to be registered. A form was used by the women to daily register at least one and at most 3 negative and positive incidents, respectively (min 2 and max 6 per day) for 10 days. All incidents were ranked on one negative and one positivea 1-10 point scale where –10 was the most negative and +10 was the most positive incident.

Treatments

Because lymphoedema is a chronic, generally incurable ailment, it requires, as other chronic diseases, lifelong care and attention along with the psychosocial support that may be appropriate. (ISL Consensus Document 1995, Casley-Smith 1995).

All treatments were performed at the Lymphoedema Unit, Lund University Hospital, Lund, Sweden.

Compression sleeve (Paper III)

A hand/wrist-to-shoulder compression sleeve of standard type (Rehband Anatomiska AB, Sollentuna, Sweden) was used with the intention of stabilising the volume level of the arm oedema.

Compression bandaging (Paper IV)

Compression bandaging treatment was accomplished with low stretch bandages (Hutzschenreuter et al. 1991) to ensure continuous pressure during work as well as during rest periods. The bandage was wrapped in the proximal direction, beginning at the hand and ending at the extremity root with pressure graduallly decreasing. The bandage was kept on until the next measurement was performed.

Manual lymph drainage (Paper III and IV)

The MLD was carried out according to the massage technique of Dr Vodder (Wittlinger & Wittlinger, 1987). It is applied with low pressure in a proximal direction, starting at the trunk bordering the oedematous area, slowly moving

more distally into the oedema, and ending with the hand. The MLD was performed for 45 min/day by a physiotherapist specially trained in this technique.

Sequential pneumatic compression (Paper III)

Treatment with SPC was given with Lympha-Press with 9 compression cells (Liljenberg Medical AB, Malmö, Sweden). According to practice, a pressure of 40-60 mmHg was given for 2 hours/day.

Study design

Paper I

A prospective longitudinal cohort study. Measurements of arm volume, shoulder ROM and body weight were performed preoperatively and each month until 6 months after the surgery, and at 1 and 2 years postoperatively. Shoulder and grip strength were measured preoperatively and at 6 months, as well as 1 and 2 years postoperatively. (Paper I, Fig. 1)

Paper II

A retrospective matched case-control study. The determining factors for matching were in the following order: axillary node status (positive or negative), time after axillary surgery (within two months) and age (as close as possible). Only one control was used and was identified following the determining factors in the same order. Data were collected from questionnaires and from medical records.

Paper III

A prospective randomised comparative study. All patients (n=28) wore compression sleeves for two weeks. Patients still having lymphoedema by definition (>10%) continued to wear their sleeves and were randomly allocated to either MLD (n=12) or SPC (n=12) treatment for another two weeks (Paper III, Fig. 1)

Paper IV

A prospective comparative study. All patients (n=38) received two weeks of treatment with CB. The third week the patients were allocated to continue either

with CB alone (n=17) or to continue with CB combined with MLD (n=18) (Paper IV, Fig. 1).

Paper V

A qualitative phenomenological study. Twelve women with arm lymphoedema following breast cancer treatment were interviewed with the purpose of gaining a deeper understanding of this phenomenon.

Analyses

Statistical analyses

In papers III and IV Student's t-test for paired samples was used for comparisons within groups, and t-tests for independent samples for comparisons between groups. Corresponding analyses employing Wilcoxon signed rank tests and Mann-Whitney test for paired and independent samples respectively, in paper I and as a check in paper III and IV. Data from matched cases and controls in paper II were compared by McNemar´s test for binary data, by the sign test for ordinal data, and by the paired t-test for continuous data. In paper I comparisons between the mobility reducing factors were assessed by the chi-square test (Altman 1995).

Phenomenological analysis

Analysis of the interviews in paper V were based on a phenomenological method developed by the psychologist Karlsson (1995). The five steps of the original model were modified into four steps as follows:

1. After verbatim transcription from the tape recordings, the protocols were read several times with an open-minded approach.
2. All meaning units (MU) in the text containing statements related to the arm lymphoedema were selected.
3. The MU were transformed into a language relevant to the research question and synthesised into "situated structures" or sub-themes to discern phenomenon.
4. The situated structures were moved to "general structures" or themes, which incorporated those constituents of a phenomenon that ran across several situated structures.

Results

Development of arm lymphoedema

Paper I

There was no difference in volume between the arms on the operated and non-operated side preoperatively. The arm volume difference between the sides increased significantly ($p<0.001$) at the second month in the whole group compared to the preoperative volume values. The group was then stratified regarding radiotherapy treatment. Six months postoperatively the NRT and BRT groups had stabilised in volume difference and only the ART group continued to increased ($p=0.005$) compared to the second month. The increase continued throughout the 2-year follow-up period for this group (Paper I, Fig 2). According to the 10% rule (Stillwell 1969) the arm oedema incidence for the whole group during the 2 years observation period was 12%. For the different radiotherapy groups it was 26% in the ART group, 0% in the BRT group and 8% in the NRT group. If the clinical arm lymphoedemas were also included, the incidence for the whole group was 27%, 37% in the ART group, 31% in the BRT group and 12% in the NRT group. Fifteen patients were treated for arm lymphoedema on clinical indications during the observation period.

Paper II

No differences were found between the patients with arm lymphoedema and the ones without, in treatment related factors or factors related to occupational workload. Concerning life-style related factors BMI was higher in the lymphoedema group than in the group without lymphoedema, at time of surgery as well as at time of study (Paper II, Table 5). Both groups significantly ($p<0.001$) reduced their responsibility for housework after surgery with no significant differences between the groups (Paper II, Table 6). There were no significant differences in the number of spare time activities, including exercise, between the groups before and after surgery. However, the lymphoedema group reduced the number of activities after surgery ($p<0.001$) (Paper II, Table 7).

Early diagnosis of lymphoedema

The English oncology nurse Harty Getz (1985) introduced the "primary, secondary and tertiary level of health intervention" where the first step aimed to prevent the condition, the second step to detect and treat in an early stage and the last step involved the long-time care of the lymphoedema patients. Paci et al. (1996) also stated that early diagnosis and conservative treatment seems to be predictive of a reduced risk of lymphoedema. The results from paper I, III, and IV have guided a follow-up and treatment program at the Lymphoedema Unit, Lund University Hospital, Sweden, for patients receiving radiotherapy to the axilla. Sixty-nine patients have attended the program at least 1 year. The mean follow-up time is 30±10 months and during that time 27 (39%) women have developed arm lymphoedema, 12 by definition >10% and the rest visible and palpable. The women were treated with compression therapy alone or in combination with MLD depending on the state of the oedema. The mean oedema volume at the detection of the oedema was 222±137 ml (9%) and at the latest measurement 142±107 ml (6%) revealing not only a stabilisation of the oedema but also a reduction of it by 36%.

Treatment of arm lymphoedema

Compression (Paper III and IV)

In one group of patients with arm lymphoedema (n=24), treatment with compression sleeve of standard type was performed for 2 weeks (Paper III) resulting in mean oedema reduction of 49±87 ml ($p<0.01$) and 7±18% ($p=0.057$). In a similar group (n=38) compression bandaging with low stretch bandages was applied for 2 weeks (Paper IV) showing a mean oedema reduction of 188±155 ml ($p<0.001$) and 26±15% ($p<0.001$). The bandaging was continued for a third week for half the group (n=17) with no further reduction (20±46 ml ($p=0.08$) and 4±10% (n.s.)).

Manual lymph drainage (Paper III and IV)

Treatment with manual lymph drainage for 2 weeks (Paper III) showed a mean lympoedema reduction of 75±37 ml ($p<0.001$) and 15±9% ($p<0.001$) in one group of patients with arm lymphoedema (n=12). In a similar group (n=18) treatment with manual lymph drainage for 4 days showed a reduction of 47±42 ml ($p<0.001$) and 11±9% ($p<0.001$).

Sequential pneumatic compression (Paper III)

Treatment with sequential pneumatic compression for 2 weeks showed a mean lymph oedema reduction of 28±38 ml (p=0.03) and 7±12% (p=0.07) in patients with arm lymphoedema (n=12).

Women's experiences of arm lymphoedema

Interviews (Paper V)

A phenomenological analysis of the interviews revealed three main themes common to all of the women (n=12). These themes were 1. Attitudes from people in the surroundings including reactions on the problem from other people e.g. questions or supervising. It also included reactions from the women on the attitudes from other people e.g. appearance and asking for help. 2. The chronic disease mainly expressed in the discovery of the oedema, understanding of a chronic disease and its treatment. 3. Coping (Lazarus & Folkman 2001) including both problem-focused strategies e.g. practical solutions, and emotion-focused strategies e.g. minimising or accepting the condition. The findings indicate that there are many different practical and psychosocial problems related to arm lymphoedema. Thus, it is of great importance that health care professionals should be aware of and have knowledge about these problems.

Critical incident (Paper V)

The 12 women taking part in the study reported 246 positive and 196 negative incidents during 10 days. Randomly selected examples of such incidents within different score categories are shown in paper V, Table 3. Eleven of the incidents were related to lymphoedema, all negative (Paper V, Table 4).

Development of increased shoulder mobility and strength

Shoulder mobility (Paper I)

During the first five postoperative months the reduction of ROM of shoulder abduction was the most frequent, being observed by 48% of the patients at five months. At six months reduced internal rotation was most frequent (61%) folllowed by abduction (41%), external rotation (34%) and flexion (33%). At the

two-year follow-up the corresponding percentages of reduction were 63%, 43%, 30% and 27%.

Abduction and flexion were impaired one month after operation compared to the preoperative measurement ($p<0.001$), but normalised during the six-month observation period except for the patients who received radiotherapy to the axilla (Paper I, fig. 3 and 4). There was less impact on external rotation but the same trend was observed (Paper I, fig 5). In internal rotation none of the groups returned to their preoperative values (Paper I, fig 6). Analyses were performed each month for all four ROMs comparing the NRT and ART groups. There were no differences between the groups at any ROM at one and two months. At three months reduced mobility in the ART group was found for abduction ($p=0.003$) and flexion ($p=0.017$) and at six months for external rotation ($p<0.021$).

At the two-year follow-up the trends from the six-month observation period were constant. The ART group showed continuous impairment of ROM but the NRT and BRT groups had virtually normal ROM except for internal rotation (Paper I, fig. 7,8,9 and 10).

At six months, 79% of the ART group had decreased mobility in any one ROM (47% of these in all four ROMs). In the BRT and NRT groups the figures were 19% and 23%, respectively, for decreased mobility in any one ROM. At the two-year follow-up 94% of the ART group, 67% of the BRT group and 74% of the NRT group had decreased mobility in any one ROM.

Factors associated with decreased shoulder mobility

Two factors were found to be associated with decreased shoulder mobility during the six- month observation period. The first factor was named vascular string. It can be described as a ”tendon” or a ”violin string” most commonly seen in the axilla and palpated along the medial side of the upper arm, sometimes even on the forearm and radial part of the hand (Paper I, fig.11). In a few cases it has also been located on thorax below the axilla. In the immediate postoperative phase, the ”string” is usually tense and painful, especially when the arm is abducted. In seven patients a biopsy of the string was made four to five weeks after the operation and the pathological examination showed vein tissue in six of the cases with an inflammatory process in four, suggesting thrombophlebitis. The second factor was named stiff tissue in the operation area. When maximum ROM was maintained hard, stiff tissue was palpated on the lateral side of pectoralis major muscle and in the axillary area or from the scars. Some patients also reported a vague feeling of stiffness in the breast and pectoralis.

This might be explained by oedema followed by a fibrotic reaction in the thoracic tissue after radiotherapy (Gillette et al. 1995), since all of the patients reporting (n=7) had received radiotherapy, one to the breast only and six to both breast and axilla. The patients also reported other factors impairing the ROM, like general pain of the shoulder (n=1) and stiffness or pain on the lateral or dorsal side of the upper arm and/or of the shoulder joint (n=3).

Vascular string (factor 1), was most frequently noted in the first month, being palpated in 77% (n= 47) of the patients and associated with decreased mobility in 66% (n= 40). In the period three to six months it was stiffness in the operation area (factor 2) that was the most frequently noted factor.

Isometric muscle strength

Independent of radiotherapy treatment all patients with axillary node dissection showed significant decrease in isometric muscle strength at six month, one year and two years for flexors ($p<0.05$), adductors ($p<0.01$) and internal rotators ($p<0.05$) of the shoulder. There was no change in gripping strength.

General discussion

Physiotherapy in the oncological field can be divided into two main areas; one managing patients with chronic disease and the other managing those cured from their disease needing rehabilitation of impairments related to the cancer treatment. Arm lymphoedema following breast cancer treatment is such an impairment.

Methods and definitions

The most common method to measure arm lymphoedema is to determine the volume of both arms and calculate the difference between the affected and non-affected side. The most common method to determine volume is probably to use circumference measurements (Sitzia et al. 1997). However, in this thesis we chose to measure the volume by the water displacement method, which is more reliable than circumference measurements (Bednarczyk et al.1992) and easier to administrate. In 1996 Bernas et al. claimed that the proper approach and statistics to describe lymphoedema in limbs, and its change due to treatment, were very much open to question, and still are. We chose to take the individual physique into account, thus expressing the arm lymphoedema in percentage (Stillwell 1969) instead of cubic measurements. During treatment the lymphoedema volume, at the start of the session, was always expressed as 100%, representing the difference between the affected and non-affected arm. Considering the uncertain proper approach to represent lymphoedema changes mentioned above, reduction was expressed both in millilitres and in percentage in Papers III and IV. However, assessing the percentage reduction has been reported to be the most useful method to evaluate and compare the efficacy of different treatment protocols (Bernas et al. 1996).

When defining arm lymphoedema for treatment protocols a certain lowest limit has to be determined. Stillwells (1969) definition that the affected arm has 10% larger volume than the non-affected is well accepted. However, our experience is that oedema may be detected at a lower percentage level (Paper I) and thus also treated earlier. Cornish et al. (2000) have proved the new technique,

bioelectrical impedance, able to predict arm lymphoedema as early as 4 months before it could be clinically diagnosed. This technique measures the increase of the extracellular fluid content by passing a tiny current through the limb at different frequencies measuring resistance (Cornish et al. 1996). Palpation of the skin thickness is also a clinical useful method to detect oedema at a very early stage. However, this method has only been tested for reliability (unpublished data, own series) but not for validity. In the future palpation might be validated through correlation with the bio-impedance method.

Prevention and early detection of arm lymphoedema

The Halsted radical mastectomy, developed in the early 20th century, with removal of the pectoralis muscle and the surrounding lymph nodes became accepted as the primary surgical method and these principles prevailed for several decades (Eberlein 1994). The combination with cobalt radiotherapy in the '50s reduced local recurrence dramatically but generated even more tissue injuries resulting in severe arm lymphoedema and impaired shoulder function in many cases. As breast cancer treatment has developed, and become less aggressive, the incidence of arm lymphoedema has slowly decreased (Kissin et al. 1986, Schuneman & Willich 1997). However, due to increase in the number of breast cancer patients and survival rate there is a growing number of patients with lymphoedema. For many women arm lymphoedema will become a chronic disease, which untreated will increase in amount with time (Casley-Smith 1994). Thus, prevention and early detection and treatment must be of major importance.

Recommendations how to prevent arm lymphoedema are often given to the patients and the number of recommendations sometimes make up a long list (Földi et al. 1989, Einfeldt 1991, Reinhart-Ayres 1998, Rockson 1998). They derive from clinical experiences and have not changed appreciably in several generations of cancer therapy. Very little objective data has been collected to validate the clinical recommendations (Olszewski & Engeset 1980, Swedborg 1993). Professionals often summarise their advice telling the patient to "be careful" with the arm. Limits for exertion of the arm, at work as well as in recreational activities, are of substantial concern to the patients. Results in paper II reveals that there are no differences in assessed workload between a group of patients with arm lymphoedema matched to controls without oedema. Furthermore, the controls did not reduce their recreational activities such as exercise and hobbies postoperatively, as the oedema group did. These results

indicated that the workload does not have to be eased and that physical activity might even have a preventive influence on the development of arm lymph oedema. This may be due to a higher degree of muscle activity in the arm on the affected side, resulting perhaps in increased propelling of lymph. It might also be due to inactivity in the affected arm, combined with physical activity in the rest of the body, with vasoconstriction of non-activated muscles resulting in less fluid transportation (Berne & Levy 1998, Guyton & Hall 2000). Theoretically, the latter might be preferable in reference to results of a study showing a higher proportion of patients with increased arterial flow in the arm with oedema (Svensson et al. 1994). Increased muscle activity might then produce even higher fluid flow to an already impaired system. However, the influence of muscle activity on lymph flow is under debate. Olszewski & Engeset (1980) showed increased lymphoedema flow in cannulated leg lymph vessels by flexing exercises of the foot. On the other hand a recent study showed no difference in local lymph flow between exercised and non-exercised lymphoedema arms measured by lymphscintigraphy (Stanton 2001). Thus, further research must be focused on lymph transportation in extremities with lymphoedema in order to generate hypothesis for clinical research.

Breast cancer patients treated with axillary dissection and axillary radiotherapy show a higher incidence of arm lymphoedema than those not treated with axillary radiotherapy (Paper I). This has been supported by many studies (Swedborg & Wallgren 1981, Kissin et al. 1986, Ryttov et al.1988, Christensen & Lundgren 1989, Segerström et al. 1991). Although an increase in arm volume was found for all patient with axillary dissection within 2 months after surgery, the groups with NRT or BRT stabilised whereas the ART group continued to increase during the two-year follow-up. The stabilisation in the BRT group with no further increase of volume indicated that this group was not in considerable risk of developing arm lymphoedema. This is supported by paper II showing a tendency towards higher frequency ($p=0.06$) of patients with BRT among the controls with no arm lymphoedema.

The time intervals for reduction of shoulder mobility was equal to that for lymphoedema. The impairment was also found within 2 months after surgery and the decrease of ROM continued in the ART group. The factor associated with reduced ROM during the following months was “stiff tissue” in the operation area. As shown in animal experiments, radiotherapy is highly potential to increase collagen tissue, including scar tissue (Fajardo 1992, Gillett et al. 1995). Palpation of this “stiff tissue” area revealed very hard tissue formations. Clinical experience within the field suggests that when reduced ROM related to this tissue is once established it is very hard to provide an effective treatment. Results

from a Danish study (Lauridsen et al. 2000) showed physiotherapy treatment including stretching of scare tissue and skin as well as exercises based on extension and relaxation to improve mobility. However, the results were based on binomial data (improved/not improved) and further research using continuos data may reveal to what extent this treatment is useful.

The sentinel lymph node biopsy, now more frequently applied, means a less aggressive surgery to the lymph system. However, axillary node dissection will still be performed in patients with metastasis in the sentinel node and some of them will also received radiotherapy to the axilla. This fact indicates that the number of patients with arm lymphoedema and impaired shoulder mobility will still be considerable even if the sentinel node technique promises to spare 50 % of the axillas from an unnecessary axillary dissection. Recently there has also been a change in the adjuvant chemotherapy treatment from CMF to FEC for some patients with axillary metastasis. FEC is more sensitive to radiotherapy and therefore the cytotoxic treatment is administrated 6 months before the radiotherapy treatment resulting in a delay of radiotherapy. This delay might increase the possibility for the ART group (Paper I, fig 3-5) to reach preoperative shoulder ROM similar to the BRT and NRT groups. It is reasonable to believe that the reduction of shoulder ROM might be less in the ART group compared to the results of the present study (Paper I). However, as FEC is a stronger sensitiser it might cause an even larger reduction due to increase in fibrotic tissue because of more pronounced inflammatory process. The influences of these new procedures on arm lymphoedema and shoulder ROM must be examined in further studies.

Treatment

The mechanisms of the lymphoedema treatments are mostly theoretical. They rely on patophysiological hypotheses that have only partly been proven, and sometimes with results contradictory to one another. This can be illustrated by the fact that some authors claim lymphoedema to be protein-rich (Földi et al. 1989, Witte & Witte 1991) while Bates et al. (1994), on the other hand, found no evidence for a higher level of protein in the lymphodematous tissue. Földi et al. (1989) consider lymphoedema to be caused by injury to the lymph system alone while other authors have suggested influence from both venous outflow obstruction (Svensson et al. 1994) and increased arterial inflow (Svensson et al. 1994). Thus it is very unsure how a clinical approach should be made and could perhaps be characterised as “trial and error”.

Early detection of lymphoedema is only of great importance if it can be treated effectively. Considering the risk that the untreated oedema will continue to develop (Casley-Smith 1995), treatment ought to be started as soon as possible and the oedema reduced as quickly as possible. Two weeks of treatment with standard compression sleeves was shown to have a volume reducing effect of 7% (Paper III), which might be considered enough reduction of very slight lymphoedemas (less than 10%). The reduction by treatment with compression bandaging, also during a 2 week period was 26% (Paper IV). This seems to be the preferable compression treatment to reduce the oedema as quick as possible.

The additive effect of MLD might be questioned considering the high volume reducing effect of CB. However, a comparative study revealed MLD to give a highly sufficient reduction in a very short time (11% in 4 days) (Paper IV). The significant short-time effect of CB combined with MLD has been confirmed by Badger et al. (2000) who compared this treatment to treatment with a hosiery (arm and leg) alone. The results were sustained over a six-month observation period. In the present study no long-time follow-up was carried through because the main purpose was to compare specific treatments and not the combination of them as previously done in several studies (Morgan et al. 1992, Boris et al. 1997, Ko et al. 1998, Daane et al. 1998).

Treatment with sequential pneumatic compression has been used since the ‘60s (Britton & Nelson 1962) and several reports have been presented evaluating its effect (McNair et al. 1976, Raines et al. 1977, Swedborg 1984, Yamazaki et al. 1988, Baulieu et al. 1989, Pappas & O’Donell 1992, Zanolla et al. 1984, Richmand et al. 1985, Berlin et al. 1999). Unfortunately there are almost as many different methods described as there are studies performed. Two major treatment components can be found where a distinction can be made, namely pressure applied and treatment time used. Results of these different factors are discussed in detail in paper III. With the intention of imitating MLD treatment where the physiological mechanisms are better known, we chose to use a low pressure and a relatively short treatment time. This combination of pressure and time showed significant reduction of lymphoedema volume but other combinations may generate an even greater decrease in volume. However, as long as the physiological mechanisms of pneumatic compression treatments are unclear the chances to find optimal treatment procedures are limited.

In the comparison between MLD and SPC treatments no differences were found in percentage reduction of the lymphoedema but a difference in millilitre reduction were seen (Paper III). This might show an advantage for MLD over SPC. Another advantage for MLD that might be of importance is the better chance of palpating the oedema areas during MLD and thus providing a treat-

ment more individually designed. Newly published results on regional differences in lymphatic function in the arm (Stanton et al. 2001) might support this hypothesis. On the other hand, treatment with MLD on severe arm lymphoedema is connected with physical strain on the therapist. In this case SPC seems to be useful provided that lymphoedema at the extremity root can be treated with MLD (Boris et al. 1998).

The quantitative measurements of arm lymphoedema focus on volume and its reduction. Regular follow-ups of breast cancer patients, with risk of developing arm lymphoedema, early detection of slight lymphoedema and sufficient treatment reduce the development. Women within such a treatment program are likely to have arm lymphoedema being slight or at the most moderate but never severe. This group of women is not physically disabled and is able to continue with their work and other physical activities. However, in a psychosocial approach evaluated by qualitative methods the outside perspective of these women changes and other kind of problems, both practical and emotional, are revealed (Paper V). The women's experiences of the attitudes of people in the surroundings, and of having a chronic disease, points out a need for another kind of professional approach than the traditional quantitative volume reducing one. Instead, it calls for a deeper understanding and acceptance of the patient's individual problems, and in particular, the emotional ones. It also calls for a development of professional skills to help the patient handle these problems.

Conclusions

General

Physiotherapeutic management needs to focus on patients at risk of developing arm lymphoedema following breast cancer treatment, early detection and treatment of the oedema and the patient's need for expressing psychosocial problems related to the oedema.

Specific on arm lymphoedema

Development

Breast cancer patients treated with axillary lymph node dissection and radiotherapy to breast and axilla were associated with early development of arm lymphoedema with no regress during a 2-year follow-up period.

Women treated for breast cancer with axillary node dissection, with or without adjuvant radiotherapy, can be recommended to maintain their level of occupational workload and physical activity without an added risk of developing arm lymphoedema. It is also reasonable to assume that a higher BMI before and after operation increases the risk.

Treatment

Low stretch CB is an effective treatment reducing volume of slight or moderate arm lymphoedema in women treated for breast cancer. Also, compression treatment with standard compression sleeve gives a reduction. MLD adds a positive effect to both compression treatments. MLD and SPC each reduce arm lymphoedema with no difference between the treatments.

The subjective feelings of tension in the tissue and heaviness of the arm were reduced at treatment with compression sleeve and bandaging, and with MLD, but not with SPC.

Experiences

Women with slight or moderate arm lymphoedema expressed experiences about attitudes from people in the surroundings and the chronic disease. The problems integrated in daily life were of low frequency but of considerable importance to these women. Both problem-focused and emotion-focused coping strategies were used. Thus, it is of importance that health care professionals are aware of and have knowledge about these problems. The women's need for expressing their experiences might be encouraged and efforts made to strengthen the women's coping skills.

Specific on shoulder ROM and strength

Breast cancer patients treated with axillary lymph node dissection and radiotherapy to breast and axilla were associated with early development of reduced shoulder mobility with no regress of the impairments during a 2-year follow-up period. Reduced shoulder muscle strength connected to the breast cancer treatment area was found in all patients irrespective of radiotherapy treatment.

Factors associated with the reduced shoulder mobility were vascular string during the first postoperative months and stiff tissue probably caused by an increasing fibrotic feature in the tissue.

Abstract

Ten percent of the female population in Sweden will be diagnosed with breast cancer during their lifetime, but only a minority will die from the disease. Arm lymph oedema is a well-known complication following breast cancer treatment and the incidence varies between about 10% when axillary node dissection is performed and about 40% when axillary radiotherapy is added.

The general aim of this thesis was to identify risk factors and onset, evaluate treatments and explore, from a physiotherapeutic perspective, the experiences of patients with arm lymphoedema following breast cancer treatment.

Results revealed that patients treated with additional axillary radiotherapy were associated with early development of arm lymphoedema and reduced shoulder mobility that remained during a 2-year follow-up period. Shoulder muscle strength was reduced to all patients treated with axillary node dissection independent of radiotherapy treatment. Women treated for breast cancer with axillary node dissection, with or without adjuvant radiotherapy, can be recommended to maintain their level of occupational workload and physical activity without an added risk of developing arm lymphoedema. However, it is reasonable to assume that a higher body mass index increases the risk.

Two intervention studies showed that compression with low-stretch bandaging was the most effective short-time lymphoedema reducing treatment. Manual lymph drainage, a massage technique, also reduced the lymphoedema considerably. Manual lymph drainage, combined with compression bandaging, was more effective than compression bandaging alone. Sequential pneumatic compression also had a lymphoedema reducing effect and in comparison with manual lymph drainage, no difference between the treatments was found.

In a qualitative interview study, women with slight or moderate arm lymphoedema expressed their experiences, revealing problems with attitudes from people in the surroundings and problems with the chronic disease. The problems integrated in daily life were of low frequency but of considerable importance to the women. The women used both problem-focused and emotion-focused coping strategies. Thus, it is of importance that health care professionals are aware of and have knowledge about these problems. It is reasonable to believe, that the women's need to express their experiences, should be encouraged and efforts made to strengthen the women's coping skills.

Summary in Swedish/ svensk sammanfattning

Bröstcancer är den vanligast förekommande cancerformen hos kvinnor i Sverige. Under sin livstid kommer tio procent av den kvinnliga befolkningen att få bröstcancer men endast en minoritet kommer att avlida av den. Operation är den vanligaste behandlingen och kombineras oftast med strålbehandling. Armlymfödem samt nedsatt axelrörlighet och muskelstyrka är välkända sidoeffekter till dessa behandlingar. Sjukgymnastik används ofta i syfte att förebygga och behandla dessa sidoeffekter.

Det huvudsakliga syftet med denna avhandling var att söka kunskap om vilka bröstcancerbehandlade patienter som riskerar att få lymfödem, när i tiden efter operationen ödemet debuterar och hur det utvecklas, förebyggande åtgärder, behandling samt slutligen patientens upplevelse av att ha armlymfödem. Avhandlingen består av fem delarbeten:

I det första arbetet, som är en prospektiv studie, mättes armvolym, axelrörlighet och styrka hos 61 kvinnor, som opererats med axillutrymning med eller utan tillägg av strålbehandling. Mätningarna gjordes före operationen samt varje månad upp till 6 månader och vid 1 och 2 år efter operationen. Resultaten visar på vikten av att sjukgymnasten noga följer förloppet speciellt för tidig upptäckt av ödem och nedsatt axelrörlighet i den grupp som fått strålbehandling mot axillen, och nedsatt styrka för hela gruppen.

I det andra arbetet jämfördes 71 bröstcancerbehandlade kvinnor som utvecklat armlymfödem med lika många, som cancerbehandlats på samma sätt, men inte fått ödem. Jämförelsen avsåg cancerbehandlingen, yrke/sysselsättning och livsstil. Resultaten pekar på att kvinnor, som bröstcancerbehandlats med eller utan tillägg av strålbehandling, kan bibehålla samma arbetsbelastning och aktivitetsnivå, som före operationen, utan ökad risk att utveckla armlymfödem. Ett högre body mass index (vikt i förhållande till längd) kan möjligen öka risken för att utveckla lymfödem.

I det tredje arbetet, som är en interventionsstudie, jämfördes effekterna av behandlingsmetoderna manuellt lymfdränage (MLD) och lymfpulsator (LP). Tjugoåtta kvinnor med armlymfödem efter bröstcancer fick först 2 veckors behandling med kompressionsstrumpa av standardtyp och därefter ytterligare 2

veckors behandling med antingen MLD eller LP. Såväl behandling med strumpa som med MLD eller LP gav mätbar minskning av ödemet och man såg ingen skillnad i den ödemminskande effekten av MLD jämfört med LP. MLD gav också minskad tyngd- och spänningskänsla i armen.

I det fjärde arbetet, som också är en interventionsstudie, undersöktes effekterna av bandagering med lågkompressivt bandage (CB) enbart eller i kombination med manuellt lymfdränage för 38 kvinnor med armlymfödem efter bröstcancer. Efter behandling med CB enbart i 2 veckor allokerades patienterna till antingen fortsatt CB behandling eller till CB kombinerat med MLD under 1 vecka. Resultaten visar att CB är en effektiv behandling med avseende på ödemreduktion och subjektiv tyngd- och spänningskänsla. Tillägg med MLD minskar ytterligare ödemet och även smärtupplevelse.

I det femte arbetet, som är en kvalitativ studie, intervjuades 12 yrkesarbetande kvinnor med lätta till måttliga armlymfödem efter bröstcancerbehandling. Syftet var att nå en djupare kunskap om hur de upplevde sin situation med fokus på lymfödemet. Vid analys har ett fenomenologiskt perspektiv tillämpats och även ”critical incident” metoden har använts. Resultatet pekar på att det finns många praktiska och psykosociala problem relaterade till armlymfödemet. Tre huvudtemata framstod som viktiga, nämligen:1) attityder från omgivningen, 2) den kroniska sjukdomen samt olika sätt att hantera sin situation dvs 3) copingstrategier, såväl problemfokuserade som emotionfokuserade. Det är av stort värde att sjukvårdspersonalen har förståelse för problemen och möjlighet att stärka patientens förmåga att hantera situationen.

Sammanfattningsvis pekar denna avhandling på att sjukgymnastik med syfte att förebygga armlymfödem bör motverka sänkning av den fysiska aktivitetsnivån, samt fokusera på patienter med ökad risk att utveckla lymfödem. När ett lymfödem uppstått bör tyngdpunkten ligga på tidig upptäckt och behandling, samt på patientens behov av att få uttrycka både fysiska och psykosociala problem relaterade till lymfödemet.

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References

Aboul-Enein A, Eshmawy I, Arafa S, Abboud A. The role of lymphovenous communication in the development of postmastectomy lympedema. Surgery 1984; 95:562-5.

Airaksinen O, Partanen K, Kolari JP, Soimakallio S. Intermittent pneumatic compression therapy in posttraumatic lower limb edema: computed tomography and clinical measurements. Arch Phys Med Rehabil 1991;72:667-70.

Aitken RJ, Gaze MN, Rodger A, Chetty U, Forrest APM. Arm morbidity within a trial of mastectomy and either nodal sample with selective radiotherapy or axillary clearance. Br J Surg 1989;76:568-71.

Altman DG. *Practical statistics for medical research*. London: Chapman and Hall, 1995.

American Academy of Orthopaedic Surgeons. *Joint motion. Edinburgh:* Churchill & Livingstone, 1985.

Asdonk J. Über Wirksamkeit, Indikationen und Kontraindikationen der Manuellen Lymphdrainage-therapie bei Schmerzödemen. Z Lymphol 1995;19:16-22.

Badger C, Peacock JL, Mortimer PS. A randomized, controlled, parallel-group clinical trial comparing multilayer bandaging followed by hosiery versus hosiery alone in the treatment of patients with lymphedema of the limb. Cancer 2000;88:2832-7.

Bates DO, Levick JR, Mortimer PS. Starling pressures in the human arm and their alteration in postmastectomy oedema. J Physiol (Lond) 1994;477:355-63.

Baulieu F, Baulieu JL, Vaillant L, Secchi V, Barsotti J. Factorial analysis in radionuclide lymphoghraphy: assessment of the effects of sequential pneumatic compression. Lymphology 1989;22:178-85.

Bednarczyk JH, Hershler C, Cooper DG. Development and clinical evaluation of computerized limb volume measurement system (CLEMS). Arch Phys Med Rehabil 1992;73:60-3.

Berlin E, Gjöres JE, Ivarsson C, Palmqvist I, Thagg G, Thulesius O. Postmastectomy lymphoedema. Int Angiol 1999;18:294-8.

Bernas M, Witte M, Witte C, Belch D, Summers P. Limb volume measurements in lymphedema issues and standards. Lymphology (Suppl) 1996;29:199-202.

Berne RM, Levy MN. The cardiovascular system. In: Berne RM, Levy MN, editors. *Physiology*. St. Louis: Mosby, 1998:319-502.

Bertelli G, Venturini M, Forno G, Macchiavello F, Dini D. An analysis of prognostic factors in response to conservative treatment of postmastectomy lymphedema. Surg Gynecol Obstet 1992;175:455-60.

Bohannon RW. Test-retest reliability of hand-held dynamometry during a single session of strength assessment. Phys Ther 1986;66:206-9.

Boris M, Weindorf S, Lasinski B. Persistence of lymphedema reduction after noninvasive complex lymphedema therapy. Oncology (Huntingt) 1997;11:99-109.

Boris M, Weindorf S, Lasinski BB. The risk of genital edema after external pump compression for lower limb lymphedema. Lymphology 1998;31:15-20.

Brennan MJ, DePompolo RW, Garden FH. Focused Review: Postmastectomy lymphedema. Arch Phys Med Rehabil 1996;77:s74-80.

Britton RC, Nelson PA. Causes and treatment of postmastectomy lymphedema of the arm: report of 114 cases. J Am Med Assoc 1962;180:95-102.

Brodin H. *Fysioterapi I*. Lund: Studentlitteratur, 1971.

Brorson H, Svensson H. Complete reduction of lymphoedema of the arm by liposuction after breast cancer. Scand J Plast Reconstr Surg Hand Surg 1997;31:137-43.

Brorson H, Svensson H. Liposuction combined with controlled compression therapy reduces arm lymphedema more effectively than controlled compression therapy alone. Plast Reconstr Surg 1998;102:1058-67.

Bunce IH, Mirolo BR, Hennessy JM, Ward CW, Luke CJ. Post-mastectomy lymphoedema treatment and measurement. Med J Aust 1994;161:125-8.

Bundred NJ, Morgan DAL, Dixon JM. Management of regional nodes in breast cancer. In: Dixon JM, editor. *ABC of breast diseases*. London: BMJ Books, 2000:44-60.

Cameron K, Gregor F. Chronic illness & compliance. J Adv Nurs 1987;12:671-6.

Carter BJ. Women's experiences of lymphedema. Oncol Nurs Forum 1997;24:875-82.

Casley-Smith JR. Measuring and representing peripheral oedema and its alterations. Lymphology 1994;27:56-70.

Casley-Smith JR. Alterations of untreated lymphoedema and its grades over time. Lymphology 1995;28:174-85.

Casley-Smith JR, Földi M, Ryan TJ, Witte MH, Witte CL, Cluzan R, et al. Summery of the 10th International Congress of Lymphology. Work group discussions and recommendations. Lymphology 1985;18:175-80.

Castenholz A. Structure of initial and collecting lymphatic vessels. In: Olszewski WL,

editor. *Lymph stasis: Pathophysiology, diagnosis and treatment.* Boca Raton, Florida: CRC Press, 1991:15-42.

Charmaz GK. “Discovering” chronic illness: Using grounded theory. Soc Sci Med 1990;30:1161-72.

Christensen SB, Lundgren E. Sequelae of axillary dissection vs axillary sampling with or without irradiation for breast cancer. Acta Chir Scand 1989;155:515-20.

Cornish BH, Bunce LH, Ward LC, Jones LC, Thomas BJ. Bioelectrical impedance for monitoring the efficacy of lymphoedema treatment programmes. Breast Cancer Res Treat 1996;38:169-76.

Cornish BH, Chapman M, Thomas BJ, Ward LC, Bunce IH, Hirst C. Early diagnosis of lymphedema in postsurgery breast cancer patients. Ann NY Acad Sci 2000;904:571-5.

Daane S, Poltoratszy P, Rockwell WB. Postmastectomy lymphedema management: evolution of the complex decongestive therapy technique. Ann Plast Surg 1998;40:128-34.

Dennis B. Acquired lymphedema: A chart review of nine women's responses to intervention. Am J Occup Ther 1993;47:891-9.

Dixon JM, Mansel RE. Symptoms, assessment, and guidelines for referral. In: Dixon JM, editor. *ABC of breast diseases*. London: BMJ Books, 2000:1-9.

Duff M, Hill ADK, McGreal G, Walsh S, McDermott EW, O'Higgins NJ. Prospective evaluation of the morbidity of axillary clearance for breast cancer. Br J Surg 2001;88:114-7.

Eberlein TJ. Current management of carcinoma of the breast. Ann Surg 1994;220:121-36.

Einfeldt H. Klinik, Diagnostik und Therapie. In: Hutzschenreuter P, Einfeldt H, Besser S, editors. *Lymphologie fur die Praxis*. Stuttgart: Hippokrates Verlag, 1991:60.

European Comittee for standardisation (CEN/TC 205WG2). Medical compression hosiery. European Standard CEN/ENV 12718, 2001.

Fajardo LF. Morphology of radiation effects on normal tissues. In: Richardson J, Rubin DK, editors. *Principles and practice of radiation oncology*. Philadelphia: Lippincott Co, 1992:114-23.

Flanagan JC. The critical incident technique. Psychol Bull 1954;51:327-58.

Földi E, Földi M. Komplexe physikalische Entstauungstherapie des chronischen Gleidmassenlymphödems. Folia Angiol 1981;29:161-8.

Földi E, Földi M, Clodius L. The lymphedema chaos: A lancet. Ann Plast Surg 1989;22:505-15.

Földi M. Insufficiency of lymph flow. In: Földi M, Casley-Smith JR, editors. *Lymphangiology*. Stuttgart: Schattauer, 1983:195-210.

Gaffney RM, Casley-Smith JR. Excess plasma proteins as a cause of chronic inflammation and lymphoedema: biochemical estimations. J Pathol 1981;133:229-42.

Gage I, Schnitt SJ, Nixon AJ, Silver B, Recht A, Troyan SL, et al. Pathologic margin involvement and the risk of recurrence in patients treated with breast-conserving therapy. Cancer 1996;78:1921-7.

Gashev AA, Zawieja DC. Physiology of human lymphatic contractility: a historical perspective. Lymphology 2001;34:124-34.

Gillette EL, Mahler PA, Powers BE, Gillette SM, Vujaskovic Z. Late radiation injury to muscle and peripheral nerves. Int J Radiat Oncol Biol Phys 1995;31:1309-18.

Godal R, Swedborg I. A correction for the natural asymmetry of the arms in the determination of the volume of the oedema. Scand J Rehabil Med 1982;14:193-5.

Godfrey CM. Postmastectomy lymphedema. Appl Ther 1969;11:440-1.

Guba EC. Carrying on the dialogue. In: Guba ED, editor. *The paradigm dialogue*. Newbury Park, Calif: Sage, 1990.

Guyton AC, Hall JE. Muscle blood flow and cardiac output during exercise. In: Guyton AC, Hall JE, editors. *Textbook of medical physiology*. Philadelphia: W.B. Saunders Co., 2000:223-33.

Göltner E, Gass P, Haas JP, Schneider P. The importance of volumetry, lymphscintigraphy and computer tomography in the diagnosis of brachial edema after mastectomy. Lymphology 1988;21:134-43.

Harty Getz D. The primary, secondary and tertiary nursing intervention of lymphedema. Cancer Nurs 1985;8:177-84.

Hermanek P, Sobin LH. editor. *UICC:TMN Classification of malignant tumors*. Springer-Verlag, 1987:

Hladiuk M, Huchcroft S, Temple W, Schnurr BE. Arm function after axillary dissection for breast cancer: A pilot study to provide parameter estimates. J Surg Oncol 1992;50:47-52.

Hoe AL, Iven D, Royle GT, Taylor I. Incidence of arm swelling following axillary clearance for breast cancer. Br J Surg 1992;79:261-2.

Husserl E. *Ideas: general introduction to pure phenomenology*. New York: Macmillan, 1931.

Hutzschenreuter P. Grundlagen. In: Hutzschenreuter P, Einfeldt H, editors. *Lymphologie für die Praxis*. Stuttgart: Hippokrates Verlag, 1991:11-35.

Hutzschenreuter P, Bruemmer H. Influence of complex physical decongesting therapy on positive interstitial pressure and on lymphangiomotor activity. Progress in Lymphology 1988;XI:557-60.

Höjris I, Andersen J, Overgaard M, Overgaard J. Late treatment-related morbidity in breast cancer patients randomized to postmastectomy radiotherapy and systemic treatment versus systemic treatment alone. Acta Oncol 2000;39:355-72.

ISL, Consensus document of the International Society of Lymphology Executive Committee. Lymphology 1995;28:113-7.

Ivens D, Hoe AL, Podd TJ, Hamilton CR, Taylor I, Royle GT. Assessment of morbidity from complete axillary dissection. Br J Cancer 1992;66:136-8.

Jacobsson L, Lindgärde F, Manthorpe R, Ohlsson K. Effect of education, occupation and some lifestyle factors on common rheumatic complaints in a Swedish group aged 50-70 years. Ann Rheum Dis 1992;51:835-43.

Johansson K, Lindfeldt J. Funktionsstörningar hos bröstcanceropererade kvinnor. Sjukgymnasten 1993;11:66-8.

Jonsson K, Wallace S, Jing BS. The clinical significance of lympho-venous anastomoses in malignant disease. Lymphology 1982;15:95-9.

Karlsson G. *Psychological Qualitative research from a phenomenological perspective*. Stockholm, Sweden: Almqvist & Wiksell International, 1993.

Kettle JH, Rundle FF, Oddie TH. Measurement of upper limb volumes: A clinical method. Aust N Z J Surg 1958;27:263-70.

Kiel KD, Rademacker AW. Early-stage breast cancer: arm edema after wide excision and breast irradiation. Radiology 1996;198:179-283.

Kissin MW, Querci della Rovere G, Easton D, Westbury G. Risk of lymphoedema following the treatment of breast cancer. Br J Surg 1986;73:580-4.

Ko DS, Lerner R, Klose G, Cosimi AB. Effective treatment of lymphedema of the extremities. Arch Surg 1998;133:452-8.

Lauridsen MC, Törsleff KR, Husted H, Erichsen C. Physiotherapy treatment of late symptoms following surgical treatment of breast cancer. The Breast 2000;9:45-51.

Lazarus RS, Folkman S. *Stress appraisal and coping*. New York: Springer-Verlag, 1984:

Leak L. Fine structure of the lymphatic capillary and the adjoining connective tissue area. Am J Anat 1966;118:785.

Leak L. Studies of the permeability of lymphatic capillaries. J Cell Biol 1971;50:300.

Mackenzie,S. Elephantiasis treated by elastic bandaging. Lancet 1880;619.

Maunsell E, Brisson J, Deschênes L. Arm problems and psychological distress after surgery for breast cancer. Can J Surg 1993;36:315-20.

McNair TJ, Martin IJ, Orr JD. Intermittent compression for lymphoedema of arm. Clin Oncol 1976;2:339-42.

McPherson K, Steel CM, Dixon JM. Breast cancer – epidemiology, risk factors, and genetics. BMJ 2000;321:624-8.

Miller GE, Seal J. Lymphatic clearance during compressive loading. Lymphology 1981;14:161-6.

Mirolo BR, Bunce IH, Chapman M, Olsen T, Eliadis P, Hennessy JM, et al. Psychosocial benefits of postmastectomy lymphedema therapy. Cancer Nurs 1995;18:197-205.

Mislin H. Experimenteller Nachweis der autochtonen Automatic der Lymphgefässe. Experientia 1961;17:29.

Mislin H. The lymphangion. In: Földi M, Casley-Smith JR, editors. *Lymphangiology*. Stuttgart: Schattauer, 1983:165-73.

Morgan RG, Casley-Smith JR, Mason MR, Casley-Smith JR. Complex physical therapy for the lymphoedematous arm. J Hand Surg [Br] 1992;17B:437-41.

Mortimer PS. The pathophysiology of lymphedema. Cancer (Suppl) 1998;83:2798-802.

Nelson PA. Recent advances in treatment of lymphedema of the extremities. Geriatrics 1966;21:162-73.

Nikkanen TA, Vanharanta H, Helenius-Reunanen H. Swelling of the upper extremity, function and muscle strength of shoulder joint following mastectomy combined with radiotherapy. Ann Clin Res 1978;10:273-9.

Olsen NK, Pfeiffer P, Johannsen L, Schrøder H, Rose C. Radiation-induced brachial plexopathy: neurological follow-up in 161 recurrence-free breast cancer patients. Int J Radiat Oncol Biol Phys 1993;26:43-9.

Olszewski WL. Lymphology and the lymphatic system. In: Olszewski WL, editor. *Lymph stasis: pathophysiology, diagnosis and treatment*. Boca Raton, Florida: CRC Press, 1991:4-12.

Olszewski WL, Engeset A. Intrinsic contractility of prenodal lymph vessels and flow in human leg. Am J Physiol 1980;239:775-83.

Paci E, Cariddi A, Barchielli A, Barchielli A, Bianchi S, Cardona G, et al. Long-term sequelae of breast cancer surgery. Tumori 1996;82:321-4.

Pappas CJ, O'Donnell TF. Long-term results of compression treatment for lymphedema. J Vasc Surg 1992;16:555-64.

Raines JK, O'Donnell TF, Kalisher L, Darling RC. Selection of patients with lymphedema for compression therapy. Am J Surg 1977;133:430-7.

Reed RK, Aukland K. Interstitial edema-preventing mechanisms. In: Olszewski WL, editor. *Lymph stasis: Pathophysiology, diagnosis and treatment*. Boca Raton, Forida: CRC Press, 1991:43-53.

Richmand DM, O'Donnell TF, Zelikovski A. Sequential pneumatic compression for lymphedema. Arch Surg 1985;120:1116-9.

Rinehart-Ayres ME. Conservative approaches to lymphedema treatment. Cancer (Suppl) 1998;83:2828-32.

Rockson SG. Precipitating factors in lymphedema: Myths and realities. Cancer (Suppl) 1998;83:2814-6.

Ryan TJ. Structure and function of lymphatics. J Invest Dermatol (Suppl) 1989;93:18-24.

Ryan TJ, Curri SB. Lymphatics and adipose tissue. Clin Dermatol 1995;13:493-8.

Ryttov N, Holm NV, Qvist N, Blichert-Toft M. Influence of adjuvant irradiation on the development of late arm lymphedema and impaired shoulder mobility after mastectomy for carcinoma of the breast. Acta Oncol 1988;27:667-70.

Sainsbury JRC, Anderson TJ, Morgan DAL. Breast cancer. BMJ 2000;321:745-50.

Scandinavian Occupational Classification. Arbetsmarknadsstyrelsen, Allmänna förlaget, Stockholm, 1978.

Schuneman H, Willich N. Lymphedema after breast carcinoma. A study of 5868 cases. Dtsch Med Wochenschr 1997;122:536-41.

Scott J, Huskisson EC. Graphic representation of pain. Pain 1976;2:175-84.

Scott J, Huskisson EC. Accuracy of subjective measurements made with or without previous scores: an important source of error in serial measurement of subjective states. Ann Rheum Dis 1979;38:558-9.

Segerström K. Factors that influence the incidence of brachial oedema after treatment of breast cancer. Scand J Plast Reconstr Surg Hand Surg 1992;26:223-7.

Sitzia J, Stanton AW, Badger C. A review of outcome indicators in the treatment of chronic limb oedema. Clin Rehabil 1997;11:181-91.

South Swedish Breast cancer group. Care program for breast cancer. Lund: Center of Oncology, 1997.

Stanton AWB, Northfield JW, Holroyd B, Mortimer PS, Levick JR. Validation of an optoelectronic limb volumeter (Perometer). Lymphology 1997;30:77-97.

Stanton AWB, Svensson WE, Mellor RH, Peters AM, Levick JR, Mortimer PS. Differences in lymph drainage between swollen and non-swollen regions in arms with breast-cancer-related lymphoedema. Clinical Sience 2001;101:131-40.

Stillwell GK. Treatment of postmastectomy lymphedema. Mod Treat 1969;6:396-412.

Svensson WE, Mortimer PS, Tohno E, Cosgrove DO. Colour doppler demonstrates venous flow abnormalities in breast cancer patients with chronic arm swelling. Eur J Cancer 1994;30A:657-60.

Svensson WE, Mortimer PS, Tohno E, Cosgrove DO. Increased arterial inflow demonstrated by doppler ultrsound in arm swelling following breast cancer treatment. Eur J Cancer 1994;30A:661-4.

Swedborg I. Voluminometric estimation of the degree of lymphoedema and its therapy by pneumatic compression. Scand J Rehabil Med 1977;9:131-5.

Swedborg I. Effectiveness of combined methods of physiotherapy for postmastectomy lymphedema. Scand J Rehabil Med 1980;12:77-85.

Swedborg I. Effects of treatment with elastic sleeve and intermittent pneumatic compression in post-mastectomy patients with lymphoedema of the arm. Scand J Rehabil Med 1984;16:35-41.

Swedborg I, Borg G, Sarnelid M. Somatic sensation and discomfort in the arm of - postmastectomy patients. Scand J Rehabil Med 1981;13:23-9.

Swedborg I, Norrefalk JR, Piller NB, Åsard C. Lymphoedema post-mastectomy: Is elevation alone an effective treatment? Scand J Rehabil Med 1993;25:79-82.

Swedborg I, Wallgren A. The effect of pre- and postmastectomy radiotherapy on the degree of edema, shoulder-joint mobility, and gripping force. Cancer 1981;47:877-81.

Szuba A, Rockson SG. Lymphedema: classification, diagnosis and therapy. Vasc Med 1998;3:145-56.

Tanigawa M. Comparison of the hold-relax procedure and passive mobilization on increasing muscle length. Phys Ther 1972;52:725-35.

Taylor SJ, Bogdan R. Introduction: Go to the people. In: Taylor SJ, Bogdan R, editors. *Introduction to qualitative research methods*. New York: John Wiley & Sons, 1984:1-14.

Tengrup I, Tennvall-Nittby L, Christiansson I, Laurin M. Arm morbidity after breast-conserving therapy for breast cancer. Acta Oncol 2000;39:393-7.

Thompson AM, Air M, Jack WJL, Kerr GR, Rodger A, Chetty U. Arm morbidity after breast conservation and axillary therapy. The Breast 1995;4:273-6.

Threefoot SA, Kossover MF. Lymphaticovenous communications in man. Arch Intern Med 1966;117:213-23.

Tobin MB, Lacey HJ, Meyer L, Mortimer PS. The psychological morbidity of breast cancer-related arm swelling. Psychological morbidity of lymphoedema. Cancer 1993;72:3248-52.

Van der Molen HR, Toth LM. The conservative treatment of lymphedema of the extremities. Angiology 1974;25:470-83.

Velanovich V, Szymanski W. Quality of life of breast cancer patients with lymphedema. Am J Surg 1999;177:184-7.

Veronesi U, Volterrani F, Luini A, Saccozzi R, Del Vecchio M, Zucali R, et al. Quadrantectomy versus lumpectomy for small size breast cancer. Eur J Cancer 1990;26:671-3.

Vodder E. Kirtel-dräneringen. En ny terapeutisk metode i skönhedens tjenste. Ny tid og vi 1936;9:131-5.

Vodder E. Lymph-drainage - als grundlage der Gesichts- und Körperpflege. Kosmetikerinnen-Fachzeitung 1957;59:1-4.

Vodder E. Die manuelle Lymphdrainage und ihre medizinischen Anwendungsgebiete. Erfahrungsheilkunde 1966;7:217-22.

Winiwarter A. Die chirurgischen Krankheiten der Haut und des Zellgewebes. Dtsch Chirurg 1892;23:356-408.

Witte CL, Witte MH. Pathophysiology of lymphatic insufficiency and principles of treatment. In: Olszewski WL, editor. *Lymph statis: Pathophysiology, diagnosis and treatment*. Boca Raton, Florida: CRC, 1991:327-44.

Wittlinger H, Wittlinger G. Einfürung in die Manuelle Lymphdrainage nach dr Vodder. Heidelberg: Haug Verlag, 1987.

Woods M. An audit of swollen limb measurements. Nurs Stand 1994;9:24-6.

Yamazaki Z, Idezuki Y, Nemoto T, Togawa T. Clinical experiences using pneumatic massage therapy for edematous limbs over the last 10 years. Angiology 1988;39:154-63.

Zanolla R, Monzeglio C, Balzarini A, Martino G. Evaluation of the results of three diffferent methods of postmastectomy lymphedema treatment. J Surg Oncol 1984;26:210-3.

Zeissler RH, Rose GB, Nelson PA. Postmastectomy lymphedema: late results of treatment in 385 patients. Arch Phys Med Rehabil 1972;53:159-66.

Zelikovski A, Manoach M, Giler S, Urca I. Lympha-Press. A new pneumatic device for the treatment of lymphedema of the limbs. Lymphology 1980;13:68-73.

ORIGINAL ARTICLE

Arm Lymphoedema, Shoulder Mobility and Muscle Strength after Breast Cancer Treatment – A Prospective 2-year Study

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Abstract

Arm lymphoedema and impaired shoulder mobility and muscle strength are well known side-effects to breast cancer treatment. The aim of this prospective study was to follow closely and describe the arm volume, range of motion of the shoulder and muscle strength of the shoulder and hand after breast cancer treatment in order to form a basis for further studies in the area including physiotherapy intervention. Sixty-one women treated for breast cancer with axillary dissection, with or without postoperative radiotherapy, were examined preoperatively and monthly until 6 months after the operation with 1- and 2-year follow-ups. 1 month after the operation, results revealed decrease in range of motion, after 2 months increase in arm volume difference and after the first 6 months decrease in muscle strength of shoulder adductors, flexors and internal rotators. A greater increase in arm volume difference and decrease in shoulder abduction, flexion and external rotation were noted throughout the follow-up period for the group receiving radiotherapy to the axilla area. Postoperative physiotherapeutic management needs to pay special attention to early impairments after breast cancer treatment particularly to the group receiving radiotherapy to the axilla area. Physiotherapeutic treatment might be introduced during the period when radiotherapy is being given.

KEY WORDS: Arm lymphoedema – isometric muscle strength – mastectomy – postoperative – radiotherapy – range of motion – shoulder impairment – swollen arm – water displacement method.

INTRODUCTION

Breast cancer is the most common malignancy in women (1). Ten per cent of the female population will be diagnosed with breast cancer during their lifetime, but only a minority will die from the disease (2). Arm lymphoedema and impaired shoulder mobility and muscle strength are well known side-effects. After breast cancer treatment, lymph transport is impeded by damaged or blocked lymphatic vessels and lymphoedema might develop in the arm or in the thoracic part connected to the treatment area or in both (3). The incidence of arm lymphoedema following breast cancer treatment in the last 10 years has varied widely in Europe from 0 to 60% (4–9), depending on the breast cancer treatment and on methods for measuring and definition of lymphoedema. Axillary node dissection (4,9–12) and radiotherapy (4,7,9,10) are factors associated with lymphoedema. Breast cancer patients with lymphoedema experience more functional impairments and psychosocial distress than patients without lymphoedema (13). Difficulties in finding suitable clothes and cosmetic problems are common among these patients (14). When not treated, secondary arm lymphoedema, such as after breast cancer treatment, develops faster than other lymphoedema, such as leg lymphoedema or primary lymphoedema (15). Long-standing lymphoedema can become irreversible due to adipose tissue (16) and fibrosis (17,18). The oedema sometimes calls for lifelong physiotherapeutic treatment (19). Thus it is important to identify risk patients for preventive measures and early treatment, particularly among women treated for breast cancer risking lymphoedema in the arm.

Several studies report limited shoulder range of motion (ROM) after primary therapy (20–24) as well as reduced muscle strength (21,23). Hladiuk et al. (25) found that 12% of 57 patients reported decreased shoulder mobility 1 year after axillary node dissection for breast cancer. Most of the im-

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pairment occurred within 6 months after surgery. These observations are consistent with the results of a Swedish exploratory study of 28 breast cancer patients (own series, not published). Both studies also pointed out that postoperative measurements at 1 and 2 years respectively showed small changes from the measurements at 6 months. Thus, it must be of importance to describe the onset of decreased mobility already during the first 6 postoperative months.

The aims of axillary node dissection according to the recommendations of the "Care program for breast cancer" in the south of Sweden (26) are to remove tumour-infiltrated nodes. If no such nodes are seen or felt, 8–10 nodes are removed for staging of the breast cancer disease. The operation involves the nodes below and medial to the axillary vein (level I and II) (27) saving the long thoracic and the thoracodorsal nerves. The wound surface is relatively large and the fibrotic tissue developed during wound healing has been related to occlusion of the remaining lymphatic channels (28) and may by clinical experience also contribute to decreased shoulder mobility.

Postoperative radiotherapy has been reported to be another contributing factor to lymphoedema and decreased shoulder mobility (4,7,9,10,29). Increasing fibrotic tissue in the shoulder area may also cause nerve entrapment (30). At 2–10 months after large single doses given to muscle of various species of animals, progressive muscle injury has been reported as probably caused by vascular lesions resulting in loss of capillaries and increased collagen formation (31). It was supposed that the fibrosis occurring might be mediated additionally by inflammation that accompanies vessel damage (31).

To summarize, the literature describes the treatment of breast cancer as being associated with shoulder and arm impairments. Thus, the postoperative treatment ought to try to prevent these impairments and early identification of related factors seems to be important.

The aim of this prospective study was to follow closely and describe the arm volume, range of motion of the shoulder and muscle strength of the shoulder and hand until 2 years after breast cancer treatment, in order to form a basis for further studies in the area including physiotherapy intervention. For the same reason, factors possibly related to decreased shoulder range of motion were explored.

MATERIALS AND METHOD

Subjects

From September 1995 to October 1996, 90 women undergoing axillary dissection combined with mastectomy or segmental resection for breast cancer at the Department of Surgery, Lund University Hospital, Lund, Sweden, were included in the present study. The following exclusion criteria were employed: previous contralateral breast disease, recurrent cancer, disorders related to muscles or joints and difficulties in participating in the study, for example dementia. Seven women declined to participate for personal reasons. Twenty women were not examined preoperatively because of short notice before the operation. Two women, aged 38 and 44 years, dropped out due to fatigue after the 1st and the 3rd month, respectively. The demographic data of the remaining 61 women are presented in Table I. Twenty-six patients received no radiotherapy (NRT), 16 patients received radiotherapy to the breast only (BRT) and 19 patients received radiotherapy to both

TABLE I: Demographic data for the total study group of breast cancer treated women ($n=61$) and for the subgroup treated with adjuvant radiotherapy ($n=35$)

Age (years), mean ± SD		56 ± 10
Operation site: right/left		39/22
Operation side: dominant/non dominant/ambidextrous		38/21/2
Type: partial mastectomy/mastectomy		35/26
Postoperative seroma [a]		26
Postoperative wound infection [a]		6
Chemotherapy (CMF)		15
Tamoxifen		15
Radiotherapy (25 × 2Gy)	Breast only	16
	Breast and axilla	19
Dermatitis after radiotherapy	None	2
	Slight	12
	Moderate	7
	Severe	14

[a] Obtained from patients' records.

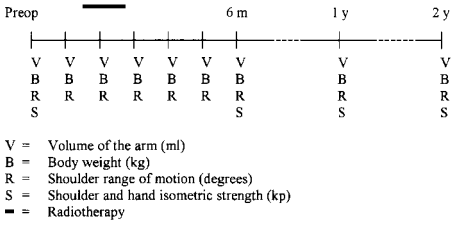

Fig. 1. Study design. V = Volume of the arm (ml); B = Body weight (kg); R = Shoulder range of motion (degrees); S = Shoulder and hand isometric strength (kp); – = Radiotherapy.

breast and axilla (ART) covering two-thirds of the humeral head. The radiotherapy dose given was 50 Gy in fractions of 2 Gy/day over 5 weeks, starting approximately 6 weeks after the operation.

Four patients were excluded at the 1- and 2-year follow-up ($n = 57$) because of recurrent cancer 8–23 months after the primary operation.

Four patients were not able to come to one test each (two at the 3-month assessment and two at the 4-month assessment) during the first 6-month observation period. Six patients missed the 1-year ($n = 51$) and one patient the 2-year ($n = 56$) follow-up.

Design

The study design is illustrated in Fig. 1. All measurements were performed by one experienced physiotherapist (KJ), preoperatively and each month until 6 months after the operation, and at 1 and 2 years postoperatively except for strength. Because of the involvement of pain from the surgical area during the first postoperative months we choose not to examine muscle strength of the shoulder until 6 months postoperatively.

A daily home exercise programme and an oedema-prevention programme, both verbal and written, were instructed preoperatively to all patients by an experienced physiotherapist. The exercise programme included shoulder flexion and abduction in a supine position and internal and external rotation in a sitting position. The patients were told to do each exercise five times, three times a day, to the pain limit without stretching. The oedema-prevention programme included instructions to keep the arm in a high position as much as possible and to do pumping exercises with the hand. The patients were also told to avoid heavy or monotonous work and infections. The programmes were to be continued for 6 months according to the recommendations of the "Care program for breast cancer" in the south of Sweden (26) and then as long as the patients felt they needed to.

Measurements

Volume of the arm. Each arm was submerged in a container of water and the volume displacement was measured in millilitres according to Kettle (32) and validated by Bednarczyk et al. (33) and found to have a high test–retest correlation ($r = 0.999$). The contralateral arm was used as control. Arm lymphoedema, measured by the water displacement method, was defined as an increase in volume of 10% compared to the non-operated arm (34). A correction for the natural asymmetry of the arms was performed with 1.6% for right-handed and 1.4% for left-handed (35). The body weight was also registered.

Shoulder range of motion. In a supine position, in the same order, passive abduction, flexion, internal and external rotation of the shoulder on the operated side were measured with a goniometer. Internal and external rotation were measured with the arm in 90° abduction or, if this position could not be reached, in maximal abduction ($n = 9$). The ROMs were expressed in degrees as recommended by the American Academy of Orthopaedic Surgeons (36).

In a prior pilot study ($n = 12$) the test--retest reliability of the above ROM measurements was evaluated by one physiotherapist (KJ). Results showed a mean absolute difference of $4.0 \pm 3.6°$ (abduction), $4.4 \pm 2.1°$ (flexion), $5.4 \pm 3.0°$ (internal rotation), and $5.6 \pm 3.2°$ (external rotation) between two test occasions performed again within 3 days.

The limit for reduced mobility was set at $\geq 5\%$ for flexion and abduction, and $\geq 10\%$ for internal and external rotation. The percentages 5% and 10% were chosen to represent approximately 10 degrees of reference values (36) for each range of motion, to avoid measurement errors. Whenever this limit for reduced ROM, compared to the preoperative measurements, was exceeded, the patients perceived and expressed a feeling of stiffness in the tissue. Still with

the arm in the limited position the patient guided the physiotherapist to palpate and identify the area mainly associated with the reduction of the ROM.

At the 6-month test the involvement of increased muscle tension was examined by measuring the ROMs before and immediately after performing the hold–relax technique (37) in the different ranges. At the 2-year follow-up, the glenohumeral joint involvement was tested by passive abduction of the arm up to 90° with a stabilized scapula (36). Any movement of the scapula within 90° abduction was noted.

Isometric shoulder muscle strength. In a supine position, in the same order, the flexors, extensors, adductors, abductors and internal rotators of the shoulder on the operated side were measured with a hand-held spring dynamometer with a range of 1–25 kp (10–250 N) and a precision of 0.5 kp. The device was placed just proximal to wrist joint with the arm straight in 90° flexion of the shoulder, except for internal rotators where the arm was held close to the body with a 90° flexion of the elbow. A breaking force technique was employed. The method is highly reliable with significant correlations ($p \leq 0.01$) for repeated measurements (38). The gripping force of the hand on the operated side was measured with a Jamar dynamometer with the patient in a sitting position, and the arm held close to the body with a 90° flexion of the elbow. The highest value of three was registered for each test.

Statistical analysis

Comparisons between the mobility reducing factors were assessed by the chi-squared test. The remaining analyses were performed using the Mann–Whitney test for comparisons between groups and the Wilcoxon's signed rank test for comparisons within groups.

RESULTS

Oedema of the arm

The mean preoperative volumes on the operated and non-operated sides were 2312 ± 434 ml and 2310 ± 424, respectively. The volume difference between sides increased significantly ($p < 0.001$) at the second month in the whole group to 38 ± 94 ml compared to the preoperative volume values. Six months postoperatively the NRT and BRT groups had stabilized in volume difference and only the ART group continued to increased to 83 ± 131 ml ($p = 0.005$) compared to the second month. The development of volume differences up to 2 years after the operation can be seen in Fig. 2. There were significant differences between the ART and NRT groups at the 1- and 2-year follow-ups ($p < 0.05$) and ($p < 0.02$), respectively.

Seven patients developed arm lymphoedema according to the 10% rule (34). One was found 1 month after the operation, one at 2 months, one at 1 year and four at 2 years. All seven patients were treated with compression sleeves and manual lymph drainage. For two of the patients treated within the 2-year follow-up period the lymphoedema remained throughout the period. One patient who had an oedema 2–6 months after the operation had no oedema at the 1- and 2-year follow-ups. Eight patients were treated with a compression garment for clinical visible oedema in the hand ($n = 4$) or forearm ($n = 4$), which had not reached a volume difference of 10%.

According to the 10% rule, the arm oedema incidence for the whole group during the 2-year observation period was 12%. For the different radiotherapy groups it was 26% in the ART group, 0% in the

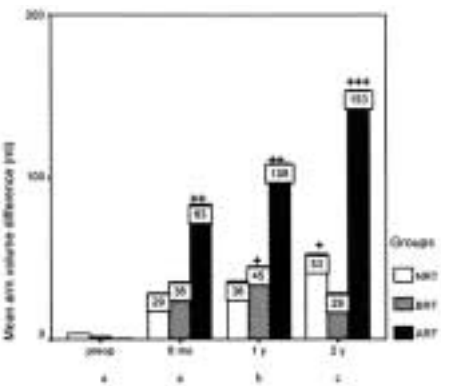

Fig. 2. Arm volume difference two years after breast cancer operation in the groups NRT (no radiotherapy), BRT (only breast radiotherapy) and ART (breast and axilla radiotherapy). p-values show volume differences compared to preoperative measurements: $*p \leq 0.05$; $**p \leq 0.01$; $***p \leq 0.001$. (a) $n = 61$; (b) $n = 51$; (c) $n = 56$.

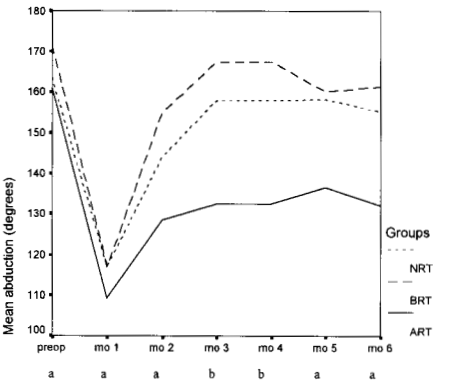

Fig. 3. Abduction–ROM during the first 6 postoperative months after breast cancer operation in the groups NRT (no radiotherapy), BRT (only breast radiotherapy) and ART (breast and axilla radiotherapy). (a) $n = 61$; (b) $n = 59$.

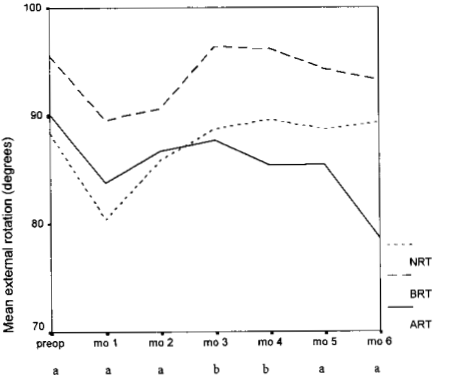

Fig. 5. External rotation–ROM during the first 6 postoperative months after breast cancer operation in the groups NRT (no radiotherapy), BRT (only breast radiotherapy) and ART (breast and axilla radiotherapy). (a) $n = 61$; (b) $n = 59$.

BRT group and 8% in the NRT group. If the clinical arm lymphoedemas were also included, the incidence for the whole group was 27%, 37% in the ART group, 31% in the BRT group and 12% in the NRT group.

During the 2-year observation period the mean body weight for the whole group increased from 70.1 ± 12 to 72.5 ± 13 kg ($p > 0.001$).

A correction for natural asymmetry of the arms was performed (35), but did not noticeably change the results. The volumes presented are measurements without correction.

Shoulder mobility

During the first 5 months the reduction of ROM of shoulder abduction was the most frequent, being

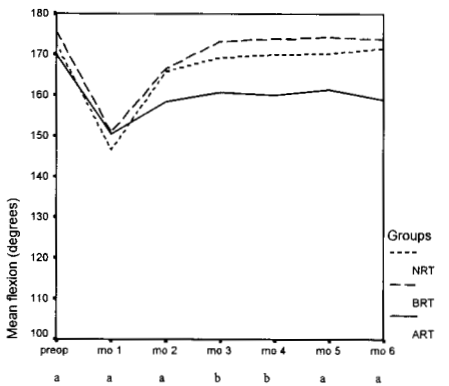

Fig. 4. Flexion–ROM during the first 6 postoperative months after breast cancer operation in the groups NRT (no radiotherapy), BRT (only breast radiotherapy) and ART (breast and axilla radiotherapy). (a) $n = 61$; (b) $n = 59$.

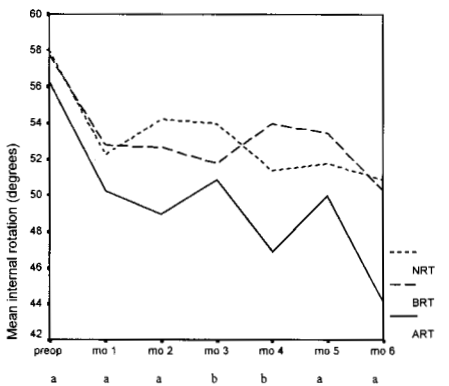

Fig. 6. Internal rotation–ROM during the first 6 postoperative months after breast cancer operation in the groups NRT (no radiotherapy), BRT (only breast radiotherapy) and ART (breast and axilla radiotherapy). (a) $n = 61$, (b) $n = 59$.

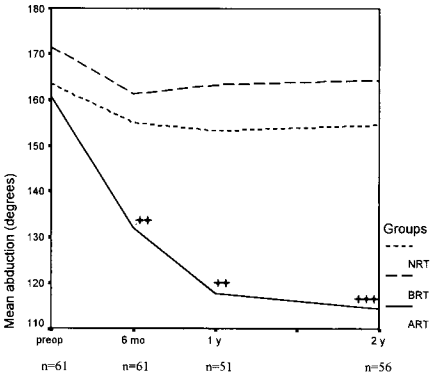

Fig. 7. Abduction–ROM 2 years after breast cancer operation in the groups NRT (no radiotherapy), BRT (only breast radiotherapy) and ART (breast and axilla radiotherapy). p-values show ROM compared to preoperative measurements: $**p \leq 0.005$; $***p \leq 0.001$.

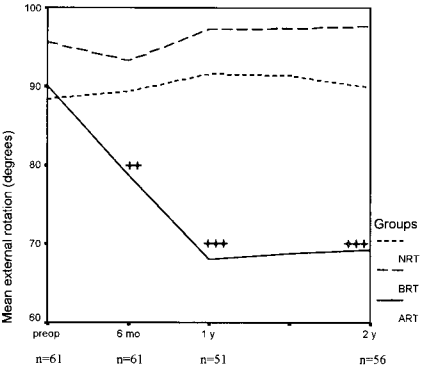

Fig. 9. External rotation–ROM 2 years after breast cancer operation in the groups NRT (no radiotherapy), BRT (only breast radiotherapy) and ART (breast and axilla radiotherapy). p-values show ROM compared to preoperative measurements: $**p \leq 0.005$; $***p \leq 0.001$.

observed on 48% of the patients at 5 months. At 6 months, reduced internal rotation was most frequent (61%), followed by abduction (41%), external rotation (34%) and flexion (33%). At the 2-year follow-up the corresponding percentage reduction were 63%, 43%, 30% and 27%.

Abduction was impaired 1 month after operation compared to the preoperative measurement ($p \leq 0.001$) but normalized during the 6-month observation period except for the patients who received radiotherapy to the axilla (Figs. 3–6). The same observation was found concerning flexion. There was less impact on external rotation but the same trend was observed . The internal rotation was the ROM most heavily influenced by the breast cancer treatment as none of the groups returned to their preoper-

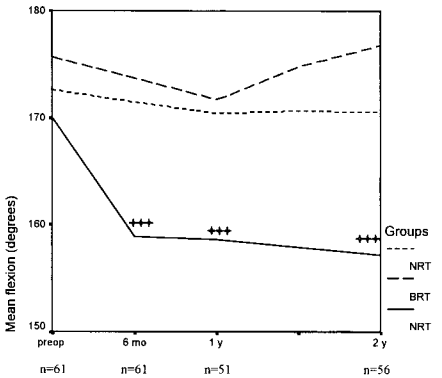

Fig. 8. Flexion–ROM 2 years after breast cancer operation in the groups NRT (no radiotherapy), BRT (only breast radiotherapy) and ART (breast and axilla radiotherapy). p-values show ROM compared to preoperative measurements: $***p \leq 0.001$.

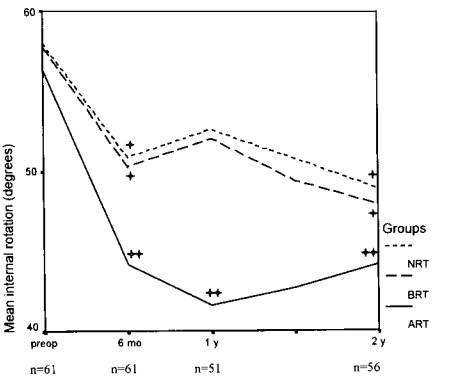

Fig. 10. Internal rotation–ROM 2 years after breast cancer operation in the groups NRT (no radiotherapy), BRT (only breast radiotherapy) and ART (breast and axilla radiotherapy). p-values show ROM compared to measurements: $*p \leq 0.05$; $**p \leq 0.005$.

ative values. Analyses each month were performed for all four ROMs comparing the NRT and ART groups. There were no differences between the groups at any ROM at 1 and 2 months. At 3 months, reduced mobility in the ART group was found for abduction ($p = 0.003$) and flexion ($p = 0.017$) and at 6 months for external rotation ($p < 0.021$).

At the 2-year follow-up, the trends from the 6-month observation period were constant. The ART group showed continuous impairment of ROM but the NRT and BRT groups had virtually normal ROM except for internal rotation (Figs. 7–10).

At 6 months, 79% of the ART group had decreased mobility in any one ROM (47% of these in all four ROMs). In the BRT and NRT groups, the figures were 19% and 23%, respectively, for decreased mobility in any one ROM. At the 2-year follow-up, 94% of the ART group, 67% of the BRT group and 74% of the NRT group had decreased mobility in any one ROM.

At 6 months, decreased shoulder mobility was not improved by a hold–relax technique and at 2 years no patient showed any involvement of the glenohumeral joint when the abduction test with a stabilized scapula was performed.

Factors associated with decreased shoulder mobility

Two factors were found to be associated with decreased shoulder mobility during the 6-month observation period:

1. Vascular string. It can be described as a "tendon" or a "violin string" most commonly seen in the axilla and palpated along the medial side of the upper arm, sometimes even on the forearm and radial part of the hand (Fig. 11) (39). In a few cases it has also been located on thorax below the axilla. In the immediate postoperative phase the "string" is usually tense and painful, especially when the arm is abducted. In seven patients, a biopsy of the string was made 4–5 weeks after the operation and the pathological examination showed veinus tissue in six of the cases, with an inflammatory process in four suggesting thrombophlebitis.
2. Stiff tissue in the operation area. When maximum ROM was maintained hard, stiff tissue was palpated on the lateral side of pectoralis major muscle and in the axillary area or from the scars. Some patients also reported a vague feeling of stiffness in the breast and pectoralis. This might be explained by oedema followed by a fibrotic reaction in the thoracic tissue after radiotherapy (31), since all of the patients ($n = 7$), had received radiotherapy, one to the breast only and six to both breast and axilla.

The patients also reported other factors impairing the ROM like general pain of the shoulder ($n = 1$) and stiffness or pain on the lateral or dorsal side of the upper arm and/or of the shoulder joint ($n = 3$).

Vascular string (factor 1) was most frequently noted in the first month, being palpated in 77% ($n = 47$) of the patients and associated with decreased mobility in 66% ($n = 40$). In the period 3–6 months, it was stiffness in the operation area (factor

Fig. 11. "Vascular string" visible in the axilla region the first weeks after axillary node dissection.

TABLE II: The number of patients with reduction of any shoulder ROM (abduction, flexion, internal or external rotation) noted during the 6-month test period. Comparison is performed between the two categories of mobility reducing factors

Factors	Month					
	1	2	3	4	5	6
1. Vascular string	40***	21	2	2	4	4
2. Stiff tissue	15	27	42***	43***	40***	41***

*** $p \leq 0.001$.

2) that was the most frequently noted factor (Table II).

In nine patients, abduction was decreased to less than 90°, mobility being $76 \pm 5°$ at month 1. Thus, internal and external rotations were measured in maximum abduction for each of the nine patients. The results for internal and external rotation at month 1 did not noticeably change when the statistical analyses were restricted to 52 patients.

Isometric muscle strength

In the whole group a significant decrease in isometric muscle strength was found at 6 months, 1 year and 2 years for flexors, adductors and internal rotators of the shoulder, respectively. There was no change in gripping force (Table III). At the 2-year follow-up, the material was stratified into the three different radiotherapy groups (NRT, BRT and ART) but no differences were found between the groups.

DISCUSSION

In the south of Sweden, the mean age of the breast cancer treated women is only 58 years (40). Many patients are working and still have many years to live. Impairments such as arm lymphoedema and reduced shoulder mobility, as well as pain and other neurological problems from the treatment area, are important reasons for sick leave or changes in working capacity and activities of daily living (41,42). Some authors have also described psychological morbidity (43) and psychosocial distress (13,14) generated by these impairments. This study focuses on some of these impairments and identifies patients at risk of arm lymphoedema, decreased shoulder ROM and muscle strength.

The increasing arm volume suggests an early influence on the lymph transport, particularly for patients receiving axillary radiotherapy. The incidence of arm lymphoedema in this study (12%) was relatively low compared to other Swedish studies (18% and 29%) (4,44) with patients treated for breast cancer in a similar way and measured for arm volume with the water displacement method. In this study, the patients with oedema were identified and found early, probably preventing later and larger problems as described by Casley-Smith et al. (15). This can be seen particularly in the BRT group, where 33% had clinical visible oedema after 2 years but no one developed lymphoedema according to the 10% rule. The oedemas were found early and treated, and this might indicate that the increase of volume could be limited.

Arm lymphoedema is often defined as an increase in volume of 10% compared to the non-operated arm (4,25,35,40,45). In this study, eight patients were found with clinical visible oedema that did not exceed the 10% volume limit. A very small increase in volume situated only to the hand might be as distressing to the patient as a considerable increase of volume of the arm because the hand is much more exposed than the rest of the arm. This gives reason to question if very small lymphoedemas need to be defined in another way and to search for measurements that are more sensitive. Measurements like subjective assessment on a visual analogue scale (VAS) for tension and heaviness of the arm (45,46) or palpation of the thickness of the skin compared to the non-operated side might be useful and have to be evaluated.

It is shown in this study, as well as in several others (22,24,25,29,47), that the shoulder ROM is influenced by the breast cancer treatment and that decreased shoulder mobility can persist for many years after the operation. This study also reveals that

reduction of abduction, flexion and external rotation of the shoulder is found in the group receiving axillary radiotherapy. These three ROMs may all be reduced by stiffness in the axillar region and pectoralis muscle. The stiffness in this region was first found 3 months after the operation, that is, 1 week after completion of radiotherapy. In a pig model of radiation injury, a two- to fourfold increase in transforming growth factor was found as early as 3 weeks after large single doses. The increase was still twofold 1 year later (48). Providing human growth factors react similarly, this might explain the early reducing influence and also the long-term effect on collagen tissue, including scar tissue in the axillar region. This is consistent with the results of Bentzen et al. (40) who evaluated decreased shoulder mobility after postmastectomy radiotherapy in 163 breast cancer patients and stated that damage to the pectoralis major muscle was most likely an important factor. Clinical experience suggests that when reduction is once established it is very hard to provide effective treatment. Therefore it seems appropriate that treatment is introduced as soon as the decrease is noticed or as soon as possible, to prevent the reduction of ROM.

The reduction of ROM could not be explained by any limitations of the glenohumeral joint, even though two-thirds of the humeral head was covered by radiotherapy. Thompson et al. (29) examined 121 breast cancer patients also demonstrating decreased shoulder mobility. In their study, the humeral head and the glenohumeral joint were protected from radiotherapy and they suggested a damage to the rotator cuff muscles rather than the joint capsule as an explanation for decreased shoulder mobility. Regarding the influence on axilla tissue and pectoralis major muscle, we suggested that a home exercise programme comprising stretching exercises needs to be evaluated.

The influence of the vascular string (Fig. 11) on shoulder mobility in the immediate postoperative period also appeared important. Although it has an influence on abduction range of motion, as seen in nine patients with less than 90° at 1 month, it did not seem to be related to internal or external rotation. This is supported by the observation that the string can be observed being stretched very much by abduction but very little or not at all by internal or external rotation, but from the third month it has a very limited influence on any ROM. However, patients are often concerned with pain associated with the string, and in order to find an explanation for the phenomenon, biopsies were performed. This string has to our knowledge not been described earlier by other authors, but is in general believed to be caused by lymphatic involvement. Our results indicated that the possible cause is damage to veins, probably due to thrombophlebitis.

This study also identified some factors associated with reduced ROM. An assessment of such factors

TABLE III: Comparison between preoperative values and 6 months, 1 year and 2 years after breast cancer surgery for isometric muscle strength (mean ± SD) of the shoulder (kp) and gripping force of the hand (kp/cm²)

Muscle groups	Preop.	6 months	1 year	2 years
	$n = 61$	$n = 61$	$n = 51$	$n = 56$
Flexors [a]	8.3 ± 1.5	8.0 ± 1.5 *	7.6 ± 1.4 ***	7.8 ± 1.5 *
Extensors [a]	9.2 ± 1.7	9.1 ± 1.8	8.8 ± 1.9	8.8 ± 1.9
Adductors [a]	6.2 ± 1.5	5.8 ± 1.3 **	5.6 ± 1.3 **	5.4 ± 1.3 **
Abductors [a]	6.9 ± 1.5	7.1 ± 1.3	7.0 ± 1.7	7.1 ± 1.5
Internal rotators [a]	13.2 ± 3.5	12.4 ± 2.9 *	11.9 ± 2.6 **	12.1 ± 2.8 **
Gripping force	34 ± 11	34 ± 10	35 ± 11	35 ± 11

[a] One patient with back pain was excluded.
* $p \leq 0.05$.
** $p \leq 0.01$.
*** $p \leq 0.001$.

has, to our knowledge, not previously been made. Thus, the assessments were made as unbiased as possible, allowing the patients to express their subjective experiences of stiffness and having them point out the area to which these feelings were related. The purpose was not to explain the causes of the ROM reductions but to try and seek guidance for further studies. Some possible explanations, however, have been discussed here.

In this study we found reduced isometric muscle strength for flexors and adductors of the shoulder, which is in line with the results of Nikkanen et al. (23) but we also found the strength of internal rotators to be reduced. The pectoralis major muscle is involved in these three muscle groups. This influence could not be explained by radiotherapy or by type of operation, neither could it be explained by inactivity or ageing because then the strength of the other muscle groups measured should have been reduced in a similar way. Maybe the explanation is the injury that axillary dissection might cause the pectoralis muscle. This question has to be assessed in a study where breast cancer patients without axillary dissection are included.

CONCLUSIONS

Results indicated a very early increase of arm lymphoedema and decrease of shoulder mobility in women treated for breast cancer, especially for patients receiving radiotherapy to the breast and axilla area, and decreased shoulder muscle strength for the whole group. Postoperative physiotherapeutic management needs to pay special attention to these early impairments. Treatment of these impairments might be introduced already during the radiotherapy period. Physiotherapy treatment, however, requires further studies.

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REFERENCES

1. Swedish Cancer Registry. Cancer incidence in Sweden 1995. Stockholm: National Board of Health and Welfare, 1998.

2. Harris JR, Morrow M. Local management of invasive breast cancer. In: Harris JR, Morrow M, Lippman ME, Hellman S, editors. Diseases of the breast. Philadelphia: Lippincoll Raven, 1996: 487–547.

3. Brennan MJ, DePompolo RW, Garden FH. Focused review: Postmastectomy lymphedema. Arch Phys Med Rehabil 1996;77:s74–80.

4. Christensen SB, Lundgren E. Sequelae of axillary dissection vs axillary sampling with or without irradiation for breast cancer. Acta Chir Scand 1989;155:515–20.

5. Clarysse A. Lymphoedema following breast cancer treatment. Acta Clin Belg Suppl 1993;15:47–50.

6. Hoe AL, Iven D, Royle GT, Taylor I. Incidence of arm swelling following axillary clearance for breast cancer. Br J Surg 1992;79:261–2.

7. Ryttov N, Holm NV, Qvist N, Blichert-Toft M. Influence of adjuvant irradiation on the development of late arm lymphedema and impaired shoulder mobility after mastectomy for carcinoma of the breast. Acta Oncol 1988;27:667–70.

8. Segerström K. Factors that influence the incidence of brachial oedema after treatment of breast cancer. Scand J Plast Reconstr Surg Hand Surg 1992;26:223–7.

9. Suneson B-L, Lindholm C. Clinical incidence of lymphoedema in breast cancer patients in Jönköping County, Sweden. Eur J Cancer Care 1996;5:7–12.

10. Kissin MW, Querci della Rovere G, Easton D, Westbury G. Risk of lymphoedema following the treatment of breast cancer. Br J Surg 1986;73:580–4.

11. Larson D, Weinstein M, Goldberg I, et al. Edema of the arm as a function of the extent of axillary surgery in patients with stage I–II carcinoma of the breast treated with primary radiotherapy. Int J Radiat Oncol Biol Phys 1986;12:1575–82.

12. Pezner RD, Patterson MP, Hill LR, Lipsett JA, Desai KR, Vora N, et al. Arm lymphedema in patients treated conservatively for breast cancer: relationship to patient age and axillary node dissection technique. Int J Radiat Oncol Biol Phys 1986;12:2079–83.

13. Tobin MB, Lacey HJ, Meyer L, Mortimer PS. The psychological morbidity of breast cancerrelated arm swelling. Psychological morbidity of lymphoedema. Cancer 1993;72:3248–52.

14. Carter B. Women's experiences of lymphedema. Oncol Nurs Forum 1997;24:875–82.

15. Casley-Smith JR. Alterations of untreated lymphoedema and its grades over time. Lymphology 1995;28:174–85.

16. Ryan TJ, Curri SB. Lymphatics and adipose tissue. Clin Dermatol 1995;13:493–8.

17. Casley-Smith JR, Gaffney RM. Excess plasma proteins as a cause of chronic inflammation and lymphoedema: quantitative electron microscopy. J Pathol 1981;133:243–72.

18. Gaffney RM, Casley-Smith JR. Excess plasma proteins as a cause of chronic inflammation and lymphoedema: biochemical estimations. J Pathol 1981;133:229–42.

19. Földi E, Földi M, Weissleder H. Conservative treatment of lymphoedema of the limbs. Angiology 1985;36:171–80.

20. Aitken RJ, Gaze MN, Rodger A, Chetty U, Forrest APM. Arm morbidity within a trial of mastectomy and either nodal sample with selective radiotherapy or axillary clearance. Br J Surg 1989;76:568–71.

21. Ivens D, Hoe AL, Podd TJ, Hamilton CR, Taylor I, Royle GT. Assessment of morbidity from complete axillary dissection. Br J Cancer 1992;66:136–8.

22. Maunsell E, Brisson J, Deschênes L. Arm problems and psychological distress after surgery for breast cancer. Can J Surg 1993;36:315–20.

23. Nikkanen TA, Vanharanta H, Helenius-Reunanen H. Swelling of the upper extremity, function and muscle strength of shoulder joint following mastectomy combined with radiotherapy. Ann Clin Res 1978;10:273–9.

24. Paci E, Cariddi A, Barchielli A, et al. Long-term sequelae of breast cancer surgery. Tumori 1996;82:321–4.

25. Hladiuk M, Huchcroft S, Temple W, Schnurr BE. Arm function after axillary dissection for breast cancer: a pilot study to provide parameter estimates. J Surg Oncol 1992;50:47–52.

26. South Swedish Breast Cancer Group. Care program for breast cancer. Lund: Center of Oncology, 1997.

27. Hermanek P, Sobin LH. UICC: TMN Classification of malignant tumors. Fourth revision. Berlin: Springer-Verlag, 1987.

28. Markowski J, Wilcox JP, Helm PA. Lymphedema incidence after specific postmastectomy therapy. Arch Phys Med Rehabil 1981;62:449–52.

29. Thompson AM, Air M, Jack WJL, Kerr GR, Rodger A, Chetty U. Arm morbidity after breast conservation and axillary therapy. The Breast 1995;4:273–6.

30. Olsen NK, Pfeiffer P, Johannsen L, Schröder H, Rose C. Radiation-induced brachial plexopathy: neurological follow-up in 161 recurrence-free breast cancer patients. Int J Radiat Oncol Biol Phys 1993;26:43–9.

31. Gillette EL, Mahler PA, Powers BE, Gillette SM, Vujaskovic Z. Late radiation injury to muscle and peripheral nerves. Int J Radiat Oncol Biol Phys 1995;31:1309–18.

32. Kettle JH, Rundle FF, Oddie TH. Measurement of upper limb volumes: a clinical method. Aust N Z J Surg 1958;27:263–70.

33. Bednarczyk JH, Hershler C, Cooper DG. Development and clinical evaluation of computerized limb volume measurement system (CLEMS). Arch Phys Med Rehabil 1992;73:60–3.

34. Stillwell GK. Treatment of postmastectomy lymphedema. Mod Treat 1969;6:396–412.

35. Godal R, Swedborg I. A correction for the natural asymmetry of the arms in the determination of the volume of oedema. Scand J Rehabil Med 1982;14:193–5.

36. American Academy of Orthopaedic Surgeons. Joint motion. Edinburgh: Churchill & Livingstone, 1985

37. Tanigawa M. Comparison of the hold-relax procedure and passive mobilization on increasing muscle length. Phys Ther 1972;52:725–35.

38. Bohannon RW. Test-retest reliability of hand-held dynamometry during a single session of strength assessment. Phys Ther 1986;66:206–9.

39. Johansson K, Albertsson M, Ingvar C, Ekdahl C. Ealy and late decreased shoulder mobility and arm lymphedema after breast cancer. Lymphology (Suppl) 2000; 33: 226–8.

40. Bentzen SM, Overgaard M, Thames HD. Fractionation sensitivity of functional endpoint: Impaired shoulder movement after post-mastectomy radiotherapy. Int J Radiat Oncol Biol Phys 1989;17:531–7.

41. Satariano WA, Ragheb NE, Branch LG, Swanson MG. Difficulties in physical functioning reported by middle-aged and elderly women with breast cancer: A case contol comparison. J Gerontol 1990;45:M3–M11.

42. Wingate L, Croghan I, Natarajan MS, Michalek AM, Jordan C. Rehabilitation of the mastectomy patient: a randomized, blind, prospective study. Arch Phys Med Rehabil 1989;70:21–4.

43. Hack TF, Cohen L, Katz J, Robson LS, Goss P. Physical and psychological morbidity after axillary lymph node dissection for breast cancer. J Clin Oncol 1999;17:143–9.

44. Swedborg I, Borg G, Sarnelid M. Somatic sensation and discomfort in the arm of postmastectomy patients. Scan J Rehab Med 1981;13:23–9.

45. Johansson K, Albertsson M, Ingvar C, Ekdahl C. Effects of compression bandaging with or without manual lymph drainage treatment in patients with postoperative arm lymphedema. Lymphology 1999;32:103–10.

46. Johansson K, Lie E, Ekdahl C, Lindfeldt J. A randomized study comparing manual lymph drainage with sequential pneumatic compression for treatment of postoperative arm lymphedema. Lymphology 1998;31:56–64.

47. Keramopoulos A, Tsionou C, Minaretzis D, Michalas S, Aravantinos D. Arm morbidity following treatment of breast cancer with total axillary dissection: a multivariated approach. Oncology 1993;50:445–9.

48. Martin M, Lefaix JL, Pinton P, Crechet F, Daburon F. Temporal modulation of TGF-B and B-actin gene expression in pigskin and muscular fibrosis after ionizingradiation. Radiat Res 1993;134:63–70.

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Factors Associated with the Development of Arm Lymphedema

Following Breast Cancer Treatment: A Match Pair Case-control Study

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ABSTRACT

We examined factors that may influence the development of arm lymphedema following breast cancer treatment including the specific mode of therapy, patient occupation and life style. Medical record data and a questionnaire were used to collect information after surgery concerning such issues as wound seroma, infection, adjuvant treatment, vessel string (phlebitis), body mass index, smoking habits and stress. Occupational workload was assessed after surgery whereas housework, exercise, hobbies and body weight were assessed both before and after surgery. Seventy-one breast cancer treated women with arm lymphedema lasting more than 6 months but less than 2 years were matched to women similarly treated for breast cancer but without arm lymphedema (controls). The matching factors included axillary node status, time after axillary dissection, and age. In the lymphedema group, there was a higher body mass index at time of surgery ($p=0.03$) as well at time of study ($p=0.04$). No differences were found in occupational workload ($n=38$) or housework, but the lymphedema group reduced their spare time activities including exercise after surgery compared with the controls ($p<0.01$).

In conclusion, women treated for breast cancer with axillary node dissection with or without adjuvant radiotherapy could maintain their level of physical activity and occupational workload without an added risk of developing arm lymphedema. On the other hand a higher body mass index before and after operation increases the risk.

INTRODUCTION

Although an increasing number of patients are surviving long-term after surgery and often radiotherapy for management of breast cancer, some women develop post-treatment arm lymphedema. The incidence of this complication in Scandinavia varies widely from 0-60% (1-5) depending on mode of therapy and how edema is defined. The risk of developing lymphedema, however, persists regardless of the time after operative treatment (6). Without treatment of the arm, swelling gradually worsens with time (7).

Most studies on lymphedema concentrate on its management, emphasizing the use of compression garments, bandaging, pumps, massage and exercise (8-12), rather than on its prevention.

In Sweden, preoperative information is usually given to the patient with breast cancer including recommendations how to minimize the later development of arm lymphedema (13). The recommendations are often based on empiricism, only in part on scientific evidence, e.g. elevating the arm (14) and propelling lymph flow by skeletal muscle contractions (15). As these recommendations have broad ramifications on the activities of daily living, they should be well grounded. There may also be other predisposing factors in lymphedema development not as yet included in the recommendations. Accordingly, we examined potential factors including specific form of breast cancer treatment, patient occupation and lifestyle associated with the development of arm lymphedema after breast cancer therapy.

SUBJECTS

The study included 103 women treated for breast cancer who developed arm lymphedema but without recurrence of the malignancy. The onset of edema had to be at least 3 months or more after operation, was noted in the medical record between January 1997 and June 1998 and persisted for at least six months. Patients were identified through physiotherapists's registry of lymphedema patients in 11 hospitals in the South Sweden Health Care Region. Permission from each patient was obtained through these physiotherapists. Two control patient groups treated for breast cancer (but without arm lymphedema) were identified for each subject through the Regional Tumor Registry. The determining factors for matching were in the following order: axillary node status (positive or negative for metastasis), time after axillary surgery (within a two month interval) and age (as close as possible) (Table 1). Only one control

group was used and was identified following the determining factors in the same order. To exclude women with unrecognized arm lymphedema in the control group, each woman was asked to provide information about arm swelling when returning the questionnaire. Sociodemographic data for the two groups are shown in Table 2.

The study was approved by the Research Ethics Committee, Lund University, 1998.

Table 1. Treatment related factors for breast cancer patients with arm lymphedema and without (controls).

	Lymphedema n=71	Controls n=71	p-value
Age (mean±SD) years	58.2±10.5	58.1±9.4	n.s.
Surgery			
Time from operation (mean±SD) months	33.0±16.7	33.1±16.8	n.s.
Site, right/left, number	33/38	30/41	n.s.
Side, dominant/nondominant/ambidextrous, number	36/34/1	40/28/3	n.s.
Type, partial/mastectomy, number	29/42	36/35	n.s.
Tumor size (mean±SD) ml	22.5±16.1	20.3±13.1	n.s.
Axillary nodes (mean±SD), number dissected	13.0±5.1	12.0±4.7	n.s
number with metastasis	2.2±3.4	2.8±4.3	n.s
Seroma			
In drain,[a] (mean±SD)ml,	233.0±284.4	247.0±263.6	n.s
time, (mean±SD)days	2.9±1.8	3.2±2.8	n.s
By punction, number of patients	28	21	n.s.
(mean±SD)ml	250.1±742.0	134.5±357.6	n.s.
number of suctions(mean±SD)	0.9±1.5	0.6±1.2	n.s.
time, (mean±SD)days first to last punction	7.6±15.4	4.2±9.5	n.s.
Adjuvant treatment			
Radiotherapy,			
breast and axilla, number	40	40	n.s.
breast only, number	19	24	n.s. p=0.06
no radiotherapy, number	12	7	n.s. p=0.06
Chemotherapy, number	22	27	n.s.
Tamoxifen, number	28	20	n.s.
Edema preventive information, number	45	36	n.s.

[a] 64 pairs with complete data.

METHODS

Data was collected from the medical records and from a questionnaire. The questionnaire was mailed to clinical subjects and controls in February 1999 with a single reminder. Questions were asked in relation to the time period before operation (1 year) for all individuals. The time period after surgical treatment was related to “since surgery” for the control group and “from surgery until onset of arm lymphedema” for the edema group.

In a pilot study, the questionnaire was tested for relevance of questions in 15 breast cancer treated women with arm lymphedema. The women were asked to complete the questionnaire and report if any question was unclear or not relevant. Results revealed data making it possible to change opened questions into closed ones within the fields housework, exercise, and hobbies.

Sociodemographic data

Living conditions were reported in the questionnaire including marital status and number and age of children living in the household. Formal education was classified as low if the woman had received only nine or less years basic education, and high if she had studied in university or a comparable institution. Sick leave (months) following the breast cancer treatment was reported by the women as full- time or part-time. Part-time sick leave was converted into full-time before final analysis.

Treatment related factors

The following information concerning treatment related factors was collected: type of operation and site, tumor size, number of excised lymph nodes and metastases in the axilla, postoperative seroma drainage and its evacuation by punctures, wound infection; history of vessel string (phlebitis) (5) and cellulitis (erysipelas). Radiotherapy to the axilla was also codified. Other adjuvant pharmacological treatments registered included anti-estrogen drugs (Tamoxifen) or cytotoxic chemotherapy.

Factors related to occupational workload

Women working outside their homes were asked to state their occupations and describe the occupational workload in terms of flexible/sedentary, monotonous/varied, heavy/easy, extra aids etc. In 5 subjects, the answers had to be compiled by a telephone interview.

Physiotherapeutic assessment

One of the team (KO), a physiotherapist with experience within the ergonomic field, classified workload of the different occupations represented, according to a previous model (16). Five items were assessed concerning the upper extremity, namely: 1) lifting (practical nurse, child minder); 2) repetitive and/or static work (telephone operator, factory worker); 3) awkward working posture with respect to the neck and shoulder (medical secretary, hairdresser); 4) heavy work with hands and/or forearms (shop assistant, cleaner); 5) exposure to hand vibrations (bus driver, farmer). Each item was rated on a four point scale (0-3), with 3 as maximum exposure. Examples of occupations given the rating 2 are given above within parentheses. The classification was performed blindly, that is, without knowledge of the subject's life-style.

Intra-reliability test for each of the 5 items was performed in 20 subjects randomly selected from the main 38 pairs. This test was performed two months after the first assessments were made in order to assure that no details from the first assessment might be remembered. The test showed good correlation (Spearman's rs =0.919, $p<0.001$).

Self- assessment

Women were asked to self-assess their occupational workload. The following five weight categories were employed to assess lifting: "less than 1 kg", "1-5 kg", "6-20 kg", "20-50 kg" and "> 50 kg". Further questions were asked regarding sudden unexpected loads (1 question), repetitive or static work (3 questions), and hand vibrations (1 question). A four-part scale with the levels never/rarely, sometimes, rather frequently and frequently was used. The questions were an excerpt from The Scandinavian Occupational Classification (17).

Life-style related factors

Body weight, smoking and psychological stress

Information was collected regarding height and preoperative body weight at time of surgical treatment, from the medical record, and from the questionnaires. Body mass index (BMI) was calculated. A smoking history was catalogued including the number of cigarettes used daily. The following question concerning stressful events was posed: "The initial cancer treatment might cause a high level of psychological distress. Have there been any circumstances after the operation also causing deep distress e.g. death of a close relative or friend, divorce, unemployment, economic problems or similar situations?

Housework
Women were asked to what extent they took responsibility for housework in the period before and after surgery. The alternatives were: not at all, 25%, 50%, 75% or all.

Exercise
Women were asked how many times a week they regularly exercised such as by walking, cycling, physical training and other activities (open question) for more than 30 minutes each time period before and after surgery.

Hobbies
Women were queried if they did easy (e.g., weeding), medium or heavy work (e.g., digging) in the garden, and what kind of needlework or other hobbies (open question) they practiced regularly, both before and after surgery.

Factors influencing arm lymphedema

The women with arm lymphedema (n=71) were asked where the upper extremity was actually swollen at the time of the study. The choices given were hand, forearm, upper arm, and chest wall. They were also asked if they had noticed any improvement or worsening of arm edema with housework, exercise or hobbies.

STATISTICS

Data from matched subjects were compared by McNemar´s test for binary data, by the sign test for ordinal data, and by the paired t-test for continuous data (18). When response data was missing for some patients with lympedema or without lymphedema (controls), only pairs with complete information were included in the statistical testing procedure.

RESULTS

Subjects

Two women initially placed in the control group reported having arm lymphedema and were excluded. The response rate was 78% for the entire group of subjects and 80% for matched pairs (n pairs=71). In 38 of the matched pairs both women were working at least half-time. One control and 3 women in the lymphedema group had decreased their work to half-time after surgery. Other sociodemographic data are shown in Table 2. Data in medical record was incomplete for body weight at time of operation for 5 subjects and for an indwelling drain for seroma for 7 records. Seventeen women did not recall if they had a vessel string (sign of phlebitis).

Table 2. Sociodemographic data for breast cancer patients with arm lymphedema and without (controls).

	Lymphedema n=71	Controls n=71	p-value
Civil status (living alone/together)	13/58	12/59	n.s.
Number of children < 14 years (none/at least one)	59/12	63/8	n.s.
Education level (low/medium/high)	24/28/19	31/24/16	n.s.
Sick leave after surgery			
number of patients (sick leave less than 2 weeks/ sick leave more than 2 weeks/retired)	1/50/20	4/46/21	n.s.
months (mean±SD)a	6.0±5.3	5.0±9.3	n.s.

[a] Lymphedema group n=51, controls n=50

Treatment related factors

There were no significant differences in the breast cancer treatment between the groups concerning type of surgery or adjuvant therapy (Table 2). However, there was a trend toward a higher number of women treated with radiotherapy to the breast only in the non-edematous (control) group (p=0.06) and also a trend toward higher number of women who did not receive radiotherapy in the lymphedema group (p=0.06) (Table 1).

There were no significant differences between the two groups concerning a vessel string (i.e., phlebitis) wound infection (Table 3), or seroma formation,

treated by an indwelling drain or by suction (Table 1). More women in the lymphedema group had a history of erysipelas compared to the control group (Table 3) but the difference was not statistically significant.

Table 3. Frequencies of postoperative wound infection, erysipelas and vessel string in matched pairs of breast cancer patients with arm lymphedema or without (controls).

	Wound infection n=71			Erysipelas n=71				Vessel string n=54			
	Lymphedema			Lymphedema				Lymphedema			
		+	-			+	-			+	-
Controls	+	0	2	2	+	0	1	1	+	22	12	34
	-	2	67	69	-	5	65	70	-	14	6	20
		2	69	71		5	66	71		36	18	54

Factors related to occupational workload

Physiotherapeutic assessment of occupational workload

Three control patients and 4 women in the lymphedema group had decreased their occupational workload after surgery. Comparisons were made between the edema group and the control group for each item of workload except for item 5, namely, exposure to hand vibrations, as this exposure was extremely rare in both groups (n=3 and n=1, respectively). The analyses showed no significant differences between the groups in each queried workload item. Frequencies are shown in Table 4A.

Self- assessment of occupational workload

Comparisons were made between the edema group and the control group for each weight category and workload conditions. The analyses showed no significant differences between the groups in any item. Frequencies are shown in Table 4B and 4C.

Table 4A. Numbers of matched pairs (n=38) of breast cancer patients with arm lymphedema and without (controls) in different kinds of work-load conditions (for details, see text) rated by a physiotherapist on a 0-3 scale.

	Heavy lifting				Repetitive/static				Neck/shoulder				Hand/forearm				Vibrations			
	-	+	++	+++	-	+	++	+++	-	+	++	+++	-	+	++	+++	-	+	++	+++
Lymphedema	24	5	9	0	22	8	8	0	15	14	9	0	23	9	6	0	37	0	1	0
Controls	26	4	8	0	21	6	11	0	16	10	12	0	24	10	4	0	35	1	2	0

- = never/rarely, + = sometimes, ++ = rather frequently, +++ = frequently

Table 4B. Numbers of matched pairs (n=38) of breast cancer patients with arm lymphedema and without (controls) rating workload (for details, see text).

	Less than 1 kg				1-5 kg				6-20 kg				20-50 kg				> 50 kg			
	-	+	++	+++	-	+	++	+++	-	+	++	+++	-	+	++	+++	-	+	++	+++
Lymphedema	7	5	7	19	4	14	12	8	16	13	7	2	32	4	1	1	34	3	0	1
Controls	10	3	7	18	10	6	11	11	17	11	5	5	31	5	1	1	34	2	1	1

- = never/rarely, + = sometimes, ++ = rather frequently, +++ = frequently

Table 4C. Numbers of matched pairs (n=38) of breast cancer patients with arm lymphedema and without (controls) rating in different kinds of workload conditions (for details, see text).

	Unexpected load				Lifted arms position				Repetitive movements				Static, exact work				Vibrations			
	-	+	++	+++	-	+	++	+++	-	+	++	+++	-	+	++	+++	-	+	++	+++
Lymphedema	32	5	1	0	6	12	11	9	11	9	7	11	26	9	0	3	34	3	0	1
Controls	30	7	0	1	9	12	8	9	10	12	8	8	30	4	2	2	34	2	1	1

- = never/rarely, + = sometimes, ++ = rather frequently, +++ = frequently

Life-style related factors

Body weight, smoking and psychological stress

BMI was higher in the lymphedema group than in the control group both at time of surgery and at time of study (Table 5). No significant difference was found in weight gain during this period. There were no significant differences between the groups concerning smoking habits or stressful events (Table 5). The most frequent examples of such events given by the women were severe illness or death of close relatives or friends (n=21) and worry about or crises with husband, children or parents (n=13).

Table 5. Life-style related factors for breast cancer patients with arm lymphedema and without (controls).

	Lymphedema n=71	Controls n=71	p-value
BMI at time for surgery, (mean±SD)[a]	26.4±4.0	25.0±4.3	p=0.04
BMI at time for study, (mean±SD)	26.6±3.8	25.0±4.5	p=0.03
BMI increase,(mean±SD)[a]	0.3±1.8	0.3±1.9	n.s.
BMI ≥30, at time for surgery[a], number at time for study,	11 15	8 9	n.s. n.s.
Smoking, number of patients (none/1-5 cig/5-20cig/>20cig/day)	59/3/8/1	58/2/9/2	n.s.
Stressful events, number of patients (no/yes)	44/27	50/21	n.s.

[a] 66 pairs with complete data

Housework

Both groups significantly ($p<0.001$) reduced their responsibility for housework before surgery compared to after surgery. There were no significant differences between the groups either before surgery or after surgery (Table 6).

Table 6. Part of responsibility for housework (number of patients) for breast cancer patients with arm lymphedema and without (controls).

	Not at all	25%	50%	75%	all	p-value
Lymphedema, before/after surgery	0 / 0	2 / 4	9 / 16	15 /19	45 / 32	p<0.001
Controls, before/after surgery	0 / 0	0 / 6	7 /12	26 / 22	38 / 31	p<0.001

Exercise

Except for walking, cycling and physical training that was specially asked about, the patients mentioned other physical activities such as jogging, swimming, pool aerobics, tennis, badminton, table tennis, golf, boule, bowling, body building, work-outs, dancing, and riding. The number of activities per week for each patient was totaled. There was no significant difference in number of physical activities between the two groups before and after surgery, although the patients with arm lymphedema reduced the number of exercise activities after surgery ($p<0.001$) (Table 7). Even when walking and cycling (regarded as "no arm activities") was excluded, the outcome was the same ($p=0.017$).

Table 7. Number of physical activities per week, median (range), for breast cancer patients with arm lymphedema and without (controls).

		Before surgery	After surgery	p-value
Lymphedema	n=71	4 (0-15)	2 (0-14)	<0.001
Controls	n=71	4 (0-22)	4 (0-24)	n.s

Hobbies

The data collected was binary (yes/no). As to the gardeners there was no significant difference between the groups in any of the categories (easy, medium or heavy) before or after surgery. The edema group reduced their medium and heavy garden work ($p=0.003$ and $p<0.001$ respectively) after surgery compared with beforehand (Table 8). The kind of needlework mentioned by the women were embroidery, sewing, knitting, crocheting and weaving. There was no significant difference between the groups in number of women performing needlework before and after surgery. After surgery the number was reduced in the edema group ($p<0.001$)(Table 8).

Table 8. Numbers of breast cancer patients with arm lymphedema and without (controls) with different kinds of hobbies before (b) and after (a) surgery.

		Gardening easy		medium		heavy		Needle work		Other hobbies	
		b	a	b	a	b	a	b	a	b	a
Lymphedema	n=71	27	31	31	17**	19	4***	27	16***	18	12
Controls	n=71	31	34	26	20	10	7	31	27	12	14

**: p=0.003, *** : p<0.001.

Factors influencing arm lymphedema

Twenty-two of the women with arm lymphedema that still were working (n=38) considered that their occupation worsened the edema. Most frequently mentioned activities was working at computer or word processor (n=8) and heavy lifting (n=7).

Thirty-five of the patients in the lymphedema group considered housework to aggravate the arm edema. The five activities most often cited were window cleaning (n=14), vacuum cleaning (n=10), floor wiping (n=7), carrying (n=7) and ironing (n=7).

Fourteen of the patients with arm lymphedema considered exercise to have negative impact on the arm edema, whereas 10 thought it helped. Examples of negative impact were walking or cycling with the arm hanging (n=8), heavy exercises, work-outs, bodybuilding, riding, golf, boule and cross-country skiing. A positive influence was found in light exercises/Qigong (n=8) and pool aerobics/swimming (n=3).

Eighteen patients with arm lymphedema thought hobby activities exerted a negative influence on the edema and one found a positive influence. The most frequent negative examples cited by were gardening (n=13) and sewing/ embroidery (n=6). Weaving was considered beneficial.

DISCUSSION

Professionals often advice women treated for breast cancer to rest the arm and “be careful” to avoid arm lymphedema (19-21). Such advice promotes the idea that inactivity is beneficial. In the present study, we found no support for this admonition. Rather, an unchanged level of physical activity after treatment seems preferable.

Another suggestion to minimize arm edema is to avoid heavy lifting. This advice makes some women hesitate in return to heavy work such as that in the health care sector. To our knowledge, there has been no previous attempt to determine if there are any differences in work load during occupational work or spare time activities for women who develop arm lymphedema after treatment of breast cancer. Most questionnaires do not take these issues into consideration. Because in our clinical experience such questions were included using parts of a tested questionnaire (17) created primarily to assess loading on musculoskeletal structures, they were considered relevant to this study. In this regard there was no statistical difference objectively (Table 4A) or subjectively (Table

4B, 4C) between those women with or without arm lymphedema after treatment for breast cancer.

The women with arm lymphedema restricted exercise and hobby activities after operation (Table 7, 8). This finding may relate to greater pain (22), depression (23), or professional advice. Nonetheless, the fact remains that they have been less physically active after operation but this inactivity was not advantageous in preventing the onset of lymphedema. It seems that more directed help (e.g. follow-up programs and personal advisce) to continue physical activity level unchanged may be the wisest course. As for increased physical activity, Harris et al. (24) examined 20 breast cancer treated women taking part in an upper-extremity strengthening and aerobic condition program to prepare and carry through Dragon Boat racing. At the end of the racing season (7-8 months), no women showed significant difference in circumference between the operated and non-operated arm. This finding suggests that even vigorous physical activity is unlikely to promote arm lymphedema. In the present study, we did not examine the risk associated with various exercise and hobby program but such studies need to be prospectivly examined as physical activity affects the production, metabolism, and excretion of the “female” hormones which may be linked to a lower risk of breast cancer in active women (25, 26). Exercise may also contribute to recovery from the impact of breast cancer treatment by resetting the symphathetic tone of the lymphatic vessels (27), activating lymphangions and propelling lymph flow by skeletal muscle contraction (15), improving range of motion (28) and stimulating the immune system (29).

Previous studies have suggested that obesity contributes to arm lymphedema after treatment of breast cancer (2, 30, 31). This conclusion is supported by our findings showing BMI to be higher in the women who developed arm lymphedema (Table 5). We also found, however, that the BMI of those who developed arm lymphedema was already higher at time of surgery or at the time the arm was without edema. Thus, it seems appropriate to instruct women who are obese to lose weight including the already determined safety of maintaining or even increasing physical activity. Because weight gain was similar in the control group and in the lymphedema group, the contribution of arm edema as opposed to the influence of increased body weight in development and progression of arm lymphedema seems negligible.

For actual treatment related factors to the development of arm lymphedema, there was no difference between the groups as to the specific regional treatment performed (Table 1) as found in previous studies (32, 33). Soft tissue infections were more common in the lymphedema group (Table 3) but not statistical significant, with a very small number of subjects. Segerström et al (2) noted the

development of soft tissue infections in the arm as a contributer to the development of arm lymphedema.

In retrospective questionnaire, accuracy of data collection depends on human factors, such as memory and perception, that are inherently subject to distortion (34). Aseltine et al. (35), for example, examined the recallection among patients treated for benign prostatic hyperplasia. Whereas they found that retrospective changes in how patients felt showed good agreement with prospective symptomatic assessment, they also showed that a patient's retrospective reports of change in overall health were more favorable than objectively benefit before and after treatment. Litwin et al. (36) also showed that men treated for prostate cancer tended to remember their baseline health-related quality-of-life before surgery as being better than it actually was. Other studies suggest that for recall of sociodemographic data (37), the bias may not have as great an impact and may stabilaze over time (38). Our study questionnaire was more related to sociodemografic data, and thus the bias is probably less than if it had been quality-of-life related. Litwin et al. also noted that recall bias decreased with better education but did not vary with age or time after operation. Because there were no differences between the two groups in our study concerning time after operation, age and education, any potential bias was dissipated.

In the matching procedure, two subgroups of patients were defined, one with and the other without axillary radiotherapy. Women receiving radiotherapy to the breast only or no radiotherapy were not divided, because earlier studies have shown no difference in later arm lymphedema in these two subgroups (5). Nonetheless, an increased risk of developing arm lymphedema for patients receiving radiotherapy to the axilla has been well documented (1, 2, 5, 32); accordingly, these women were analyzed separately.

In the matched pairs of patients there was a similar time frame from surgery to study (Table 1), although, during this interval women developed arm lymphedema. Thus, time for exposure to risk factors was longer for the women in the control group (i.e., they did not as yet develop arm edema). The fact that these women did not develop arm lympedema supports the findings that occupational workload and life-style related factors were not significant risk factors for later development of arm lymphedema.

In summary, women with arm lymphedema showed a higher BMI compared with women without arm lymphedema both before and after development of arm swelling making a higher BMI an increased risk for this complication. Thus, it seems reasonable to assume that a higher BMI might increase the risk of developing lymphedema. Despite the fact that women without arm lymphedema displayed a similar level of occupational workload to those of the

lymphedema group shows that work is not itself a contributor to its development. Indeed, the lymphedema group had also decreased their overall level of physical activity after surgery compared with those who did not have arm lymphedema. Thus, the soundest advice for a woman treated for breast cancer by axillary node dissection with or without adjuvant radiotherapy, seems to be to continue with her occupational workload and maintain her level of physical activity after therapy.

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REFERENCES

1. Christensen, SB, E Lundgren. Sequelae of axillary dissection vs axillary sampling with or without irradiation for breast cancer. *Acta Chir Scand* 155 (1989), 515.
2. Segerström, K. Factors that influence the incidence of brachial oedema after treatment of breast cancer. *Scand J Plast Reconstr Surg Hand Surg* 26 (1992), 223.
3. Suneson, B-L, C Lindholm. Clinical incidence of lymphoedema in breast cancer patients in Jönköping County, Sweden. *Eur J Cancer Care* 5 (1996), 7
4. Höjris, I, J Andersen, M Overgaard et al. Late treatment-related morbidity in breast cancer patients randomized to postmastectomy radiotherapy and systemic treatment versus systemic treatment alone. *Acta Oncologica* 39 (2000), 355.
5. Johansson, K, C Ingvar, M Albertsson et al. Arm lymphoedema, shoulder mobility and muscle strength after breast cancer treatment. A prospective 2 years study. *Advances in Physiotherapy* 3 (2001), 55.
6. Brennan, MJ, RW DePompolo, FH Garden. Focused Review: Postmastectomy lymphedema. *Arch Phys Med Rehabil* 77 (1996), s74.
7. Casley-Smith, JR. Alterations of untreated lymphoedema and its grades over time. *Lymphology* 28 (1995), 174.
8. Ko, DS, R Lerner, G Klose et al. Effective treatment of lymphedema of the extremities. *Arch Surg* 133 (1998), 452.
9. Boris, M, S Weindorf, B Lasinski. Persistence of lymphedema reduction after noninvasive complex lymphedema therapy. *Oncology* 11 (1997), 99.

10. Brorson, H, H Svensson. Liposuction combined with controlled compres-sion therapy reduces arm lymphedema more effectively than controlled compression therapy alone. *Plast Reconstr Surg* 102 (1998), 1058.

11. Johansson, K, E Lie, C Ekdahl et al. A randomized study comparing manual lymph drainage with sequential pneumatic compression for treatment of postoperative arm lymphedema. *Lymphology* 31 (1998), 56.

12. Johansson, K, M Albertsson, C Ingvar et al. Effects of compression bandaging with or without manual lymph drainage treatment in patients with postoperative arm lymphedema. *Lymphology* 32 (1999), 103.

13. South Swedish Breast Cancer Group: *Care program for breast cancer. Center of Oncology*, Lund, 1997.

14. Swedborg, I, JR Norrefalk, NB Piller et al. Lymphoedema post-mastectomy: Is elevation alone an effective treatment? *Scand J Rehab Med* 25 (1993), 79.

15. Olszewski, WL, A Engeset. Intrinsic contractility of prenodal lymph vessels and flow in human leg. *Am J Physiol* 239 (1980), 775.

16. Jacobsson, L, F Lindgärde, R Manthorpe et al. Effect of education, occupation and some lifestyle factors on common rheumatic complaints in a Swedish group aged 50-70 years. *Ann Rheum Dis* 51 (1992), 835.

17. Scandinavian Occupational Classification. Arbetsmarknadsstyrelsen, Allmänna förlaget, Stockholm 1978.

18. Altman, DG: *Practical statistics for medical research*. Chapman and Hall London, 1995.

19. Einfeldt, H: *Klinik, Diagnostik und Therapie: Lymphologie fur die Praxis*. Hutzschenreuter, P, H Einfeldt, S Besser. Stuttgart: Hippokrates Verlag 1991, 60.

20. Rinehart-Ayres, ME. Conservative approaches to lymphedema treatment. *Cancer (Suppl)* 83 (1998), 2828.

21. Rockson, SG. Precipitating factors in lymphedema: Myths and realities. *Cancer (Suppl)* 83 (1998), 2814.

22. Tasmuth, T, K von Smitten, E Kalso. Pain and other symptoms during the first year after radical and concervative surgery for breast cancer. *Br J Cancer* 74 (1996), 2024.

23. Tobin, MB, HJ Lacey, L Meyer et al. The psychological morbidity of breast cancerr-related arm swelling. Psychological morbidity of lymphoedema. *Cancer* 72 (1993), 3248.

24. Harris, SR, SL Niesen-Vertommen. Challenging the myth of exercise-induced

lymphedema following breast cancer: A series of case reports. *J Surg Oncol* 74 (2000), 95.

25. Thune, IT, T Brenn, E Lund et al. Physical activity and risk of breast cancer. *N Engl J Med* 336 (1997), 1269.

26. McTiernan, A, JL Stanford, NS Weiss et al. Occurrence of breast cancer in relation to recreational exercise in women 50-64 years. *Epidemiology* 7 (1996), 598.

27. Roddie, IC. Lymph transport mechanisms in peripheral lymphatics. *News in Physiological Sciences* 5 (1990), 85.

28. Wingate, L, I Croghan, MS Natarajan et al. Rehabilitation of the mastectomy patient: A randomized, blind, prospective study. *Arch Phys Med Rehabil* 70 (1989), 21.

29. Pedersen, BK, H Bruunsgaard. How physical exercise influences the establishment of infections. *Sports Med* 19 (1995), 393.

30. Werner, RS, B McCormick, J Petrek et al. Arm edema in conservatively managed breast cancer: Obesity is a major predictive factor. *Radiology* 180 (1991), 177.

31. Bunce, IH, BR Mirolo, JM Hennessy et al. Post-mastectomy lymphoedema treatment and measurement. *Med J Aust* 161 (1994), 125.

32. Kissin, MW, G Querci della Rovere, D Easton et al. Risk of lymphoedema following the treatment of breast cancer. *Br J Surg* 73 (1986), 580.

33. Hoe, AL, D Iven, GT Royle et al. Incidence of arm swelling following axillary clearance for breast cancer. *Br J Surg* 79 (1992), 261.

34. Herrman, D. Reporting current, past and changed health status: What we know about distortion. *Med Care* 33 (1995), AS89.

35. Aseltine, RH, KJ Carlson, FJ Fowler. Comparing prospective and retrospective measures of treatment outcomes. *Med Care* 33 (1995), AS67.

36. Litwin, MS, KA McGuigan. Accuracy of recall in health-related quality-of-life assessment among men treated for prostate cancer. *J Clin Oncol* 17 (1999), 2882.

37. Krieger, N, A Okamoto, JV Selby. Adult female twins´ recall of childhood social class and father's education: A validation study for public health research. *Am J Epidemiol* 147 (1998), 704.

38. Berney, LR, DB Blane. Collecting retrospective data: Accuracy of recall after 50 years judged against historical records. *Soc Sci Med* 45 (1997), 1519.

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A RANDOMIZED STUDY COMPARING MANUAL LYMPH DRAINAGE WITH SEQUENTIAL PNEUMATIC COMPRESSION FOR TREATMENT OF POSTOPERATIVE ARM LYMPHEDEMA

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ABSTRACT

We compared manual lymph drainage (MLD) with sequential pneumatic compression (SPC) for treatment of unilateral arm lymphedema in 28 women previously treated for breast cancer. After 2 weeks of therapy with a standard compression sleeve (Part I) with maintenance of a steady arm volume, each patient was randomly assigned to either one of two treatment regimens (Part II). MLD was performed according to the Vodder technique for 45 min/day and SPC was performed with a pressure of 40-60 mmHg for 2 hours/day. Both treatments were carried out for 2 weeks. Arm volume was measured by water displacement. Arm mobility, strength, and subjective assessments were also determined.

Lymphedema was reduced by 49 ml (7% reduction) ($p=0.01$) in the total group during Part I. During Part II, the MLD group decreased by 75 ml (15% reduction) ($p<0.001$) and the SPC group by 28 ml (7% reduction) ($p=0.03$). The total group reported a decrease of tension ($p=0.004$) and heaviness ($p=0.01$) during Part I. During Part II, only the MLD group reported a further decrease of tension ($p=0.01$) and heaviness ($p=0.008$).

MLD and SPC each significantly decreased arm volume but no significant difference was detected between the two treatment methods.

Postoperative arm lymphedema is a common complication of breast cancer treatment. The incidence during the last 10 years varies widely from 0 to 60% in Europe (1-8) depending on treatment and the method for measuring and defining lymphedema. Axillary dissection (1,2,4,8,9) and irradiation (1,3,4,8) are known as key predisposing factors. The volume of arm lymphedema correlates with subjective sensations such as tension and heaviness (10). The swollen arm is cosmetically unappealing and it often is difficult to find suitable clothes, disabilities that contribute to emotional distress (11).

Arm lymphedema is difficult to manage and often requires life-long physiotherapy as treatment (12). Without treatment, lymphedema tends to worsen and with fibrosis becomes intractable (12). In rare instances, a highly malignant lymphangiosarcoma is associated with longstanding lymphedema (13).

Various methods for treatment have been proposed. In most western countries, nonoperative treatment with manual lymph drainage (MLD) (12,14-16) or sequential pneumatic compression (SPC) (14,17,18) is used either separately or together and commonly combined with bandaging or a compression sleeve. Arm volume reducing effect of MLD when combined with bandaging is reported to be 20% (16), and for MLD in conjunction with an elastic sleeve or benzopyrone administration is reported as

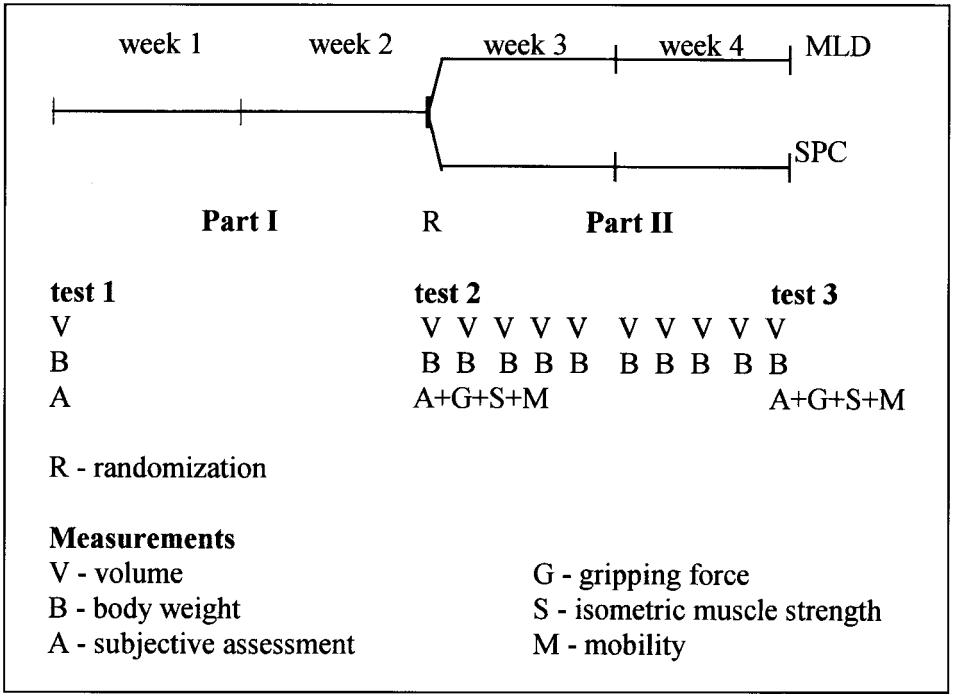

Fig. 1. Study Design: For the first 2 weeks, only a standard compression sleeve garment was used. Thereafter the patients were randomized to either manual lymph drainage (MLD) or sequential pneumatic compression (SPC).

25% (14). SPC also reduces arm volume by 5-45% depending on the pressure applied and the treatment time (14,17-19). The use of a standard elastic sleeve alone is reported to give a volume reduction of 25% (20). However, the volume reducing effect of MLD and SPC individually and compared to each other without adjuvant compression or drug treatment has not been examined.

Accordingly, we determined the effects of treatment with MLD and SPC individually and by comparison with each other regarding changes in arm volume, shoulder mobility, isometric muscle strength and subjective assessment of arm function including feelings of heaviness, tension, pain, and paresthesia of the lymphedematous arm in women after treatment for breast cancer.

Clinical Population

In this prospective study, 28 consecutive women with unilateral arm lymphedema after a breast cancer operation with axillary nodal dissection was studied over a 2.5 year period. Each patient had been operated upon in the Department of Surgery, University Hospital, Lund, Sweden. In Lund, the incidence of lymphedema, with or without radiotherapy, is 13% two years after the operation for treatment of breast cancer (unpublished observations 1991). No patient had arm edema before breast cancer treatment. Lymphedema was defined as >10% difference in volume between the abnormal and normal (contralateral) arm (21) as measured by volumetry (22).

TABLE 1
Demographics of 24 Women Undergoing Either Manual Lymph Drainage (MLD) or Sequential Pneumatic Compression (SPC) for Unilateral Arm Lymphedema

	MLD (n-12)	SPC (n=12)
	median (q^1-q^3)	median (q^1-q^3)
Age & years)	64.0 (52.5-69.5)	57.5 (47.5-69.5)
Duration of edema after op (months)	9.0 (6.0-45.8)	10.5 (4.8-29.3)
Duration of edema (months)	14.0 (3.0-76.5)	6.5 (2.3-68.3)
	number	number
Right/Left arm lymphedema	6/6	7/5
Dominant arm lymphedema	5	7
Partial mastectomy/mastectomy	1/11	2/10
Radiotherapy	10	8

The study design *(Fig. 1)* included two weeks of treatment with a hand/wrist-to-shoulder compression sleeve of standard type (Rehband Anatomiska AB, Sollentuna, Sweden) for all 28 patients (Part I) to maintain a steady volume level of arm edema before instituting the treatment regimen. The time was chosen according to the results of a previous study (23) of four weeks of treatment including massage, isometric exercises, and wearing of an elastic sleeve. The earlier results showed that the greatest edema volume reduction was during the first week, whereas over the course of the next three weeks, the therapeutic benefit decreased sharply. Any patients who after Part I did not fulfill the criteria of lymphedema (21) were excluded from Part II. After written and oral consent, the patients were randomly allocated to either MLD or SPC therapy for two weeks (Part II). Before and six months after the study period, the patients had a clinical examination including X-ray of the lungs and mammography. The study was approved by the Lund University research ethics committee.

Exclusion criteria included previous contralateral breast disease or intercurrent disease affecting the swollen arm, difficulties in participating in the study such as dementia, and complete resolution of arm edema after compression sleeve treatment in Part I. One patient was excluded because of resolution after compression during Part I. Two patients in each group were dropped during Part II; two because of recurrent breast cancer, and one because of erysipelas during the period of treatment and one who was unable to participate in repeated measuring. Demographics of the remaining 24 women are shown in *Table 1*. There were no differences between the two groups.

Physiotherapeutic Treatment

MLD or SPC treatment was administered for two weeks, 5 days a week, at approximately the same time of the day. The time chosen was based on the results of an earlier study (23) of four weeks of treatment, where the greatest edema volume reduction was

recorded during the first week of therapy. MLD was carried out according to the massage technique of Vodder (24). In theory, MLD massage mechanically stretches underlying epifascial lymph collectors (25), promotes greater frequency of lymphangion contractions (26) and increases pressure in the lymph collectors (27), thereby improving the lymph transport capacity (28). Massage is applied with low pressure in a proximal direction, starting at the trunk bordering the edematous area, slowly moving more distally and ending with the hand. MLD was performed for 45 min/day by one physiotherapist specially trained in this technique. Treatment with SPC was provided using Lympha-Press employing 9 compression cells (Liljenberg Medical AB, Malmö, Sweden). According to standard practice, a pressure of 40-60 mmHg was applied for 2 hours/day. Each patient was instructed to wear the compression sleeve during the daytime in order to maintain a similar compression level during both Part I and Part II phases of the study.

Measurements and Assessments

The study design is outlined in *Fig. 1.* Objective measurements and subjective assessments were uniformly performed before the daily treatments in Part II.

Volume of the arm: The affected and unaffected arm were each submerged in a container with water and the volume displacement was measured in ml. The method has been described by Kettle (22), who found a standard deviation of 1.5% from the mean volume. The unaffected arm was used as a control. The change in lymphedema volume was obtained by comparing the difference in volume between the affected and unaffected arm and the change expressed both in ml and as percent reduction in lymphedema for purposes of comparison with other studies. Thus,

$$\% \text{ edema reduction} = \frac{\text{diff test 2 - diff test 3}}{\text{diff test 2}} \times 100$$

where diff = volume of affected arm – volume of unaffected arm.

Body weight was also recorded.

Passive mobility: In a supine position, flexion of the elbow and flexion, abduction and in- and outward rotation of the shoulder at both sides was measured with a goniometer. The mobility was expressed in degrees (29). We estimate the test-retest error at ~5 degrees.

Isometric muscle strength: In a supine position, the flexors, abductors, and adductors of the shoulder on the affected side were measured in kp with a dynamometer. The device was placed at the wrist with the arm straight in 90° flexion of the shoulder, and a breaking force technique was employed. The method is highly reliable with significant correlations ($p<0.01$) for repeated measurements (30). The gripping force of the hand on the affected side was measured with a Jamar-dynamometer with the patient in a sitting position, and the arm held close to the body with a 90° flexion of the elbow. The highest value of three was registered for each test.

Subjective assessment: The function, heaviness, tension, pain and paresthesia of the affected arm were each scored by the patient on a 100 mm horizontal visual analogue scale (VAS) anchored by "worst imaginable" (0 mm) and "no discomfort" (100 mm). Each patient was asked to consider the subjective sensations during the week before each scoring (tests 1, 2 and 3). The initial scores from test 2 were made available to the patient on the third occasion (31).

Statistics

Student's t-tests for paired samples was performed to calculate differences within the group during Part I and within the groups MLD and SPC in Part II. t-tests for independent samples were performed to calculate differences between the two groups (MLD and SPC).

A check with Wilcoxon signed rank tests and Wilcoxon rank sum tests for paired and

TABLE 2
Arm Volumes in mL (Mean ± SD) Before and After Treatment (see Fig. 1 for time intervals of test 1-3)

	MLD (n=12)	SPC (n=12)
test 1	3025±328	2708±458
test 2	2960±335	2740±433
test 3	2866±322	2683±420

MLD = manual lymph drainage
SPC = sequential pneumatic compression

TABLE 3
Lymphedema Volume (ml) (Affected Minus Unaffected Arm) (Mean ± SD) Before and After Treatment

	MLD (n=12)	SPC (n=12)
test 1	657±308	431±201
test 2	579±258	411±203
test 3	504±252	382±193

MLD = manual lymph drainage
SPC = sequential pneumatic compression

independent samples respectively was performed. A $p<0.05$ level was taken as significant.

RESULTS

Volume of the Arm

In the total group (n=24), the mean value ± SD of the volume of the arm was 2850±81 ml on the affected side and 2355±79 ml on the unaffected side in test 1. The difference was significant ($p<0.001$). The mean lymphedema arm volumes on the different test occasions for the MLD group and the SPC group are shown in *Table 2*. During Part I when each patient was wearing a compression sleeve, a significant reduction of 49±87 ml ($p=0.01$) for the total group and a % reduction of 7±18 ($p=0.05$) were seen from test 1 to test 2. There were no significant volume differences between the two groups in test 2 at the start of Part II ($p=0.09$) (*Table 3*). During Part II, there was a reduction in lymphedema volume from test 2 to test 3 in both the MLD group (mean=75 ml, $p<0.001$) and the SPC group (mean=28 ml, $p=0.03$). The % reduction in lymphedema was 15% in the MLD group ($p<0.001$) and 7% in the SPC group (n.s.). No significant difference between the two treatments was found either in ml ($p=0.11$) or in % reduction ($p=0.36$).

Body Weight

The mean ± SD of the body weight in test 1 was 72±11 kg for the total group and did not change significantly during the study.

Shoulder Mobility

In test 2, there was reduced arm mobility compared to the unaffected contralateral arm in the total group *(Table 4)*. Treatment with MLD or SPC did not change arm mobility from test 2 to test 3.

Isometric Muscle Strength

Mean ± SD for the total group in test 2 for shoulder flexion on the affected side was 7.5±1.8 kg, for abduction 7.0±1.7 kp, for adduction 5.8±1.6 kp and for gripping force 36.7±13.2 kp/cm^2. No significant changes over time were seen for any of these in the two groups in test 3.

Subjective Assessment

During Part I, a significant decrease of

TABLE 4
Arm Mobility (in degrees) of the Edematous (Affected) and Non-edematous (Unaffected) Arm in All Women (n=24) at Test 2

Joint mobility (°)	Unaffected mean±SD	Affected mean±SD	Diff ($\bar{x}$) 95% CI	p-value
Elbow				
flexion	147±6	144±4	2 (-0.3 - 5)	=0.08
Shoulder				
flexion	164±12	149±18	15 (10 - 20)	<0.001
abduction	151±27	122±37	30 (19 - 41)	<0.001
inward rotation	70±17	58±15	12 (4 - 19)	=0.006
outward rotation	83±16	71±22	11 (2 - 21)	=0.02

feeling of tension (p=0.004) and heaviness (p=0.01) in the arm was found in the total group. In Part II, only the MLD group showed a further decrease of tension (p=0.01) and heaviness (p=0.008). In a separate analysis, the data were stratified to exclude patients who had scored 100 (no discomfort) on the scales in test 2. The results revealed the significance to be greater but still only for MLD as regards tension and heaviness. There was no significant difference between the two groups in Part II.

DISCUSSION

We compared two nonoperative methods for treatment of arm lymphedema, namely manual lymph drainage and sequential pneumatic compression, and determined changes in arm volume, shoulder mobility, isometric muscle strength as well as subjective assessment of arm function, feeling of heaviness, tension, pain, and paresthesia. Each method was effective in reducing arm volume, but no significant differences between the treatment regimens was seen.

Limb volume measurement is the most common approach to quantify the extent of lymphedema. In this study, we used volumetry by water displacement for objective measurements of changes in arm volumes because it is a simple method with high reliability (22). Yet there is normally a small biological fluctuation of arm volume over a given time period. This variation has been documented in a study by Swedborg et al (19). Over a 2 week period, there was a mean range of variation of 100.5 ml in ten normal women with a mean arm volume of 2058 ml (4.8%). This physiological variation should be taken into account when measuring edema volume as done in this study, as in others (1,5,6,19) by determining the volume difference between the affected and unaffected arms. This calculation is based on the assumption that the arm volume variations are similar bilaterally. In the 24 women studied, the mean ± SD volume variation of the unaffected (non-edematous) arm during Part II was very low (24±44 ml or 1±2%) and there was no significant difference between the two groups. This low variation of the unaffected arm, together with the fact that there was no significant change in body weight, leads us to conclude that the reduction of arm volume in the affected arm after

treatment is truly attributable to a reduction in edema fluid.

Differences in volume between a dominant and non-dominant arm have been shown by Godal et al (33). They noted significant asymmetry of arm volume, with the dominant right arm slightly larger than the left (1.6%). For the ambidextrous or dominant left arm, the right arm was slightly smaller (0.1% and 1.4%, respectively). No correction was made for asymmetry in our patients, as there were no significant differences between the groups in regards to operation on the right or left side or dominant to non-dominant arm.

We measured the shoulder and elbow mobility to determine whether edema reduction increased the range of motion by softening the tissues or altering the joints. Whereas no differences were discernible, perhaps if the volume differences between the affected and the unaffected arm were larger to begin with, a greater functional influence on the affected arm or an effect of treatment may have been seen.

The visual analogue scale (VAS) was used to evaluate subjectively arm function, heaviness, tension, pain, and paresthesia. VAS, to our knowledge, has been typically used to test for pain. Accordingly, the validity of the correlation between edema volume reduction and the assessments determined has not been verified. Nonetheless, a correlation between edema volume reduction and the feeling of tension and heaviness has been demonstrated by Swedborg et al (10) using a Borgscale (34). Our results also suggest a correlation between volume reduction and experience of heaviness and tension but the patient population was too small to substantiate this impression, and this area needs further investigation.

Although there was no significant difference between the two treatment methods (MLD and SPC), there was a tendency favoring MLD as seen in the percent reduction in lymphedema volume. For MLD during Part II, it was 15% but for compression sleeves during Part I and SPC during Part II, it was only 7%. However, the poorer outcome for SPC may be attributable to the time duration of treatment which was only 2 hours/day. Richmand et al (18) found an average reduction of arm lymphedema (n=7) of 30% using SPC for 24 hours with a pressure of 80-130 mmHg (individual tolerance). The theory of longer duration daily treatment is also supported by Zanolla et al (14) who found a volume reduction of 21% after 6 hours with a pressure of 90 mmHg (n=20).

The pressures used in the two previous studies (14,18) were higher than that used in our study. However, SPC treatment under low pressure (35-60 mmHg) has also shown a significant decrease of volume (17) with a daily treatment time of 6 hours in 54 patients. As to why both higher and lower pneumatic pressures each yield similar results may have an explanation in a recent study of manual massage of edema in dogs with a pressure of 70-100 mmHg (35). Higher pressure seems to promote damage to the lymphatics, particularly its endothelial lining, which may be assumed to worsen edema. On the other hand, such pressure loosens the connective tissue, encourages the formation of large tissue channels, and facilitates uptake of lipid droplets into initial lymphatics (35), which may be favorable for patients with lymphedema with a tendency to accumulate fat and fibrous tissue in the interstitium. As the magnitude of the reduction and the dimension of the arm are directly related to the degree of subcutaneous fibrosis (assessed by xeroradiography) (32), the outcome of higher or lower pressure treatment may depend on the severity of fibrosis in the different patient populations. Only clinical examination by palpation was performed on the patients in our study but no marked fibrosis was verified, suggesting that the low pressure that we chose was adequate for edema mobilization in this patient population. We favor that edema be diagnosed and treated at an early stage when fat and collagen deposition is at a minimum and where low pressure application

is preferably irrespective of whether MLD or SPC is chosen for treatment.

There was no difference in arm "tension" and "heaviness" in the MLD compared with the SPC cohort. Like arm volume differences, perhaps more prolonged daily treatment may have also improved the subjective assessments.

In our study, overall lymphedema volume reduction was 15%. Zanolla (14) also tried MLD using the Vodder technique (n=20) and found a reduction of 25%. However, the treatment was used in combination with benzopyrone and compression sleeves, although the compression sleeve was not applied for a period of time before MLD as done in our study. Hutzschenreuter et al (16) found a reduction of 20% using MLD, but in combination with compression bandaging therapy. The 15% volume reduction by MLD together with the 7% reduction by compression sleeve in our study (i.e., 22%) supports the results of the two previous studies (vide supra).

Hutzschenreuter et al (16), using low stretch bandages, confirms our clinical impression that bandaging provides better remodeling of arm volume and shape after each MLD or SPC treatment session, compared with that of a standard elastic sleeve alone.

In summary, we determined that manual lymph drainage or sequential pneumatic compression, when applied in conjunction with a compression sleeve, each resulted in a notable reduction of arm lymphedema in women previously treated for breast cancer. Manual lymph drainage showed a decrease of subjective sensation of tension and heaviness in the affected arm, but overall this limited study showed no notable difference between the two treatment regimens.

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REFERENCES

1. Kissin, MW, G Querci della Rovere, D Easton, et al: Risk of lymphoedema following the treatment of breast cancer. Br. J. Surg. 73 (1986), 580.
2. Pezner, RD, MP Patterson, LR Hill, et al: Arm lymphedema in patients treated conservatively for breast cancer: Relationship to patient age and axillary node dissection technique. Int. J. Radiat. Oncol. Biol. Phys. 12 (1986), 2079.
3. Ryttov, N, NV Holm, N Qvist, et al: Influence of adjuvant irradiation therapy on development of late arm lymphedema and impaired shoulder mobility after mastectomy for carcinoma of the breast. Acta. Oncol. 27 (1988), 667.
4. Christensen, SB, E Lundgren: Sequelae of axillary dissection vs. sampling with or without irradiation for breast cancer. Acta. Chir. Scand. 155 (1989), 515.
5. Segerström, K: The swollen arm. A study of patients treated for breast cancer. Umeå University Medical Dissertations, Sweden. New Series 325 (1991).
6. Hoe, AL, D Even, GT Royle, et al: Incidence of arm swelling following axillary clearance for breast cancer. Br. J. Surg. 79 (1992), 261.
7. Clarysse, A: Lymphoedema following breast cancer treatment. Acta. Clin. Belg. Suppl. 15 (1993), 47.
8. Suneson, BL, C Lindholm, E Hamrin: Clinical incidence of lymphoedema in breast cancer patients in Jönköping county, Sweden. Eur. J. Cancer Care 5 (1996), 7.
9. Larson, D, M Weinstein, I Goldberg, et al: Edema of the arm as a function of the extent of axillary surgery in patients with stage I-II carcinoma of the breast treated with primary radiotherapy. Int. J. Radiat. Oncol. Biol. Phys. 12 (1986), 1575.
10. Swedborg, I, G Borg, M Sarnelid: Somatic sensation and discomfort in the arm of post-mastectomy patients. Scand. J. Rehab. Med. 13 (1981), 23.
11. Passik, S, M Newmann, M Brennan, et al: Psychiatric consultation for women undergoing rehabilitation for upper-extremity lymphedema following breast cancer treatment. J. Pain Sympt. Manage. 8 (1993), 226.
12. Földi, E, M Földi, H Weissleder: Conservative treatment of lymphoedema of the limbs. Angiology 36 (1985), 171.
13. Tomita, K, A Yokogawa, Y Oda, et al: Lymphangiosarcoma in postmastectomy lymphedema (Steward Treves Syndrome):

Ultrastructural and immunohistologic characteristics. J. Surg. Oncol. 38 (1988), 257.
14. Zanolla, R, C Monzeglio, A Baltzarini, et al: Evaluation of the results of three different methods of postmastectomy lymphedema treatment. J. Surg. Oncol. 26 (1984), 210.
15. Clodius, L, M Földi: Secondary lymphedema of the arm. In: Surgery of breast. Strömbäck, JO, FE Rosato (Eds). Stuttgart: Thieme (1986), 225.
16. Hutzschenreuter, PO, H Wittlinger, G Wittlinger, et al: Post-mastectomy arm lymphedema: Treated by manual lymph drainage and compression bandage therapy. Eur. Phys. Med. Reh. 1 (1991), 166.
17. Swedborg, I: Effects of treatment with an elastic sleeve and intermittent pneumatic compression in postmastectomy patients with lymphoedema of the arm. Scand. J. Rehab. Med. 16 (1984), 35.
18. Richmand, DM, TF O'Donell, A Zelikovski: Sequential pneumatic compression for lymphedema. Arch. Surg. 120 (1985), 1116.
19. Swedborg, I: Voluminometric estimation of the degree of lymphoedema and its therapy by pneumatic compression. Scand. J. Rehab. Med. 9 (1977), 131.
20. Bertelli, G, M Venturini, G Forno, et al: An analysis of prognostic factors in response to conservative treatment of postmastectomy lymphedema. Surg. Obstet. Gynecol. 175 (1992), 455.
21. Stillwell, GK: Treatment of postmastectomy lymphoedema. Mod. Treatment 6 (1969), 396.
22. Kettle, JH, FF Rundle, TH Oddie: Measurement of upper limb volumes: A clinical method. Austr. N. Z. Surg. 27 (1958), 263.
23. Swedborg, I: Effectiveness of combined methods of physiotherapy for post-mastectomy lymphoedema. Scand. J. Rehab. Med. 12 (1980), 77.
24. Wittlinger, H, G Wittlinger: Einfürung in die Manuelle Lymphdrainage nach dr Vodder. Haug Verlag, Heidelberg, 1987.
25. Mislin, H: Lymphangion. In: Lymphangiology. Földi, M, JR Casley-Smith (Eds). Schattauer, Stuttgart-New York (1983), 165.
26. Olszewski, WL, A Engeset: Intrinsic contractility of prenodal lymph vessels and lymph flow in human leg. Am. J. Physiol. 239 (1980), 775.
27. Hutzschenreuter, P, H Bruemmer: Influence of complex physical decongesting therapy on positive interstitial pressure and on lymphangiomotor activity. Progress in Lymphology XI (1988), 557.
28. Földi, M: Lymphoedema. In: Lymphangiology. Földi, M, JR Casley-Smith (Eds). Schattauer, Stuttgart-New York (1983), 667.
29. American Academy of Orthopaedic Surgeons: Joint motion. Churchill & Livingstone, Edinburgh, 1985.
30. Bohannon, RW: Test-retest reliability of hand-held dynamometry during a single session of strength assessment. Phys. Ther. 66 (1986), 206.
31. Scott, J, EC Huskisson: Graphic representation of pain. Pain 2 (1976), 175.
32. Raines, JK, TF O'Donell, L Kalisher, et al: Selection of patients with lymphedema for compression therapy. Am. J. Surg. 133 (1977), 430.
33. Godal, R, I Swedborg: A correction for the natural asymmetry of the arms in the determination of the volume of oedema. Scand. J. Rehab. Med. 14 (1982), 193.
34. Borg, G: A category scale with ratio properties for intermodal and interindividual comparisons. In: Psychophysical judgment and the process of perception. Geisler, HG, P Petzold (Eds). VEB Deutscher Verlag der Wissenschaften, Berlin (1982), 25.
35. Eliska, O, M Eliskova: Are peripheral lymphatics damaged by high pressure manual massage? Lymphology 28 (1995), 21.

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EFFECTS OF COMPRESSION BANDAGING WITH OR WITHOUT MANUAL LYMPH DRAINAGE TREATMENT IN PATIENTS WITH POSTOPERATIVE ARM LYMPHEDEMA

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ABSTRACT

We examined the effects of low stretch compression bandaging (CB) alone or in combination with manual lymph drainage (MLD) in 38 female patients with arm lymphedema after treatment for breast cancer. After CB therapy for 2 weeks (Part I), the patients were allocated to either CB or CB+MLD for 1 week (Part II). Arm volume and subjective assessments of pain, heaviness and tension were measured. The mean lymphedema volume reduction for the total group during Part I was 188 ml ($p<0.001$), a mean reduction of 26% ($p<0.001$). During Part II the volume reduction in the CB+MLD group was 47 ml ($p<0.001$) and in CB group 20 ml. These differences were not significant ($p=0.07$). A percentage reduction of 11% ($p<0.001$) in the CB+MLD group and 4% in the CB group was significantly different ($p=0.04$). In both the CB and the CB+MLD group, a decrease of feeling of heaviness ($p<0.006$ and $p<0.001$, respectively) and tension ($p<0.001$ for both) in the arm was found, but only the CB+MLD group showed decreased pain ($p<0.03$).

Low stretch compression bandaging is an effective treatment giving volume reduction of slight or moderate arm lymphedema in women treated for breast cancer. Manual lymph drainage adds a positive effect.

Arm lymphedema secondary to breast cancer treatment most often develops gradually as a chronic disease (1) giving an increase of adipose tissue in subcutis with a later ingrowth of fibrosis probably due to the high protein concentration in the lymph stimulating the fibroblasts (2). Secondary lymphedema is a recognized complication of axillary node dissection, especially in combination with radiotherapy. Patients with arm lymphedema experience functional impairment, psychosocial maladjustment, and increased psychological morbidity (3), the condition being lifestyle-compromising (4).

The assumption that untreated lymphedema gradually increases in amount and grade (5) with time has been documented by Casley-Smith (1). 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 lymphedema 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 treatment (6). Compression raises the interstitial pressure, limits blood capillary filtration and increases lymph flow (7,8). The

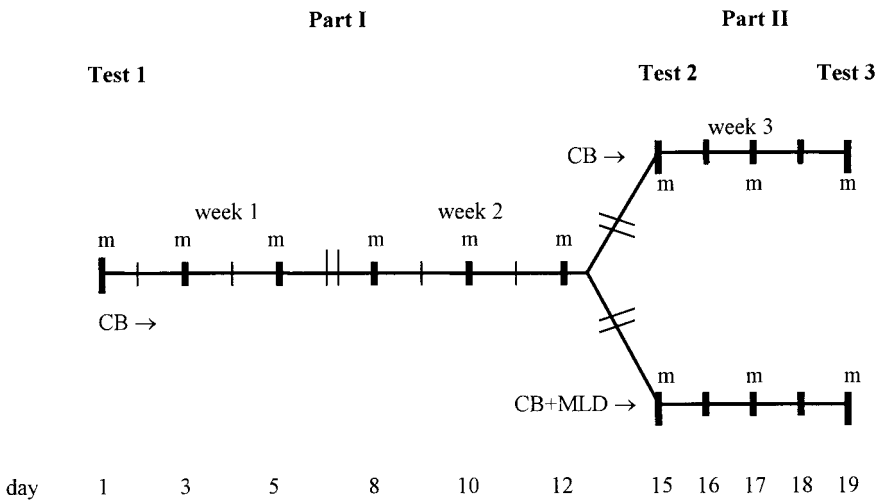

Fig 1. Study design: The first 2 weeks (Part I), only compression bandaging (CB) was used. The 3rd week (Part II) manual lymph drainage (MLD) was added to one group.

Fig. 1. Study design: The first 2 weeks (Part I), only compression bandaging (CB) was used. The 3rd week (Part III) manual lymph drainage (MLD) was added to one group.

effect of an elastic sleeve without other treatment has been evaluated in breast cancer patients undergoing mastectomy and has shown a decrease of 7-17% of the arm lymphedema, depending on how long the sleeve was administered (2 weeks-6 months) (9-11).

Manual lymph drainage (MLD) (12) combined with compression therapy is an effective treatment for lymphedema resulting in normalization of microlymphatic hypertension and an improvement of clinical appearance (13). Hutzschenreuter et al (14) showed that MLD combined with low stretch compression bandaging decreased arm lymphedema volume by 20%, and Johansson et al (9) found that MLD on its own reduced arm volume by 15%. Complex lymphedema therapy (CLT), a combination of MLD, compression bandaging, exercises and skin care, results in lymphedema reduction of about 60% (15,16). 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 CLT. There is 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 alone or when combined with

TABLE 1
Patient Characteristics

Characteristics	CB group n=18	CB+MLD group n=20
	median (q^1-q^3)	median (q^1-q^3)
Edema beginning after op, months	19 (3.8-69)	10 (6-21)
Edema duration, months	6 (1-27.3)	4 (3-42.8)
	number	number
Right/left arm lymphedema	11/7	13/7
Dominant arm lymphedema	12	12
Partial mastectomy/mastectomy	4/14	5/15
Radiotherapy	15	18

CB=compression bandaging; MLD=manual lymph drainage.

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) (17), were included over a 3 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 bandage for all patients. The bandage was changed every second day. After 2 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 contralateral 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 (18) 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. 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 was no difference between the groups are presented in *Table 1.* Sixteen patients had received different kinds of lymphedema treatment, but not within 6 months of the study, and 9 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 during Part I.

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

Physiotherapeutic Treatment

CB treatment was accomplished with low stretch bandages (20) 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 5 days. The CB and MLD treatments were performed mainly by one experienced physiotherapist specially trained in bandaging and in the MLD technique of Vodder (12). The MLD involves gentle massage starting over the 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 *Fig. 1.* During 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 (21) carried out a validity test for the water displacement method compared 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 were expressed both in ml and as percentage reduction in lymphedema. Percentage lymphedema reduction was calculated as follows:

$$\frac{diff\ test\ A - diff\ test\ B}{diff\ test\ A}$$

where diff = 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) (23). 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 (24).

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.

TABLE 2
Arm Volume (mean±SD) in ml at the Three Test Occasions

	CB n=18	CB+MLD n=20
Test 1	3073±602	3027±363
Test 2	2841±479	2882±386
Test 3	2823±474	2832±393*

CB=compression bandaging; MLD=manual lymph drainage; *= n=17.

TABLE 3
Arm Lymphedema Volume (mean±SD) in ml (Affected Minus Unaffected Arm) at the Three Test Occasions

	CB n=18	CB+MLD n=20
Test 1	770±455	626±217
Test 2	565±311	503±146
Test 3	545±311	455±157*

CB=compression bandaging; MLD=manual lymph drainage; *= n=17.

Corresponding analyses employing Wilcoxon signed rank tests and Wilcoxon rank sum tests for paired and independent samples respectively were also 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.

The mean lymphedema volume reduction during Part I when the whole group was wearing CB was 188±155 ml ($p<0.001$) and a percentage reduction of 26±15% ($p<0.001$) was seen. The percentage reduction in Part I was 21±13% ($p<0.001$) for the first week (7 days) and 6±14% ($p=0.006$) for the second week (7 days). During Part II (4 days) the volume reduction in the CB group was 20±46 ml ($p=0.8$) and in the CB+MLD group 47±42 ml ($p<0.001$). There was no significant difference ($p<0.07$) between the two groups. A percentage reduction of 4±10% (n.s.) in the CB group and 11±9% ($p<0.001$) in the CB+MLD group was obtained, revealing a significant difference ($p<0.04$) between the groups.

The mean percentage reduction in the 9 patients who wore elastic sleeves before the start of Part I was 25±11% with no difference between the groups.

Body weight: The mean±SD of the body weight for the whole group was 71.9±11 kg in test 1 and 71.6±11 in Test 2 (not significantly different).

Subjective assessment: There were no differences in mean score between the two groups at test 1. From test 1 to test 3, a decreased feeling of pain ($p=0.03$) heaviness and tension (both $p<0.001$) was found in the CB+MLD group. In the CB group, the feeling of heaviness ($p=0.006$) and tension ($p<0.001$) was decreased. There were no significant differences between the two groups at test 3.

DISCUSSION

Continuous CB with a 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 2 weeks (Part I) for CB treatment was chosen according to the outcome of a previous study (25) with a treatment period of four weeks including massage, isometric exercises and wearing of elastic sleeve. The results of that study (25) 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 (9) with 2 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 (16) 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 (15), also using CLT in 56 patients, found a similar edema reduction (62.6%) over a 30-day period.

The results from two independent studies (15,16) 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 5 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 difference observed are attributable to exercises and skin care. Another consideration is that the percentage decrease during Part I may have been greater if the 9 patients who wore elastic sleeves before the start of Part I had been excluded as having already been "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 edema treatment (6) especially to maintain an arm volume reduction for a longer period after intensive daily therapy has ceased. With an average follow-up of 9 months, Ko et al (16) 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 other treatment has been evaluated for a longer period by Swedborg (10) and Bertelli et al (11). They showed a volume reduction of 8% and 18% respectively after 6 months. With gradual decrease of the size of the sleeve over a one-year period, Brorson et al obtained a reduction of 47% (26). However, Casley-Smith found that lymphedema increased with time (1). 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 is added, the effect is only slightly greater.

In the present study, CB+MLD was administered to patients with slight and moderate lymphedema (18). 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 (27). 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 (18).

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 (28). 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 (29). However, in our study there were no significant differences between the groups regarding the side of operation or the 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 (30) using a Borgscale (31). The correlation between VAS and Borgscale was found to be good by Wilson et al (32), measuring dyspnea 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.

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REFERENCES

1. Casley-Smith, JR: Alterations of untreated lymphoedema and its grades over time. Lymphology 28 (1995), 174.
2. Casley-Smith, JR, RM Gaffney: Excess plasma proteins as a cause of chronic inflammation and lymphoedema: Quantitative electron microscopy. J. Pathol. 133 (1981), 243.
3. Tobin, MB, HJ Lacey, L Meyer, et al: The psychological morbidity of breast cancer-related arm swelling. Cancer 72 (1993), 3248.
4. Carter, B: Women's experiences of lymphedema. Oncol. Nurs. Forum 24 (1997), 875.
5. Casley-Smith, JR, M Földi, TJ Ryan, et al Lymphedema. Lymphology 18 (1985), 175.
6. Diagnosis and treatment of peripheral lymphedema: Consensus document of the International Society of Lymphology Executive Committee. Lymphology 28 (1995), 113.
7. Földi, E, M Földi, L Clodius: The lymphedema chaos: A lancet. Ann. Plast. Surg. 22 (1989), 505.
8. Mortimer, PS: Investigation and management of lymphedema. Vascular Medicine Review 1 (1990), 1.
9. Johansson, K, E Lie, C Ekdahl, et al: A

randomized study comparing manual lymph drainage with sequential pneumatic compression for treatment of post-operative arm lymphedema. Lymphology 31 (1998), 56.
10. Swedborg, I: Effects of treatment with elastic sleeve and intermittent pneumatic compression in post-mastectomy patients with lymphoedema of the arm. Scand. J. Rehabil. Med. 16 (1984), 35.
11. Bertelli, G, M Venturini, G Forno, et al: An analysis of prognostic factors in response to conservative treatment of postmastectomy lymphedema. Surg. Gynecol. Obstet. 175 (1992), 455.
12. Wittlinger, H, G Wittlinger: *Einfürung in die Manuelle Lymphdrainage nach Dr Vodder.* Haug Verlag, Heidelberg, 1987.
13. Franzeck, UK, I Spiegel, M Fischer, et al: Combined physical therapy for lymphedema evaluated by fluorescence microlymphography and lymph capillary pressure measurements. J. Vasc. Res. 34 (1997), 306.
14. Hutzschenreuter, PO, H Wittlinger, G Wittlinger, et al: Post-mastectomy arm lymphedema: Treated by manual lymph drainage and compression bandaging therapy. Arch. Phys. Med. Rehabil. 1 (1991), 166.
15. Boris, M, S Weindorf, B Lasinski: Persistence of lymphedema reduction after noninvasive complex lymphedema therapy. Oncology 11 (1997), 99.
16. Ko, DS, R Lerner, G Klose, et al: Effective treatment of lymphedema of the extremities. Arch. Surg. 133 (1998), 452.
17. Hermanek, P, LH Sobin: *UICC:TNM Classification of Malignant Tumors.* Springer-Verlag, 1987.
18. Stillwell, GK. Treatment of postmastectomy lymphedema. Mod. Treat. 6 (1969), 396.
19. Kettle, JH, FF Rundle, TH Oddie: Measurement of upper limb volumes: A clinical method. Austr. N. Z. Surg. 27 (1958), 263.
20. Hutzschenreuter, P, H Einfeldt, S Besser: Kompressionsbehandlung. In: *Lymphologie fur die Praxis.* (Ed.) Stuttgart:Hippokrates Verlag (1991), 119.
21. Bednarczyk, JH, C Hershler, DG Cooper: Development and clinical evaluation of comptuerized limb volume measurement system (CLEMS). Arch. Phys. Med. Rehabil. 73 (1992), 60.
22. Casley-Smith, JR: Measuring and representing peripheral oedema and its alterations. Lymphology 27 (1994), 56.
23. Scott, J, EC Huskisson: Graphic representation of pain. Pain 2 (1976), 175.
24. Scott, J, EC Huskisson: Accuracy of subjective measurements made with or without previous scores: An important source of error in serial measurement of subjective states. Ann. Rheum. Dis. 38 (1979), 558.
25. Swedborg, I: Effectiveness of combined methods of physiotherapy for postmastectomy lymphedema. Scand. J. Rehabil. Med. 12 (1980), 77.
26. Brorson, H, H Svensson: Liposuction combined with controlled compression therapy reduces arm lymphedema more effectively than controlled compression therapy alone. Plast. Reconstr. Surg. 102 (1998), 1058.
27. Brorson, H, H Svensson: Complete reduction of lymphedema of the arm by liposuction after breast cancer. Scand. J. Plast. Reconstr. Surg. Hand Surg. 31 (1997), 137.
28. Swedborg, I: Voluminometric estimation of the degree of lymphoedema and its therapy by pneumatic compression. Scand. J. Rehabil. Med. 9 (1977), 131.
29. Godal, R, I Swedborg: A correction for the natural asymmetry of the arms in the determination of the volume of the oedema. Scand. J. Rehabil. Med. 14 (1982), 193.
30. Swedborg, I, G Borg, M Sarnelid: Somatic sensation and discomfort in the arm of post-mastectomy patients. Scand. J. Rehabil. Med. 13 (1981), 23.
31. Borg, G: A category scale with ratio properties for intermodal and intervidual comparisons. In: *Psychophysical Judgment and the Process of Perception.* Geisler, HG, P Petzold (Eds.), VEB Deutscher Verlag der Wissenschaften (1982), 25.
32. Wilson, RC, PW Jones: A comparison of the visual analogue scale and modified Borg scale for measurement of dyspnoea during exercise. Clin. Sci. 76 (1989), 277.

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Breast Cancer Patients' Experiences of Lymphedema

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ORIGINAL ARTICLE

Breast cancer patients' experiences of lymphoedema

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Breast cancer patients' experiences of lymphoedema

The aim of this study was to explore employed women's experiences of light or moderate arm lymphoedema following breast cancer treatment in order to gain a deeper understanding of this phenomenon. Twelve women took part in a semistructured interview. A qualitative method with a phenomenological approach was applied to analyse data. In order to integrate the experiences in the everyday life of the women, a critical incident method was used. The findings indicate that there are many different practical and psychosocial problems related to arm lymphoedema. Three main themes were common to all the women. These themes were: (i) Attitudes from people in their surroundings, including reactions to the problem from other people and reactions from the women on the attitudes of other people. (ii) Discovery and understanding of oedema as a chronic disease and its treatment. (iii) Coping, including both problem-focused and emotion-focused strategies. The problems integrated in daily life were of low frequency but of considerable importance to the women. In conclusion, it is of great importance that health care professionals should be aware of and have knowledge about these problems. The women's needs for expressing their experiences of arm lymphoedema may be encouraged at the time of discovery and then regularly as long as the women seek care. Efforts may be made to strengthen the women's coping skills, eventually in a multidisciplinary approach. The interaction skills of health care professionals are probably of great importance in strengthening the resources of the women leading to a positive outcome.

Keywords: breast cancer, arm lymphoedema, qualitative study, interviews, chronic disease, coping.

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Introduction

Many breast cancer patients develop arm lymphoedema as a complication of treatment. The incidence by axillary node dissection alone is often reported at about 10% (1–4) but with a dissection combined with radiation to the axilla the incidence is about 40% or more (1, 2, 4, 5). The oedema can be noticed as early as a few months after surgery and radiation treatment (4) but can develop as many as 30 years later (6).

The treatment of breast cancer often includes axillary node dissection injuring the lymph vessels. Many patients also receive radiation to the axilla, which later may cause an increased rate of fibrosis in the tissue (7) and further reduces the possibility of lymph fluid draining from the arm. Without treatment arm lymphoedema secondary to breast cancer might develop into a chronic disease (8). The treatment of lymphoedema is mostly conservative, although severe (9) arm lymphoedema with hypertrophy of the adipose tissue can be successfully treated with liposuction (10). The conservative treatment usually includes manual lymph drainage or compression pumps to stimulate the lymph flow and to remove fluid from the affected arm (11–17). Low stretch bandaging or sleeves are used to decrease volume of the arm and to maintain pressure (11, 13, 16, 18, 19).

Lymphoedema is well-recognized as a most distressing complication. Tobin et al. studied 50 women with breast cancer-related arm lymphoedema matched with 50 control subjects. The patients with arm lymphoedema experienced greater psychological morbidity and greater impairment of physical functioning (20). Tobin also showed impaired adjustment to illness for the lymphoedema group using the Psychosocial Adjustment to Illness Scale (PAIS). PAIS was also used by Woods showing no difference before and after a 6-month treatment programme for 37 breast cancer treated women with arm lymphoedema (21). In

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semistructured interviews with the same group before the start of treatment, Woods found frustration at the limitation of performing everyday tasks and concern about the future, as well as affected perceptions of their appearance and damaged confidence concerning body image. In a phenomenological, qualitative and descriptive study, Carter interviewed 10 breast cancer patients with arm lymphoedema. It was revealed that some women experienced depression, anxiety and impairments related to their intimate, work and social relationships (22). Velanovich et al. used SF-36 to measure different domains of quality of life in 101 breast cancer treated women (23). They found that quality of life in the role-emotional and bodily pain domains were lower for patients with arm lymphoedema compared with those without. Dennis showed in a retrospective chart review of nine breast cancer treated women with arm lymphoedema that depression and pain might have interfered with the abilities of some women to comply with lymphoedema treatment (24). However, Mirolo et al. stated that intensive conservative treatment followed by a self-management phase, showed higher quality of life assessment compared with that before treatment in a 1-year follow-up (25).

Early detection and treatment of arm lymphoedema in the southern region of Sweden (4) has resulted in a gradual increase of light or moderate lymphoedema and a significant reduction in cases of severe lymphoedema. The mean age of breast cancer treated women in southern Sweden is just below 60 years (26). Breast cancer patients nowadays belong to a generation of women who are used to working outside their homes and living physically and socially active lives. Combined, these facts generate a picture of these women living 'normal Swedish lives' affected very little by their arm lymphoedema. The aim of this study was to explore employed women's experiences of light or moderate arm lymphoedema following breast cancer treatment in order to gain a deeper understanding of this phenomenon.

Methods

Subjects

Twelve women, representing all women in treatment at the Lymphoedema Unit of the University Hospital in Lund, Sweden, at the time of the study were included (Table 1). The inclusion criteria were: (i) Arm lymphoedema less than 40% (9) following breast cancer treatment. (ii) Women working outside the homes. (iii) Lymphoedema with a duration of at least 1 year. Women taking medicine for psychiatric conditions or with recurrent cancer were excluded. With the purpose to obtain a deeper knowledge of their experiences of lymphoedema, patients were asked if they were willing to take part in an interview. All 12 agreed, and written information explaining the purpose and procedures of the study and the rules of confidentiality were sent to the women.

Table 1 Characteristics of the samples (n = 12)

Sample	Age (years)	Marital status	Oedema duration (months)	Volume difference (%)	Occupation
1	44	Widow	21	22	Lunch room attendant
2	51	Married	39	11	Occupational consultant
3	46	Married	33	21	Postman
4	57	Married	44	20	Principal
5	45	Married	31	24	Recreational counsellor
6	46	Single	28	24	Reg. nurse
7	59	Partnered	48	16	Teacher spec. ed.
8	48	Married	40	12	Pract. nurse
9	58	Single	61	15	Architect
10	44	Married	61	26	Civil engineer
11	52	Married	35	27	Accountant
12	51	Married	83	11	Secretary

The study was approved by the Research Ethics Committee, Lund University, 1998.

Research design

Qualitative research methods have been suggested as being useful in psychosocial research concerning chronic illness (27). Qualitative research is based on the assumption that the individual forms her own opinion of life and reality. Thus, this experienced knowledge of life and the knowledge itself are related and mutually dependent (28). When collecting and analysing the women's stories, this study was guided by a phenomenological perspective, tracing the structure or the essential components entailed in the experience. The aim of phenomenology is to describe life experiences, i.e. how phenomena appear to people in their experience (29). The interest is not focused on the facts presented, but rather the meanings with which they were imbued by the individual (30).

The analysis of the interviews was based on a phenomenological method, developed by Karlsson (30) and previously used by Mannerkorpi et al. (31). The analysis is comprised of five steps:

1 After verbatim transcription from the tape recordings, the protocols are read several times with an open-minded approach.

2 All meaning units (MU) in the text containing statements related to the arm lymphoedema are selected.

3 The MU are transformed into a language relevant to the research question.

4 The transformed MU are synthesized into 'situated structures' to discern phenomenon.

The situated structures are moved to 'general structures' or themes, which incorporates those constituents of a phenomenon which run across several situated structures.

In this study the model was modified into four steps where steps 3 and 4 were combined into one named 'subthemes'.

Procedure

The written information was sent to the women 2 weeks prior to the interviews. Two physiotherapists (HH and IN), without previous contact with the women, performed the interviews. All interviews took place in an undisturbed place, nine of them at the hospital, two in the women's homes and one at her place of work. One physiotherapist was present at all interviews and both were present at seven, because of practical reasons. The interviews lasted 25–50 minutes and were tape-recorded. Before the interview started the women were informed of the procedures and the rules of confidentiality.

An interview guide was employed (Table 2). The areas of concern were derived from clinical practice and literature review on breast cancer treated women with arm lymphoedema (21, 22, 24, 32). A physiotherapist (KJ) with extensive experience of lymphoedema patients validated areas of concern often expressed by these patients. The areas of concern were discussed in the order they arose naturally during the interviews and the guide was only used as a memory aid.

Critical incident observations

In order to integrate the experiences of arm lymphoedema in everyday life and further illustrate the findings, a triangulation was made using the critical incident method described by Flanagan (33). The method is based on registration of observed incidents connected to special fields or questions of interest.

In this study the incidents were observed and registered by the women themselves. The special field examined concerned incidents differing from normal daily life. Two weeks before the interview, the women received forms to fill-in and were requested to register daily at least one and at most three negative and positive incidents, respectively (a minimum of two and a maximum of six per day) for 10 consecutive days. All incidents were ranked on one negative and one positive 1–10-point scale where −10 was the most negative and +10 was the most positive incident. The women were instructed to choose incidents differing from normal daily life and it was stressed that there could be no incident of such little or great importance that it could not to be registered within the 10-point scale.

Table 2 Semistructured interview guide

General experience of the arm lymphoedema
First awareness of lymphoedema symptoms
Ongoing management of lymphoedema
Impact of lymphoedema on life-style
Impact on appearance
Responses of others
Future expectations
Impression of treatment and providers

Validation procedure

Findings based on the interviews were audited for credibility and applicability by a validation group of five breast cancer patients with arm lymphoedema representing the study group by age and oedema duration. These patients were admitted to the Lymphoedema Unit in the period after the study group was recruited. The validation group was asked to read the interview guide and the findings. In a telephone interview they were then asked if the areas of concern in the guide and the findings were relevant in general to their own experiences. They were also asked to identify any major experience of their own not expressed in the findings obtained.

Findings

Sample description

Three main aspects were common to all the women despite differences in age, family circumstances, work and other factors that could be supposed to interfere with the findings. These three common themes, derived from the subthemes (Fig. 1) were: (i) reactions from others, (ii) being bound to the chronic disease and (iii) coping.

Reactions from others

In this theme, reactions to the problem from others and women's response were found.

It was primarily family or close friends that comprised that group, but reactions from strangers also occurred and here the focus was mostly on the compression sleeve. 'It helps, it's good, but it is difficult to wear. And then you notice that people are looking at you all the time' or 'People are constantly asking me: What's happened to your arm? So, it's mostly that it attracts attention.' When getting a direct question from anyone, the women did not always tell the truth: 'Well it sort of depends...I kind of avoid answering. Did you hurt it at work? they ask. Aha, yes, I say,...it depends on who is asking.' The reason for not telling the truth was not only to protect oneself from curiosity from other persons but also to protect other persons from being embarrassed: 'I say that my arm is sick. Once when I was at the bank someone asked: What in the world have you done to your arm? So I said: Ah, I've had a mastectomy. And I sort of saw how she went all pale and then I felt like I shouldn't have said anything...because I saw how she reacted and what she was thinking: She just

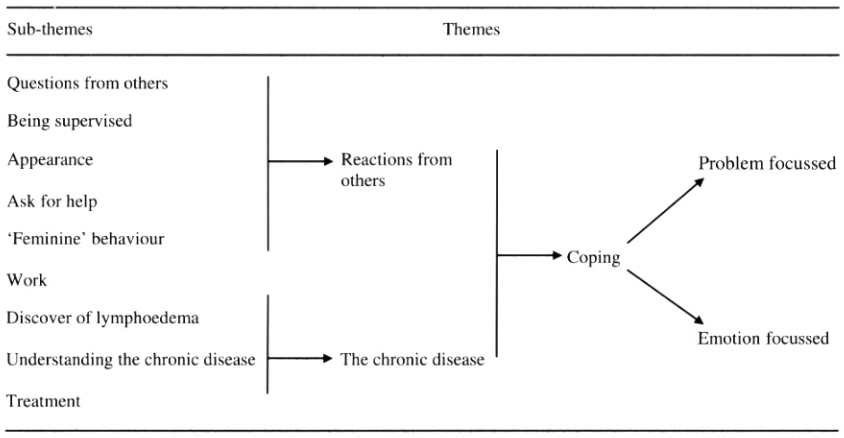

Figure 1 Subthemes and themes derived from breast cancer patients' (n = 12) experiences of arm lymphoedema.

wanted to disappear into thin air.' But sometimes the reaction from others was not enough, in particular from health care professionals: 'It feels like they (doctors) just think that lymphoedema is just a trivial matter in comparison to cancer and it is, but it can still be very annoying.' The women could feel that they were being supervised by their family, friends or colleagues, for example not to lift heavy things, to keep the arm in a high position or remember to put on the compression sleeve: 'They are always after me. Don't carry this...' or 'They are always at me about wearing my sleeve. They keep after me. They realize that it is good for me.'

The women's response to reactions from others was expressed in their image of themselves and how they looked, as related to the oedema: 'The fingers end up looking like sausages and that's no fun, right...and a little reddish and they look weird.' Their appearance was also related to the sleeve: 'If I want to dress up I don't wear it' or 'They are quite unattractive. It's like one of those old lady surgical stockings, not anything you wear when you go out well-dressed.' Also clothes caused some problems: 'Once I had to buy a larger size blouse for the arm. It was so tight and not at all attractive' or 'Even if I haven't bought a new wardrobe, I still have clothes I don't wear any longer. I spend more time thinking: What should I wear? What looks good?' Clothing was even more problematic in summertime: 'You can't wear a top in the summer because you can see this big fat lump' or 'I always wear long sleeves nowadays. It's difficult to find long-sleeved summer clothes'. Some women also expressed how other persons might look upon their appearance: 'And then when I see pictures of myself, photos where I've got short-sleeves I think: Oh, that sleeve really shows.'

Some women found it very disturbing to always have to ask for help: 'When I do something at work I think: Why can't they see that I can't do it? Must I always ask for help? Can't they just look at me, my arm and my sleeve and guess that I can't manage it? Must I always be the one to speak up?' Asking for help had effect on their self-image: 'I've always been the kind to never ask for help. I really hate having to ask...It feels like a big defeat. Yes, that I felt like a strong woman before and I feel like a weak person now.' Some women expressed that they had to behave in a more 'feminine' way, that they were not used to asking their male travel companions to carry heavy suitcases, for example. This was also expressed from a rather young woman with small children: 'I feel like this presents a wrong picture for my children since I think it is important for them to see what both parents can do...That they can do the same things and don't need to divide things up.'

The women's relationship to their surroundings also included the subtheme 'work'. All 12 women had continued with the same or similar jobs outside their homes as before surgery. Heavy work was expressed as a problem: 'I think about it all the time, because I can't lift with that arm and must always think that I can't lift that heavy bottle or heavy thing with just that arm. I always need to use both – always...The same thing when I work with heavy patients who must be lifted up in bed, then I really feel it is hard.' Also work demanding precision was troublesome: 'No, it doesn't function as usual. I notice that when I sit at the computer. I feel clumsy... wrong letters.' As well as working too much without rest: 'If we have to work overtime, I have to say that I don't dare because then I might not be able to come tomorrow. If I go home and rest I can be sure to be there tomorrow.'

The chronic disease

In this theme the women expressed experiences and reactions mainly discovery of the oedema, understanding the chronic disease and the treatment of it. Cameron and Gregor (34) have argued that chronic illness is a lived experience, involving 'permanent deviation from the normal, caused by unalterable pathological changes'. It involves a permanent alteration in the individual's way of life and a reappraisal of that which may be hoped for in terms of function and health.

The discovery of the oedema often made the women sad: 'I was a little sad because I thought I wouldn't get it since a

year and a half had already passed. The doctor made a mistake there. He said: You'll be okay if you make it 6 months. No oedema, great! You are going to do just fine... That is why I was a bit disappointed. Since then I've learned that it can appear quite late. But back then I was disappointed, thought it was a shame. I thought I had made it.' or 'Yes, of course I felt it. I was very sad, it felt hard all at once. Felt that since I hadn't had it from the beginning...' Some women did not care so much at the discovery but had a stronger reaction when they realized they had a chronic disease: 'I had so many problems then (after surgery) so it (discovery of lymphoedema) was nothing special. But, later, it became a problem. I wasn't prepared for having it for the rest of my life. I thought it would pass. I didn't realize that I might have to wear the sleeve for the rest of my life.

Treatments with compression sleeve mostly caused negative feelings: 'It feels wonderful being without it, but I realize that I need it. That's why I wear it, but I don't like it.' or 'So I stood in front of the mirror and started crying. The sleeve was so un-feminine. It was just awful.' But treatment by manual lymph drainage was mostly a positive experience: 'But when I have had my treatment it feels sort of like I've lifted a very heavy brick, and then put it down. Then it feels like my arms want to fly up.' or 'It feels like my arm is lighter when I leave. In some strange way, that obviously can't be proven, but that's how it feels'. Disappointment was expressed over the fact that no one was able to come up with an even better treatment: 'Lots of times it feels like they have done research on so many things, but nobody is trying to repair lymphvessels? It doesn't seem to have high priority at all.'

Coping

To be able to adjust to the different situations described above, the women developed certain coping strategies leading to useful practical, psychological and social adaptation. Lazarus and Folkman (35) have defined coping as constantly changing cognitive and behavioural efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resources of the person. This definition is process-centred rather than trait-centred and uses the term 'managing' which can include minimizing, avoiding, tolerating and accepting negative conditions in life. Compared with acute diseases, Ray et al. (36) found that patients with chronic diseases are generally less involved in a process but are more involved with different strategies simultaneously.

Folkman et al. (37) define two basic functions of coping:
1 Problem-focused coping consists of efforts to change the actual circumstances, e.g. by changing the environment: 'I've made a deal with my boys. They get paid extra if they vacuum once a week.' or by changing oneself: 'I have to think ahead. I can't lift very heavy things with this arm, such as moving files and other things, then I let my other arm take the punishment.' This might also be expressed in a combination of changing environment and oneself: 'I have a house all by myself. There I have been given some thought to having help. I realize that I can't do anything and everything there. I limit myself and do the gardening. It has become sort of automatic that I work a couple of hours and then go in and shower and get dressed and that feels all right. Yes, I do think ahead a little nowadays.'
2 Emotion-focused coping involves purely cognitive activities regulating emotional distress. One way is by changing its meaning, e.g. by making the lymphoedema less important than it is: 'I do everything. I don't think about it. I shouldn't carry so much but I do. I don't believe I think so much about it. I try to live as usual. Yes, the more you think about it, the stranger it becomes.' Some women also compared themselves with those in a worse situation: 'It doesn't affect me so much and I am also at that age when it (appearance) isn't as important as when I was 25.' or 'It's hard. It's very hard. I admit that, but you have to try to ease the hard parts. It is nothing in comparison to being cured. So you take it, the side-effect...I try to think positively. I've got lymphoedema but other women have lost their breast. I haven't. Maybe that compensates for it.'

Another way of regulating emotional distress is to adjust one's values to present day reality, e.g. accepting changed physical appearance: 'I have changed my values. I don't care about things like that (the arm's appearance) today. The main thing is that I am healthy. So, that doesn't matter.' or 'When I see pictures of myself I think of how people see me, but then I think: What the hell.' Some women accepted the situation without letting it rule their lives: 'It (the sleeve) is a part of me. It is automatic, taking it on and off...When I'm on the beach I don't wear it. Even if they say I must I have my own limits.' or 'I'm supposed to go for a treatment once a month. If I am an obedient patient I do, but I'm not always.'

Emotion-focused coping was more commonly represented than problem-focused coping.

Critical incident observations

There were 246 positive and 196 negative incidents reported. The reported number of positive and negative critical incidents within four chosen topics, two general (work, relationships) and two specific (cancer, lymphoedema), are shown in Table 3. Eleven of the incidents were related to lymphoedema, all negative (Table 4).

Validation

All five women in the validation group declared a general agreement with the findings with special focus on the compression sleeves and different coping strategies. No one

Table 3 Number of positive and negative critical incidents reported within 4 chosen topics

Points	*Work*	*Relationship*	*Cancer*	*Lymphoedema*
Positive 6–10	30	50	1	0
Positive 1–5	24	28	1	0
Negative 1–5	18	14	0	3
Negative 6–10	25	8	2	8

Table 4 Critical incidents related to lymphoedema

Incident	*Point*
The bra and sleeve irritates	−4
The sleeve irritates	−4
The arm is a little swollen	−5
Numbness in the hand	−6
Numbness in the hand and arm	−6
Having a bad conscience for not having contacted the physiotherapist	−7
The arm sleeve is not functioning	−7
The arm is a little swollen	−8
Numbness in the hand	−8
Heavy patients, busy, pain in the arm	−10
Were told my lymphoedema had increased by 50 mL	−10

reported any major experience of their own not expressed in the findings.

Discussion

Research exploring the breast cancer patients' experiences and adjustment problems with chronic arm lymphoedema are very limited. More knowledge in the field is needed in order to increase the understanding of health care professionals dealing with this group of patients. Although the findings cannot be generalized beyond this study sample, professionals caring for breast cancer patients with chronic arm lymphoedema may gain insights from the experiences of these women.

One of the major problems described by the women was the necessity to wear compression sleeves. In cases of light or moderate lymphoedema the arm itself was not so conspicuous but the compression sleeve attracted attention and was experienced as 'ugly, terrible, un-feminine and warm'. Some women wanted to conceal their arms by wearing special clothing, particularly in summertime. These findings are in line with the experiences of American breast cancer patients with arm lymphoedema explored in a study by Carter (22). As compression therapy has been found to be the most effective part of treatment in light and moderate arm lymphoedema (19) and also in severe ones (18), this treatment cannot be ignored in chronic lymphoedema. Thus, increased efforts should be made to improve the compression sleeves taking into account individual needs including both function and appearance.

The fact that emotion-focused coping was more commonly represented than problem-focused coping may be explained by that the problem is chronic and can be practically solved only in part. The remaining problems must be managed emotionally. Separating the experience of breast cancer treatment from the experience of an ensuing lympoedema may also be problematic, even impossible. Thus, studies of coping with chronic lymphoedema, including also idiopathic lymphoedema, may be a research issue for the future.

The interviews do not clearly tell us how great the problem is related to everyday concerns. The problems expressed differ from individual to individual, as do the coping strategies. The results of the critical incident observations (Table 3) showed that the observations related to lymphoedema were very few [some of the observations including numbness and pain (Table 4) may not even be related to lymphodema] compared with general topics like work and relationship to family and friends. However, they showed a high level of points and were entirely negative. This may be compared with the observations related to the specific topic of cancer where both positive and negative observations were found. Several other studies have found breast cancer patient to be able to describe both positive and negative aspects of their cancer experiences (38, 39), but concerning lymphoedema this does not seem to be the case. Thus, a possible interpretation of the few lymphoedema observations might be that lymphoedema can be managed quite well in everyday life. Still the high level of negative points may indicate that great stress can be experienced whenever women are unable to cope with this problem.

The interview guide did not include the impact of arm lymphoedema on sexually related issues. These kinds of questions are difficult to discuss, particularly at the first meeting. If a second meeting had taken place this issue might have been included in the interview guide. However, the guide included questions related to impact on life-style, appearance and responses of others, which offered women the opportunity to express sexually related problems. However, none of the women included in the study expressed any such experience, nor did the women in the validation group.

Some women received inaccurate information from their health care provider about when the lymphoedema might occur and that it may become a chronic problem. They expressed sadness when understanding that they had a chronic disease and some felt uncertainty for the future. Reduced information or no information at all are by some health care providers considered justified not to increase worries already made by the cancer disease. On the contrary, in our opinion the women might better cope with

these problems if they are prepared for it and if efforts are made to strengthen their coping skills (35, 40). Also more time for information ought to be given when the lymphoedema is detected and opportunities to return for discussions at individually regulated time intervals until they feel satisfied with the information received. On these occasions the interaction skills of the health care professionals may be of great importance in strengthening and reinforcing the resources of the women leading to a positive outcome. Such skills are dependent on insights gained through extensive clinical experience and qualitative research (41).

Future research within the field needs to focus on coping strategies and how they can be strengthened in the women with arm lymphoedema. Exploring the women's needs concerning compression sleeves and improved technical research on compression material to meet these needs, is also of great importance.

Conclusion

In conclusion, women with slight or moderate arm lymphoedema expressed their experiences and feelings, revealing problems that concerned the attitudes of people in their surroundings as well as the chronic disease. The problems integrated in daily life were of low frequency but of considerable importance to women. The women used both problem-focused and emotion-focused coping strategies. Thus, it is of importance that health care professionals are aware of and have knowledge about these problems. The women's need for expressing their experiences may be encouraged both at the discovery of the oedema and then regularly as long as the women seek care. Efforts may be made to strengthen the coping skills of the patients concerned.

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References

1 Kissin MW, Querci della Rovere G, Easton D, Westbury G. Risk of lymphoedema following the treatment of breast cancer. *Br J Surg* 1986; **73**: 580–4.

2 Christensen SB, Lundgren E. Sequelae of axillary dissection vs axillary sampling with or without irradiation for breast cancer. *Acta Chir Scand* 1989; **155**: 515–20.

3 Tengrup I, Tennvall-Nittby L, Christiansson I, Laurin M. Arm morbidity after breast-conserving therapy for breast cancer. *Acta Oncol* 2000; **39**: 393–7.

4 Johansson K, Ingvar C, Albertsson M, Ekdahl C. Arm lymphoedema, shoulder mobility and muscle strength after breast cancer treatment. A prospective 2-year study. *Adv Physiotherapy* 2001; **3**: 55–66.

5 Segerström K. Factors that influence the incidence of brachial oedema after treatment of breast cancer. *Scand J Plast Reconstr Surg Hand Surg* 1992; **26**: 223–7.

6 Brennan MJ, DePompolo RW, Garden FH. Focused review: postmastectomy lymphedema. *Arch Phys Med Rehabil* 1996; **77**: s74–s80.

7 Gillette EL, Mahler PA, Powers BE, Gillette SM, Vujaskovic Z. Late radiation injury to muscle and peripheral nerves. *Int J Radiat Oncol Biol Phys* 1995; **31**: 1309–18.

8 Casley-Smith JR. Alterations of untreated lymphoedema and its grades over time. *Lymphology* 1995; **28**: 174–85.

9 Stillwell GK. Treatment of postmastectomy lymphedema. *Mod Treat* 1969; **6**: 396–412.

10 Brorson H, Svensson H. Complete reduction of lymphoedema of the arm by liposuction after breast cancer. *Scand J Plast Reconstr Surg Hand Surg* 1997; **31**: 137–43.

11 Swedborg I. Effects of treatment with elastic sleeve and intermittent pneumatic compression in post-mastectomy patients with lymphoedema of the arm. *Scand J Rehabil Med* 1984; **16**: 35–41.

12 Zanolla R, Monzeglio C, Balzarini A, Martino G. Evaluation of the results of three different methods of postmastectomy lymphedema treatment. *J Surg Oncol* 1984; **26**: 210–3.

13 Bertelli G, Venturini M, Forno G, Macchiavello F, Dini D. An analysis of prognostic factors in response to conservative treatment of postmastectomy lymphedema. *Surg Gynecol Obstet* 1992; **175**: 455–60.

14 Hutzschenreuter PO, Wittlinger H, Wittlinger G, Kurz I. Postmastectomy arm lymphedema: treated by manual lymph drainage and compression bandaging therapy. *Arch Phys Med Rehabil* 1991; **1**: 166–70.

15 Boris M, Weindorf S, Lasinski B. Persistence of lymphedema reduction after noninvasive complex lymphedema therapy. *Oncology (Huntingt)* 1997; **11**: 99–109.

16 Ko DS, Lerner R, Klose G, Cosimi AB. Effective treatment of lymphedema of the extremities. *Arch Surg* 1998; **133**: 452–8.

17 Johansson K, Lie E, Ekdahl C, Lindfeldt J. A randomized study comparing manual lymph drainage with sequential pneumatic compression for treatment of postoperative arm lymphedema. *Lymphology* 1998; **31**: 56–64.

18 Brorson H, Svensson H. Liposuction combined with controlled compression therapy reduces arm lymphedema more effectively than controlled compression therapy alone. *Plast Reconstr Surg* 1998; **102**: 1058–67.

19 Johansson K, Albertsson M, Ingvar C, Ekdahl C. Effects of compression bandaging with or without manual lymph drainage treatment in patients with postoperative arm lymphedema. *Lymphology* 1999; **32**: 103–10.

20 Tobin MB, Lacey HJ, Meyer L, Mortimer PS. The psychological morbidity of breast cancerrelated arm swelling. Psychological morbidity of lymphoedema. *Cancer* 1993; **72**: 3248–52.

21 Woods M. Patients' perceptions of breast-cancer-related lymphoedema. *Eur J Cancer Care* 1993; **2**: 125–8.

22 Carter BJ. Women's experiences of lymphedema. *Oncol Nurs Forum* 1997; **24**: 875–82.

23 Velanovich V, Szymanski W. Quality of life of breast cancer patients with lymphedema. *Am J Surg* 1999; **177**: 184–7.

24 Dennis B. Acquired lymphedema: a chart review of nine women's responses to intervention. *Am J Occup Ther* 1993; **47**: 891–9.

25 Mirolo BR, Bunce IH, Chapman M, Olsen T, Eliadis P, Hennessy JM, Ward LC, Jones LC. Psychosocial benefits of postmastectomy lymphedema therapy. *Cancer Nurs* 1995; **18**: 197–205.

26 South Swedish Breast Cancer Group A. *Care Program for Breast Cancer*. 1997, Centre of Oncology, Lund University Hospital, Sweden.

27 Charmaz GK. 'Discovering' chronic illness: using grounded theory. *Soc Sci Med* 1990; **30**: 1161–72.

28 Guba EC. Carrying on the dialogue. In *The Paradigm Dialogue* (Guba EC ed.), 1990, Sage, Newbury Park, CA, 368–78.

29 Husserl E. *Ideas: General Introduction to Pure Phenomenology*. 1931, Macmillan, New York.

30 Karlsson G. *Psychological Qualitative Research from a Phenomenological Perspective*. 1993, Almqvist & Wiksell International, Stockholm, Sweden.

31 Mannerkorpi K, Kroksmark T, Ekdahl C. How patients with fibromyalgia experience their symptoms in everyday life. *Phys Res Int* 1999; **4**: 110–22.

32 Passik S, Newman M, Brennan M, Holland J. Psychiatric consultation for women undergoing rehabilitation for upper-extremity lymphedema following breast cancer treatment. *J Pain Symptom Manage* 1993; **8**: 226–3.

33 Flanagan JC. The critical incident technique. *Psychol Bull* 1954; **51**: 327–58.

34 Cameron K, Gregor F. Chronic illness and compliance. *J Adv Nurs* 1987; **12**: 671–6.

35 Lazarus RS, Folkman S. *Stress Appraisal and Coping*. 1984, Springer-Verlag, New York.

36 Ray C, Lindop J, Gibson S. The concept of coping. *Psychol Med* 1982; **12**: 385–95.

37 Folkman S, Lazarus RS, Dunkel-Schetter C, DeLongis A, Gruen RJ. Dynamics of a stressful encounter: cognitive appraisal, coping, and encounter outcomes. *J Pers Soc Psychol* 1986; **50**: 992–1003.

38 Utley R. The evolving meaning of cancer for long-term survivors of breast cancer. *Oncol Nurs Forum* 1999; **26**: 1519–23.

39 Arman M, Rehnsfeldt A, Carlsson M, Hamrin E. Indications of change in life perspective among women with breast cancer admitted to complementary care. *Eur J Cancer Care (Engl)* 2001; **10**: 192–200.

40 Fawzy IF, Fawzy NW, Arndt LA, Pasnau RO. Critical review of psychosocial interventions in cancer care. *Arch Gen Psychiatry* 1995; **52**: 100–13.

41 Lundvik Gyllensten A, Gard G, Salford E, Ekdahl C. Interaction between patient and physiotherapist: a qualitative study reflecting the physiotherapist's perspective. *Physiother Res Int* 1999; **4**: 89–109.

Abstract

Ten percent of the female population in Sweden will be diagnosed with breast cancer during their lifetime, but only a minority will die from the disease. Arm lymph oedema is a well-known complication following breast cancer treatment and the incidence varies between about 10% when axillary node dissection is performed and about 40% when axillary radiotherapy is added.

The general aim of this thesis was to identify risk factors and onset, evaluate treatments and explore, from a physiotherapeutic perspective, the experiences of patients with arm lymphoedema following breast cancer treatment.

Results revealed that patients treated with additional axillary radiotherapy were associated with early development of arm lymphoedema and reduced shoulder mobility that remained during a 2-year follow-up period. Shoulder muscle strength was reduced to all patients treated with axillary node dissection independent of radiotherapy treatment. Women treated for breast cancer with axillary node dissection, with or without adjuvant radiotherapy, can be recommended to maintain their level of occupational workload and physical activity without an added risk of developing arm lymphoedema. However, it is reasonable to assume that a higher body mass index increases the risk.

Two intervention studies showed that compression with low-stretch bandaging was the most effective short-time lymphoedema reducing treatment. Manual lymph drainage, a massage technique, also reduced the lymphoedema considerably. Manual lymph drainage, combined with compression bandaging, was more effective than compression bandaging alone. Sequential pneumatic compression also had a lymphoedema reducing effect and in comparison with manual lymph drainage, no difference between the treatments was found.

In a qualitative interview study, women with slight or moderate arm lymphoedema expressed their experiences, revealing problems with attitudes from people in the surroundings and problems with the chronic disease. The problems integrated in daily life were of low frequency but of considerable importance to the women. The women used both problem-focused and emotion-focused coping strategies. Thus, it is of importance that health care professionals are aware of and have knowledge about these problems. It is reasonable to believe, that the women's need to express their experiences, should be encouraged and efforts made to strengthen the women's coping skills.

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