

## EFFECTS OF TREATMENT WITH AN ELASTIC SLEEVE AND INTERMITTENT PNEUMATIC COMPRESSION IN POST-MASTECTOMY PATIENTS WITH LYMPHOEDEMA OF THE ARM

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**ABSTRACT.** In an attempt to reduce oedema of the arm after mastectomy, patients were provided with an elastic sleeve which was worn for a period of between 1 week and up to 6 months. A statistically significant mean relative decrease of 17% in the volume of oedema was achieved. Subsequent treatment by intermittent pneumatic compression for 10 days produced a further significant mean relative decrease of 18%. When the sleeve was worn for 6 months after this treatment there was no significant increase in arm volume—that is, no relapse.

*Key words:* cancer, mastectomy, oedema, elastic sleeve, physiotherapy, intermittent pneumatic pressure

The techniques of physiotherapy applied in the treatment for lymphoedema in post-mastectomy patients vary from hospital to hospital and from one country to another. The elastic sleeve is an important aid in preventing fluid from accumulating again in the interstitial tissue and thus for preventing relapse. At most hospitals swelling of the arm is treated by intermittent pneumatic compression supplemented with use of an elastic sleeve (1, 5, 7, 8). This therapy can be combined with manual lymph drainage, medication and surgery (2, 3, 4).

Reported reductions in oedema obtained by intermittent pneumatic compression combined with the elastic sleeve therapy range from about 30 to 65% (8, 5). Among the factors probably accounting for this variability are differences in the patient series, the initial extent of the oedema, the duration of the treatment, the time at which the individual treatments were given and the compressive force used. It is interesting to learn, however, whether the elastic sleeve therapy alone may be regarded as sufficient to obtain an acceptable and lasting reduction in oedema or whether it is necessary to supple-

ment it with other physiotherapeutic measures such as manual lymph drainage, intermittent pneumatic compression and active exercise. Long-term data observation on continued use of the elastic support in the control of the oedema is needed.

The purposes of the present study were (a) to determine the variability of the relative and the absolute volumes of the oedematous arm; (b) to measure any change in the relative and the absolute volumes after the following forms of treatment, given in turn: (1) elastic sleeve therapy (Jobst) for 1 week and for 1, 3 and 6 months; (2) intermittent pneumatic compression (Jobst) given for 2 weeks, and (3) elastic sleeve maintenance therapy for 1 week, and 1, 3 and 6 months, given to prevent relapse. The treatment schedule is shown in Fig. 1.

### THE PATIENT SERIES

During the period from April 1980 to September 1982 a total of 249 post-mastectomy patients attended the Department of Physiotherapy and Medical Rehabilitation for consultation or for treatment of swelling of the arm, pain in the arm or chest, paresis, or impairment of arm function.

A selection of the patients was made according to the following criteria:

- (1) no known metastases;
- (2) no infection of the arm after the beginning of the study;
- (3) no functional impairment, swelling, or skin alterations of the other arm (the control arm);
- (4) a difference of at least 10% in the volumes of control and oedematous arm;
- (5) the patient must have complained of pain, a feeling of heaviness in the arm, or its unaesthetic appearance;
- (6) no physiotherapy shall have been given during the 6 months preceding the present treatment.

Table I. Characteristics of the patients

Number of patients Group A + Group B	32+22=54 patients
Mean age at beginning of study	63 years
Age range	42-79 years
Distribution of patient series by year of mastectomy	1950-59, 6 patients 1960-69, 21 patients 1970-79, 26 patients 1980, 1 patient
Side of mastectomy	Right, 23 patients Left, 31 patients
Leading hand	Right, 49 patients Left, 3 patients Ambidextrous, 2 patients
Initial volume of oedematous arm expressed as a percentage of that of the control arm ( $V_{\text{oed arm rel}} \times 100$ )	Mean 147.7% S.D. 27.5 Range 110-210 Median 146
Radiotherapy	49 patients
Duration of oedema prior to treatment	Mean: 7 years 11 months Range 3 months-28 years
No previous treatment for swollen arm	32 patients (Group A)
Previous treatment received	22 patients (Group B)
Infection of the arm	22 patients

The material for the study after the process of selection consisted of 54 patients. These were divided into two groups according to whether they had never received treatment for oedema of the arm (Group A, 32 patients) or had previously received treatment and/or used an elastic sleeve (Group B, 22 patients). The characteristics of the patients are presented in Table I.

From the calculations of the results relating to the control period and the period of treatment with the elastic compression sleeve, 22 patients were excluded who had previously received treatment and/or who had used an elastic compression sleeve (Group B).

For 6 of the 32 patients comprising Group A, who had never received treatment, no measurements had been made during the control period.

These 6 patients had been given priority for intermittent pneumatic compression or had not attended for the measurements. For 2 patients there were no measurements during the first week's treatment with the elastic compression sleeve.

Moreover, not all the patients in Group A were able to complete the 6-month period of sleeve therapy, as owing to technical reasons it was necessary to advance the date for introducing the intermittent pneumatic compression therapy.

All 54 patients comprising Groups A and B had received intermittent pneumatic compression therapy.

## METHOD

### Measures of arm and definition of volume

The volume of the arm was measured by an investigator using a precise volumetric method that has been designed and tested by the author (9, 10). It was found that the variability of the observation of volume varied about a

mean of 0.5%. The modal variability was 0.2%. The basic quantity used for evaluating the effect of the treatment in this study was the relative volume of the oedematous arm.  $V_{\text{oed arm rel}}$  expressed as the ratio of the volume of the oedematous arm ( $V_{\text{oed arm}}$ ) to that of the control arm ( $V_{\text{control arm}}$ )

$$V_{\text{oed arm rel}} = \frac{V_{\text{oed arm}}}{V_{\text{control arm}}}$$

By thus expressing the volume of the oedematous arm as a ratio, any error incurred by the natural variability of the volume of the body with time was avoided. In an earlier study by the author this variability, measured over a fortnight in the arms of healthy subjects, was 5.3% (SD 3.2%).

The decrease in the relative volume of an oedematous arm,  $V_{\text{oed arm rel}}$ , between times  $t_1$  and  $t_2$  is expressed as:

$$V_{\text{oed arm rel}} = V_{\text{oed arm rel}}(t_1) - V_{\text{oed arm rel}}(t_2)$$

Another ratio that was applied is the relative volume of oedema, that is:

$$\begin{aligned} V_{\text{oed rel}} &= \frac{V_{\text{oed arm}} - V_{\text{control arm}}}{V_{\text{control arm}}} \\ &= \frac{V_{\text{oed arm}}}{V_{\text{control arm}}} - 1 \\ &= V_{\text{oed arm rel}} - 1 \end{aligned}$$

The relative decrease in the relative volume of oedema ( $\Delta V_{\text{oed rel}}$ ) in the interval from  $t_1$  to  $t_2$  (referred to below as the 'relative decrease in oedema') is expressed as the ratio:

$$\Delta V_{\text{oed rel}} = \frac{V_{\text{oed rel}}(t_1) - V_{\text{oed rel}}(t_2)}{V_{\text{oed rel}}(t_1)}$$



Control Period — Sleeve Therapy — IPC Therapy — Maintenance Sleeve Therapy

Fig. 1. The treatment schedule.

Substituting we have

$$\Delta V_{\text{oed rel}} = \frac{[V_{\text{oed arm rel}}(t_1) - 1] - [V_{\text{oed arm rel}}(t_2) - 1]}{V_{\text{oed arm rel}}(t_1) - 1}$$

$$= \frac{V_{\text{oed arm rel}}(t_1) - V_{\text{oed arm rel}}(t_2)}{V_{\text{oed arm rel}}(t_1) - 1}$$

where  $t_1$  and  $t_2$  denote the times at which measurements were made at the beginning and the end of the various periods, namely the control period, and the periods of elastic sleeve therapy, intermittent pneumatic compression, and maintenance sleeve therapy.

**Treatment schedule**

The treatment was given in four stages (Fig. 1).

1. *Control period.* In order to obtain an impression of the variability of the volume of the oedematous arm in relation to that of the unaffected arm, control measurements were made of the volume of the oedematous arm and the control arm on at least two occasions before the treatment was introduced.

2. *Elastic sleeve therapy.* The patients began by using a very carefully measured and fitted elastic sleeve (Jobst, Figure 2). This enclosed the whole of the lower and upper arm, and the hand, too, if this was swollen. The compres-

Table II. The change in the relative volume of the oedematous arm  $\Delta V_{\text{oed arm rel}}$ , the relative change of oedema  $\Delta V_{\text{oed rel}}$  and the change in the absolute volume of oedema  $\Delta V_{\text{oed abs}}$  over the control period of 4 weeks: Group A

$\Delta V_{\text{oed arm rel}}$	
Mean, %	0.38 %
SD	5.0
Mean of first and last measurements	148.44, 144.06 %
Level of statistical significance <sup>a</sup>	$P=0.703$
Number of patients	26
$\Delta V_{\text{oed rel}}$	
Mean, %	1.5 %
SD	8.9
Range	-15.4, 21.7
Number of patients	26
$\Delta V_{\text{oed abs}}$	
Mean, cm <sup>3</sup>	8.85 cm <sup>3</sup>
SD	98.4
Range	-220, 225
Number of patients	26

<sup>a</sup> Dependent two-tailed *t*-test.

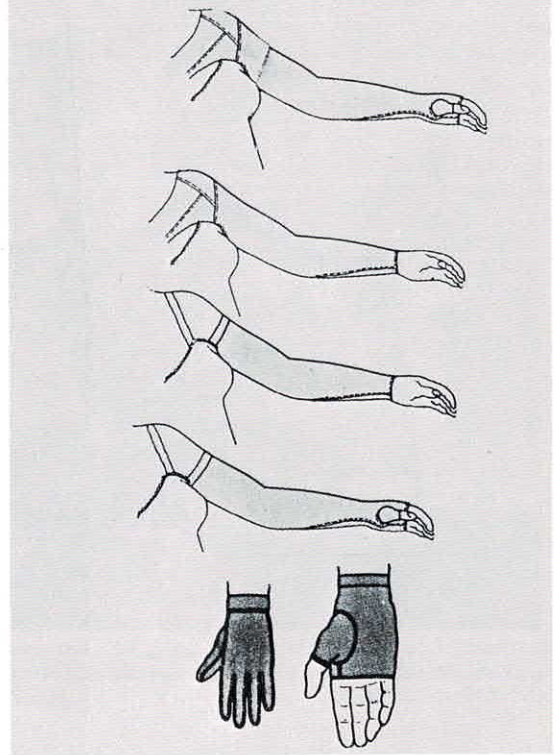
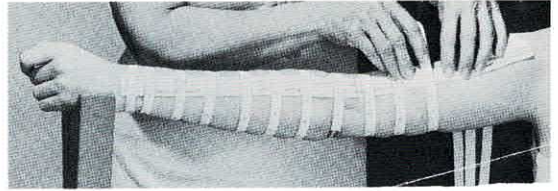


Fig. 2. Upper: Taking measurements. Lower: Various models of the Jobst elastic compression sleeve.

sive force exerted by the support at its distal end is 30–40 mmHg and this value decreases in the direction of the axilla. The sleeve was replaced if it became worn, or too large or tight. The patient was informed about infection prophylaxis, the importance of dynamic work, the unsuitability of static work, etc., and also as to the advisability of resting the arm in a raised position. The patient otherwise carried out normal tasks with no restrictions.

After the sleeve had been used for 1 week and 1, 3 and 6 months, measurements on the oedematous and the control arms were performed.

3. *Intermittent pneumatic compression therapy.* The next stage in the treatment schedule was massage of the arm with intermittent pneumatic compression (IPC), performed with a Jobst pulsator, hospital model (Fig. 3). The



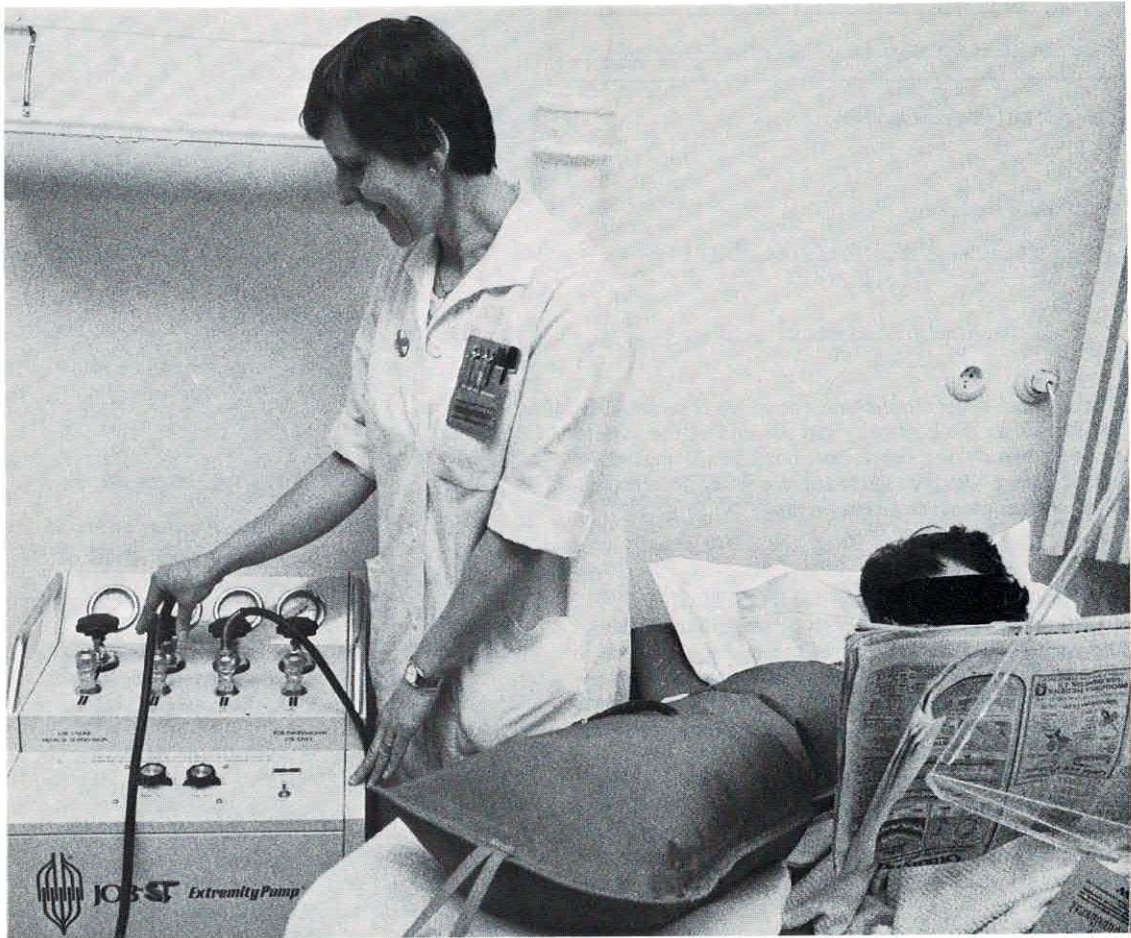


Fig. 3. Intermittent pneumatic compression therapy (Jobst Hospital Model).

treatment consisted of 10 sessions, given daily from Monday to Friday for 6 hours a day. The initial compressive force ranged from 35 to 45 mmHg, and this value was gradually increased to 60 mmHg after a daily check of the arm volume.

The IPC treatment was started after varying periods of the sleeve treatment (see point 2). Six patients were given priority for IPC treatment without having first passed through the 'control period' or been given sleeve treatment. The reason was either that the patient belonged to another administrative district, or that she was much troubled by the swollen arm. During the IPC treatment the elastic compression sleeve was worn.

4. *Maintenance sleeve therapy.* To prevent relapse, the sleeve was worn for 6 months after the intermittent pneumatic compression therapy had been terminated. The directions for use were carefully complied with. Measurements of volume were performed after 1 week and 1, 3 and 6 months.

## RESULTS AND DISCUSSION

During the control period of, on average, 4 weeks (range 1.5–10.3 weeks) during which no treatment was given, the volume of the oedematous arm decreased by about 0.4% in relation to that of the control arm. This corresponds to a reduction of the oedema of 1.5%, or about 9 cm<sup>3</sup>. The differences are not statistically significant (Table II). During the control period the results were derived only for the patients that had not earlier had any physiotherapy (Group A). The patients that had had such treatment (Group B), and that had already used the elastic sleeve were not included in the analysis of the results for the control period.

After the sleeve therapy for 1 week, and 1, 3 and

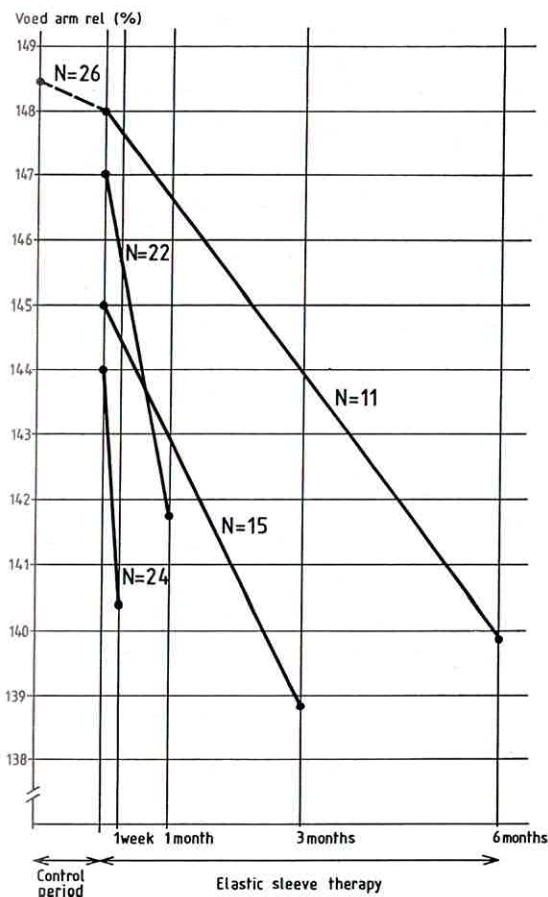


Fig. 4. The change in the relative volume of an oedematous arm ( $\Delta V_{\text{oed arm rel}}$ ) over the control period and from 1 week to 6 months of elastic sleeve therapy.

6 months there was a decrease in the relative volume of the oedematous arm by 4, 5, 6 and 8%, respectively. The values for the reduction in volume are significant (Table III, Fig. 4). As seen from the table, the number of patients gradually decreased with the duration of the treatment (for an explanation, see under 'The patient series'). Most of the reduction in volume occurred during the first week of the therapy; this has also been found earlier in the case of combined treatment, with manual massage, raised position of the arm, isometric exercises, and use of the elastic sleeve (10).

During the intermittent pneumatic compression therapy there was a further reduction of 9% in the volume of the oedematous arm in relation to that of the control. This corresponds to a mean reduction

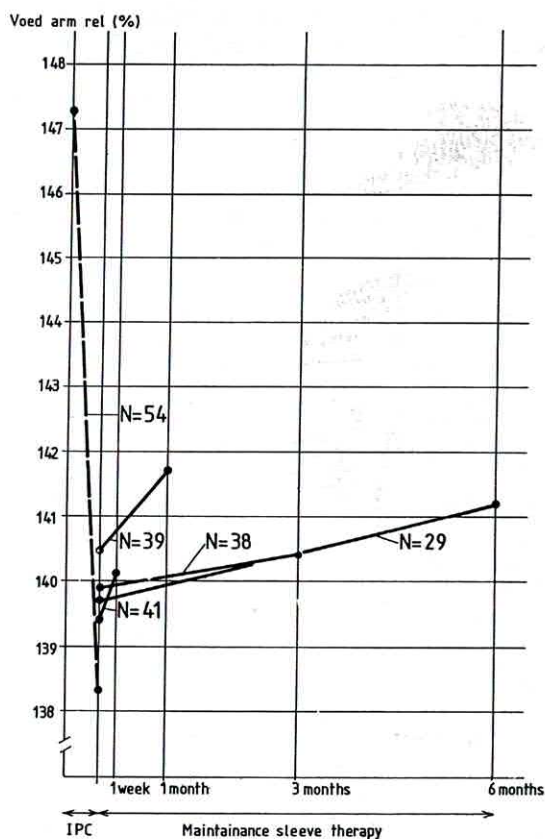


Fig. 5. The change in the relative volume of an oedematous arm ( $\Delta V_{\text{oed arm rel}}$ ) over the period of intermittent pneumatic compression therapy and maintenance sleeve therapy.

in oedema of 18%, or 213 cm<sup>3</sup>. The decreases are significant (Table III). The results of the IPC therapy relate to the 54 patients that had either had sleeve therapy (Group A) or that had received treatment on a previous occasion (Group B). It is conceivable that the results yielded by the IPC therapy when this was the first measure, were better than those reported here. However, even after the sleeve therapy the results were further improved by the IPC treatment.

During the maintenance treatment with the elastic compression sleeve the volume of the arm increased slightly, by 1–1.5%, though not to the level of statistical significance. Nor did the increase exceed the reduction in volume achieved with the IPC treatment (Table III, Fig. 5). It has been noted that



Table III. The change in the relative volume of the oedematous arm ( $\Delta V_{\text{oed arm rel}}$ ), the relative change of oedema (rel  $\Delta V_{\text{oed rel}}$ ) and the change in the absolute volume of oedema ( $\Delta V_{\text{oed abs}}$ ) over the period of elastic sleeve therapy, intermittent pneumatic compression therapy and maintenance sleeve therapy

Duration of treatment . . .	Elastic sleeve therapy Group A				IPC Groups A + B 2 weeks
	1 week	1 month	3 months	6 months	
$\Delta V_{\text{oed arm rel}} \times 100$					
Mean, %	3.7	5.3	6.2	8.1	9.0
SD	4.7				
First measurement, mean %	144.0	147.0	145.0	148.0	147.3
Last measurement, mean %	140.3	141.7	138.8	139.9	138.3
Level of significance, <i>P</i>	0.001	0.001	0.002	0.025	0.001
Number of patients	24	22	15	11 <sup>b</sup>	54
$\Delta V_{\text{oed rel}} \times 100$					
Mean, %	8.8	13.4	13.6	17.4	17.7
SD	59.2	12.2	12.6	20.2	9.3
Range	-8.9	-26	-11	-16.1	-9.9
	7.1	42	32.9	50.5	45.7
Number of patients	24	22	15	11 <sup>b</sup>	54
$\Delta V_{\text{oed abs}}$					
Mean, cm <sup>3</sup>	50	90.5	96.3	139.2	213.2
SD	82.6	100.8	127.8	184.5	181.6
Range	-120	-255	-75	-150	25
	200	265	335	345	970
Number of patients	24	22	15	12 <sup>b</sup>	54

<sup>a</sup> Dependent two-tailed *t*-test.

<sup>b</sup> Difference in number of patients due to one missing value for the control arm.

if the follow-up sleeve therapy is not given, a rapid relapse to the original arm volume can occur (10).

The net benefit of the intermittent pneumatic compression therapy and the maintenance sleeve treatment given for 1 week, 1, 3 and 6 months was a reduction in the relative volume of the oedematous arm by 8.3, 7.8, 8.5 and 7.5%, respectively.

### CONCLUSIONS

The study has shown that a marked reduction of the arm oedema can be obtained solely with the elastic compression sleeve, when worn for a fairly long time. Subsequent intermittent pneumatic compression therapy can produce a further considerable decrease in volume within a short time. For patients who are much troubled by the oedema it would seem best to begin with the IPC therapy. For those who are less affected, the sleeve therapy alone may suffice, since this form of treatment, too, is beneficial in the long run.

In order to maintain the beneficial effect of the IPC therapy it is essential to follow it up by applying the elastic compression sleeve.

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### REFERENCES

1. Beninson, J.: Post-mastectomy lymphoedema—medical therapy using intermittent compression and a pressure gradient prosthesis. Manuscript 1978.
2. Clodius, L.: Die chirurgische Behandlung der Armlymphödems nach mammaamputation. *Chir Praxis* 15: 273, 1971.
3. Clodius, L. & Wirth, W.: A new experimental model for chronic lymphoedema of the extremities. *Chir Plastica (Berl)* 2: 115, 1974.
4. Földi, M., Klüken, N. & Collard, M.: Praxis der Lymphgefäß und Venenerkrankungen. G. Fischer, Stuttgart, 1974.
5. Godfrey, C. M.: Postmastectomy lymphoedema. *Applied Therapeutics* 11: 440, 1969.
6. Jobst-Ireland Ltd, Thurles Co., Tipperary.
7. Leclaire, R. & Dupuis, M.: Traitement physiatricque du lymphoedème post mastectomie. *L'Union Médicale du Canada* 105: 700, 1976.

Maintenance sleeve therapy  
Groups A + B

1 week	1 month	3 months	6 months
-0.7	-1.2	-0.5	-1.5
139.4	140.5	139.9	138.7
140.1	141.7	140.4	141.2
0.084	0.141	0.625	0.308
41	39	38	29
-2.2	-2.5	-1.4	-6.3
8.9	12.8	16.3	19.8
-39.5	-45	-46.6	-46.6
17.7	20.3	26.4	36.2
41	39	38	29
-21.7	-35.5	-43.4	-76.9
83.0	115.4	168.3	182.3
325	-333	-505	-455
150	180	280	370
41	39	38	29

8. Stillwell, G. K.: Management of the patient with lymphoedema. 3rd Congress of the International Rehabilitation Medicine Association, Basle, 2-8 July, 1978.
9. Swedborg, I.: Volumetric estimation of the degree of lymphoedema and its therapy by pneumatic compression. *Scand J Rehab* 9: 131, 1977.
10. Swedborg, I.: Effectiveness of combined methods of physiotherapy for post-mastectomy lymphoedema. *Scand J Rehab Med* 12: 77, 1980.
11. Swedborg, I. & Wallgren, A.: The effect of pre- and post-mastectomy radiotherapy on the degree of edema, shoulder-joint mobility and gripping force. *Cancer* 47: 877, 1981.
12. Swedborg, I., Borg, G. & Sarnelid, M.: Somatic sensation and discomfort in the arm of post-mastectomy patients. *Scand J Rehab Med* 13: 23, 1981.
13. Tunedal, Th., Wikstrand, M. & Swedborg, I.: Varför och hur behandlar vi lymfödem i armen hos bröstcanceropererade patienter. *Sjukgymnasten* 1: 14, 1983.
14. Svensson, A., Engberg, Y. & Swedborg, I.: Svårigheter vid lymfödem i armen. *Arbetssterapeuten* 3: 18, 1983.

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