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Postmastectomy Lymphedema Treated With the Wright Linear Pump

Fifteen patients with postmastectomy lymphedema of the arm were treated with the Wright linear pump, a programmable, gradient pressure, sequential, intermittent compression pump. The group comprised volunteers in whom conservative measures had failed. This is a phase II trial to determine the efficacy of the pump.

All patients had subjective improvement. Objectively, all showed a reduction in edema, but this was of variable degree and depended on the amount of pre-existing lymphedema in the arm.

The Wright linear pump is easy to use and treatment was well tolerated. No fluid overload occurred due to treatment and no other medical problems were encountered.

The Wright linear pump seems more effective than other pneumatic intermittent compression pumps available.

Une étude de phase II fut entreprise afin de déterminer l'efficacité d'une pompe à compression séquentielle et intermittente (Wright linear pump) dans le traitement d'un lymphœdème du bras secondaire à une mastectomie. Quinze patientes, dont l'état demeurerait inchangé suite à des traitements traditionnels, furent sélectionnées pour participer à cette étude.

Toutes les patientes ont ressenti une amélioration subjective de leur condition. De plus, une réduction de l'œdème fut observée chez toutes les participantes.

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Cependant, cette réduction fut variable, dépendant de la sévérité du lymphœdème préexistant. Le traitement fut très bien toléré et aucun problème médical ne fut rencontré, principalement en ce qui concerne la surcharge liquidienne.

La Wright linear pump est d'usage très facile et semble être plus efficace que les autres pompes à compression intermittente présentement disponibles.

The incidence of lymphedema after mastectomy varies from 6.7% to 62.5%.¹ Its cause is due to a combination of factors, including surgical removal of lymphatic channels in the anterior axilla, especially along the axillary vein. Radiotherapy increases the incidence by scarring existing lymphatic channels and preventing the formation of new lymphatics. Obstruction of the axillary vein by scar tissue leads to lymphatic stasis, dilatation and valvular insufficiency of the lymphatics and increased susceptibility to infection. The incidence of lymphedema rises markedly with underlying infection, either superficial or deep.

Conservative management includes elevation² of the affected arm for at least 30 minutes at a time. Isometric exercises of the limb will increase the active muscle pump.³ Diuretics have been used but without much success. An elastic sleeve interrupts the cycle of edema and prevents stretching of tissues and loss of elasticity.

Available surgical procedures are not very successful. They include lymphangioplasty, omental bridging,⁴ lymphaticovenous shunting,⁵ Goldsmith's omental transposition,⁶ superficial to deep lymphatic anastomosis,⁷ lysis of axillary vein adhesions⁸ and in very severe cases as a last resort, amputation of the affected limb.

Several pneumatic intermittent compression pumps are available. The most common one, the Jobst unit,⁹ is com-

posed of a single cuff that inflates and then deflates. The unit fills all at once and the pumping milks the limb from distal to proximal. The pressure phase forces edema fluid up the lymphatic channels and the exhaust phase allows them to refill.

The Wright linear pump (Pittsburgh, Penn.) (Fig. 1)¹⁰ was developed to overcome the inherent reverse-flow characteristics of single-cuff pressure devices and thereby reduce back flow. Three cells enclose the hand and wrist, forearm and upper arm. Each cell is provided with a hose to receive air from the pump at preset times and pressures. Pressure gradients between cells from distal to proximal are at sequentially lower pressures, thus minimizing the tendency for back flow. The highest pressure is midway between the patient's systolic and diastolic blood pressures. There are three solid-state electronic timers. The "on time"

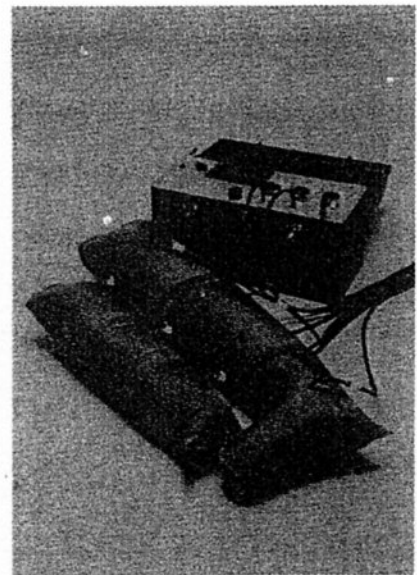


FIG. 1—Wright linear pump with cuffs for arm and leg.

controls the full time for each cycle (90 seconds). The "off time" controls the time at atmospheric pressure between

cycles (30 seconds). There are two delay timers between the three cells so that the most distal cell is on for longer than the

middle cell which again is on longer than the proximal cell (Fig. 2).

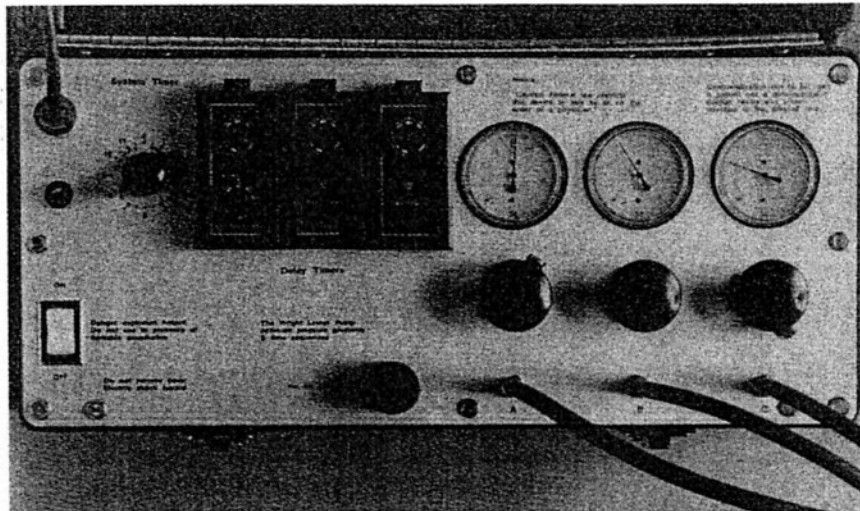


FIG. 2—Wright linear pump with three hoses to connect to three pressure devices and three solid state electronic timers.

Patients and Methods

Fifteen women with chronic lymphedema of the arm were admitted to the A. Maxwell Evans Clinic of the Cancer Control Agency of British Columbia in Vancouver for treatment on the Wright linear pump. All had had surgery for carcinoma of the breast and 14 had received adjuvant radiotherapy. They ranged in age from 35 to 81 years (median 67 years). Two patients had undergone classic radical mastectomy, nine modified radical mastectomy and four had had segmental resection with axillary node dissection. Eleven patients had axillary node involvement. Thirteen received adjuvant five-field radiotherapy to the internal mammary, supraclavicular and axillary lymph nodes and also the chest wall. One woman with no cancer in the lymph nodes received internal mammary and supraclavicular radiation only for an inner quadrant lesion (Table I).

The edema occurred from 1 to 168 months (mean 30 months) after initial therapy.

The patients were self-selected in that they requested therapy for the lymphedema. In many, conventional conservative measures had failed. None admitted to any psychological difficulty in living with a lymphedematous arm. Almost all patients complained that the arm was cumbersome and heavy, and 50% experienced some pain in the limb, but none had any functional disability. Four women had had numerous episodes of infection. In another, lymphedema was the direct result of trauma.

Six patients had been prescribed diuretics, usually furosemide or hydrochlorothiazide, but only one reported any

Table I—Patient Characteristics

Patient no.	Present age, yr	Surgery	Date of treatment	Nodal involvement	Radiation to axilla
1	70	L mrm	August 1983	+	Yes
2	70	L seg + nodes	July 1981	+	Yes
3	51	L seg + nodes	May 1980	-	Yes
4	60	R seg + nodes	July 1983	-	Yes
5	69	R mrm	January 1980	+	Yes
6	63	R mrm	December 1982	+	Yes
7	81	L radical	1968	+	Yes
8	65	R mrm	May 1985	+	Yes
9	79	R mrm	July 1975	+	Yes
10	35	L radical	December 1973	-	No
11	43	R seg + nodes	November 1981	-	Yes
12	71	L mrm	June 1984	+	Yes
13	55	R mrm	October 1984	+	Yes
14	39	R mrm	March 1982	-	No
15	59	L mrm	September 1983	+	Yes

mrm = modified radical mastectomy, seg + nodes = segmental resection and axillary node dissection, radical = radical mastectomy.

Table II—Duration of Edema and Measurements of Arm Circumference*

Patient no.	Time for edema to occur, mo	Duration, mo	Circumference of normal arm, cm	Difference between normal and affected arms, cm	Circumference of affected arm, cm		Reduction in edema, cm
					Before treatment	After treatment	
Group 1: Edema 2 - 5 cm							
2	31	25	24.3	3.7	28.0	26.9	1.1
3	5	65	20.0	4.1	24.1	23.5	0.6
4	12	19	22.8	3.7	26.5	22.6	3.9
5	69	4	23.0	2.0	25.0	24.2	0.8
7	108	108	22.0	2.2	24.2	23.0	1.2
8	1	10	22.7	2.3	25.0	24.0	1.0
10	60	93	25.7	2.3	28.0	26.0	2.0
14	24	26	23.5	3.5	27.0	26.3	0.7
15	18	30	23.0	4.5	27.5	23.8	3.7
Group 2: Edema > 5 cm							
1	30	6	19.0	5.4	24.4	22.0	2.4
6	22	15	21.7	6.7	28.4	26.0	2.4
9	12	120	20.7	13.8	34.5	29.0	5.5
11	18	38	20.0	7.0	27.0	22.5	4.5
12	1	19	26.8	6.7	33.5	28.9	4.6
13	96	168	20.0	9.0	29.0	27.8	1.2

*Measured 6 cm below the olecranon.

improvement. Twelve of the 15 patients had previously used a Jobst pneumatic intermittent compression pump. Seven used it consistently for at least 3 months but discontinued its use because of poor results. Ten patients had been measured for an elastic sleeve but none wore it consistently as they found it too hot in the summer. Cosmetically, most patients felt that the elastic sleeve attracted more attention to the arm than the edema itself.

The women were treated on the Wright linear pump according to the protocol outlined by Alexander at the DT Watson Rehabilitation Hospital, Sewickly, Pennsylvania.

The patients were screened for pre-existing cardiac, respiratory, renal or hepatic disease to reduce the risk of volume overload. All patients had recently undergone chest roentgenography, electrocardiography, complete blood count, liver function testing, measurement of blood urea nitrogen and creatinine levels and serum protein electrophoresis. Concurrent infection in the arm was a contraindication to treatment.

The hospital admission period was 48 hours. Treatment with the Wright linear pump totalled 38 hours, consisting of seven sessions of increasing time as follows: a 2-hour period, two 4-hour periods, two 6-hour periods and two 8-hour periods with 1 hour's rest between each session. Vital signs, including heart rate, blood pressure and respiration, were checked every 2 hours.

The most distal cell of the pump was inflated to the midpoint between the patient's systolic and diastolic pressures. The middle-cell pressure was 20 mm Hg lower and the proximal cell was in turn 20 mm Hg lower than that. The distal cell was on for 90 seconds. The first delay timer was set at 20 seconds so that the middle cell was on for 70 seconds. The second delay timer was also set for 20 seconds so that the proximal cell was on for 50 seconds. The "off timer" was set at 30 seconds, thus making each cycle a total of 120 seconds.

The women were arbitrarily divided into two groups (mild and moderate-severe edema) to see if there was a relation between volume of edema and response to treatment. Measurements were taken 6 cm below the olecranon,

comparing the affected with the unaffected arm. Those with a 2- to 5-cm difference in circumference fell into group 1 (nine). A difference greater than 5 cm put them into group 2 (six patients). (A difference less than 2 cm would have not been sufficient to require treatment.)

Results

All patients experienced a subjective improvement. Even those who had little objective improvement were pleased with the results. All said the arm felt lighter and pain free, and the skin felt smoother and lax. The limb was less tense, and some patients were pleased at being able to see the elbow and wrist joints and tendons along the back of the hand for the first time in years.

Objective improvement was less marked (Table II). Eight patients had a 0.5- to 2-cm reduction, three had a 2- to 4-cm reduction and three others had a 4-cm reduction in arm circumference. The patient with a 13.8 cm difference between the two arms had the most marked reduction (5.5 cm).

Discussion

The Wright linear pump is extremely easy to use and is suitable for home therapy. Subjectively all patients felt improved, but objectively the results were mixed. In general, patients with more edema had more fluid to lose and therefore had a better response, although this was not consistent (patients 3 and 13, Table II). The disability perceived was not in direct proportion to the amount of edema as the tolerance of each patient differed.

No conclusions can be drawn with such small patient numbers, but there appears to be no relation between prior episodes of infection, duration of edema and response to treatment (Table III). Underlying infection will certainly aggravate existing lymphedema as in patients 5, 9 and 13. In patient 11, the lymphedema resulted from infection after a cut from a chicken bone; three subsequent episodes of infection aggravated the edema.

Some patients complained of stiffness at the elbow joint and soreness throughout the arm but not pain while they were

on the machine. A few patients had pre-existing arthritis which was aggravated by the relatively long periods of immobilization.

One problem encountered was difficulty in fastening the Wright linear pump sleeve over the shoulder so that it did not slide down. Many patients had repeatedly to pull the sleeve up the arm. This was a problem at night when they were asleep and some had increased edema in the axilla as a result.

It was explained to all patients that they would require ongoing treatment and would probably have to be on the pump for several hours a day until a good response was obtained. Thereafter the time could be reduced to perhaps 1 to 2 hours a day. However, treatment would be for an indefinite period as this treatment was only for symptoms.

The Wright linear pump is efficient and has theoretical design advantages. A phase III study would now include randomizing patients into two groups — one group treated with the Wright linear pump and the other with the Jobst intermittent pneumatic compression pump.

A relative disadvantage of the Wright linear pump is its high cost, US \$4000.00, but this may be covered in part by some insurance companies.

Patient motivation and compliance are absolutely vital in order to obtain good results.

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Table III—Relation of Infection to Duration of Edema and Response

Patient no.	Date of first infection and no. of episodes	Difference in arm circumference, cm*	Reduction in edema after treatment, cm*
5	August 1982	4.1	0.8
9	1982 1984 6 X 1986	13.8	5.5
11	1983 4 X	7.0	4.5
13	1972 4 X	9.0	1.2

*Measured 6 cm below the olecranon.