Three case studies indicating the effectiveness of manual lymph drainage on patients with primary and secondary lymphedema using objective measuring tools

Robert Harris, Neil Piller

Abstract The superficial lymphatic system is divided into areas called lymphatic territories which are separated by watersheds. When the lymphatic system fails to remove its load either due to surgery, radiotherapy or some congenital malformation of it then the fluid (and the proteins and wastes contained within it) accumulates in that territory. Anastomotic connections exist across the watersheds and while they can work unaided, manual lymph drainage (MLD) can significantly help drainage across them into unaffected lymphatic territories. MLD also can help the movement of extracellular fluids into the lymph vessels and then along them. The purpose of the study is to examine the effectiveness of a manual technique in moving fluids and softening hardened tissues using three non-invasive examination tools. We examined the movement of fluids from the affected limbs of three lymphedema patients who underwent a standardized 45-min treatment using the Dr Vodder method of M L D. We chose a typical cross section of patients with either a primary leg, secondary leg or secondary arm lymphedema. The arm lymphedema patient was also measured for return of edema over a 30-min period after the conclusion of treatment and underwent a follow-up control measurement, 2 months later without treatment. The tools used were tonometry, multi-frequency bioelectrical impedance and perometry. All three evaluation tools indicated a movement of fluid to different and unblocked lymphatic territories as well as a softening of tissues in some of the affected limbs. Fluid movements were also detected in the contralateral, apparently normal limbs, even though they were not treated. MLD thus is an effective means of fluid clearance when it has accumulated as a consequence of a failure of the lymphatic system. It seems likely that MLD has a systemic effect on the lymphatic system and that it can improve flow from otherwise normal tissues. It is hypothesized that a series of treatments (as is the norm) would result in even more significant improvements.

Key words: Manual lymph drainage; Lymphedema; Tonometry; Perometry; Multi-frequency bio-impedance

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Introduction

Although lymphatic drainage techniques appear to work well for the great majority of patients with lymphatic and vascular disorders, there have been very few recorded occasions when the effectiveness of the treatments has been validated objectively (Johansson 2002, Moseley & Piller, 2002, Piller & Harris 2002).

In this exploratory study, which is the precursor of a full study on a series of patients, three cases of chronic lymphatic drainage insufficiency were treated with the Dr Vodder method of manual lymph drainage (MLD). The aim of this study is to objectively determine the impact of the MLD session on compositional changes including limb hardness, fluid distribution, circumference and volumes. This level of objectification is essential if we are to determine the real effect of these very important treatments and to enable health practitioners and patients alike to better know what to expect after a treatment session. Of course more marked results could reasonably be expected following a series of treatments.

Methods

The effectiveness of the technique was validated using a range of objective data collection including impact on fibrotic induration, extracellular fluid levels, volume and circumference.

Fibrotic induration assessment by tonometry (Fig. 1)

Tonometry has been frequently used since its inception in 1976 by Clodius, Deak and Piller (Clodius & Piller 1976, Liu & Olzsewski 1992, Bates et al. 1994, Stanton et al. 2000) as a means to detect fibrotic induration in the tissues. Resistance

Fig. 1 Tonometer.

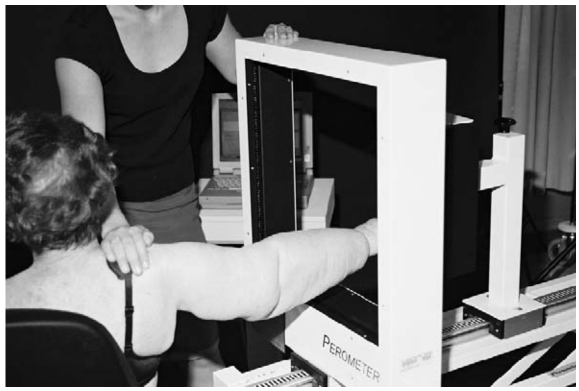

Fig. 2 Perometer.

to compression (which relates the extent of fiber build-up) is measured by placing the weight-based tonometer over the mid-point of a lymphatic territory or over a watershed. A measurement is taken of the depth that the plunger penetrates after a period of 2 seconds which is recorded on an analogue scale. All tonometry points were located using anatomical landmarks for reproducibility. For the leg patients, these were on the anterior thigh lymphatic territory on the midline of the thigh; on the posterior thigh on the watershed of the medial and lateral lymphatic territories and on the mid-calf. For the arm patient, these were on the forearm, upper arm, anterior and posterior thorax. The lymphedematous and contralateral normal limbs were always measured with the contralateral (normal one) serving as a control.

All tonometry measurements were taken with the patient supine and rested with the muscles relaxed.

Volume and circumference assessment by perometry (Fig. 2)

Perometry is rapidly becoming the gold standard for the measurement of changes in circumference and volume of affected limbs (Stanton et al. 1997, 2000). Perometry (Pero-systems, Germany) measures the circumference and volume at 3.7-mm intervals by opto-electronic means. When used correctly it is not subject to the measurement error of tapes and through its measurement at 3.7-mm intervals, provides a much more accurate and reproducible estimate of volume and circumference and of their changes with time. An additional feature of being able to perform real-time plethysmography is the advantage of being able to follow changes at previously determined positions on the limb.

To measure limb volumes and circumferences, patients were rested prone on a special bed and their foot or hand supported on a rest. After approximately 5 min of rest, the perometer frame was then moved up and down the limb and the segmental volume and circumferences recorded. Again the affected and control limbs were both measured.

Extracellular fluid assessment by multi-frequency bio-impedance (Fig. 3)

Bio-impedance involves the passage of a range of frequencies of electrical current through the tissues (Cornish et al 2001). It is able to give a clear indication of the changes in extracellular and intracellular fluids as well as other compositional changes such as body fat, lean muscle mass, etc. However, for the purpose of the study only changes in total intracellular and extracellular fluids are considered. There are a wide range of bio-impedance analyzers available ranging from the simple yet effective single low (5 kHz) frequency machine (Impedimed, Queensland Australia) for measuring extracellular fluid changes and useful for the independent practitioner, to multi-frequency ones to measure intracellular fluids and to provide estimates of percentage fat (Xitron, United States). The one used in this study was the newly available In-body 3 machine (Daniel Co., Korea). This generates a full body picture and provides a summary analysis (Wantanabe et al. 1989, Cha 1995). Full body changes including changes in the extracellular as well as intracellular fluid distribution in the arms and trunk are recorded in view of the hypothesis that when one part of the body is affected by lymphedema, the whole of the body may suffer fluid distribution changes and that MLD may have systemic effects.

Fig. 3 Bio-impedance.

To measure bio-impedance the patient's palms and soles were moistened with saline and then she or he was asked to stand on the foot plates consisting of four electrodes. They were then asked to hold in each hand, a hand grip dual pole electrode. Measurement which took about 1.5 min was then immediately initiated. At total of eight electrodes administered and recorded current, overcoming some of the problems of 4-point electrode systems.

The Cases

1. Patient with unilateral secondary leg lymphedema (Fig. 4). A 46-year-old woman had a left-sided groin clearance in association with an hysterectomy. She has a left-sided secondary lymphedema. She has experienced subjective and objective changes in the limb for a period of 8

Fig. 4 Patient with secondary leg lymphedema.

years. She has had regular treatment with lymphatic massage and frequently wears a support garment. She has also been using an aerobic exerciser daily (Moseley & Piller 2002).

2. Patient with primary leg lymphedema (Fig. 5). A 75-year-old male with a primary lymphedema of the left leg of 35 years duration. This patient received compression garments (Jobst) as required, monthly low-level helium neon–gallium arsenide scanning laser and associated lymphatic massage according to the Casely-Smith Technique (Casley-Smith & Casley-Smith, 1997). The patient was very happy with the control and the effectiveness of the previous treatment on the limb but consented to a single session of MLD to see if any further improvement could be obtained.

3. Patient with secondary arm lymphedema (Fig. 6). This 52-year-old patient had undergone a partial mastectomy with axillary clearance, radiation and chemotherapy. She had experienced lymphedema for the past 2 years. She had received

Fig. 5 Patient with primary leg lymphedema.

Fig. 6 Patient with secondary arm lymphedema.

regular laser therapy and lymphatic massage and wore a compression sleeve to control her lymphedema.

All three patients were happy with their current therapy, but consented to further therapy on the basis that some further improvement may be expected but it was emphasized that this may not be so and that was what the investigation was in part about.

MLD massage techniques

The method employed for the one-off, 45-min treatment of each patient was the Dr Vodder method of MLD. Initially developed by E. Vodder (Wittlinger & Wittlinger 1998) in France in the 1930s, the techniques were later modified and adapted for use with edema patients by Asdonk, Wittlinger and Foeldi (Kurz 1996). For a full description of the Dr Vodder method the reader is referred to previously published articles (Harris 1992, 1994). The techniques used are those taught by the Dr Vodder Schools.

The basic characteristics of the manual techniques are:

(1) Light, rhythmic, alternating pressure with a zero and pressure phase in each stroke.
(2) Skin is stretched and torqued in a bi-directional manner (lengthwise and diagonal).
(3) Pressure and stretch is applied in the desired direction of fluid movement. This may or may not be in the direction of lymph flow, dependant on the particular intervention and interruption to lymph pathways.
(4) Pressure is adapted to local edema conditions. Generally pressure is lighter over soft spongy tissues and firmer over fibrotic tissues.
(5) Maximum pressure used on non-fibrotic tissue is 30–32 mm Hg.

The five basic techniques employed in the Dr Vodder method of MLD are Stationary Circles, Thumb Circles, Pump Technique, Scoop Technique and Rotary Technique. These are described elsewhere (Wittlinger 1998, Kasseroller 1998).

Specific edema movements are variations and adaptations of the basic movements and are prescribed manual techniques, adapted specifically to the type of patient and pathology presented. In an attempt to standardize the treatment procedure, a format was used with each patient according to the pathology, with a specific amount of time spent on each body part within the time span of 45 min.

The patients had been previously assessed at the Flinders Lymphedema Assessment clinic but none of the patients had been treated by the MLD therapist in the past. Patients did however involve themselves in self-management programs as well as in the treatments indicated earlier.

The patients were asked to rest for 30 min upon arrival at the assessment clinic. They were then measured using the three devices described above. The patient was then treated and reassessed immediately after the treatment. The arm lymphedema patient was also measured at 10-min intervals for 30 min after conclusion of treatment. In addition, this patient underwent a second control baseline measurement 2 months later. During the reassessment she was assessed using the perometer and multi-frequency bio-impedance machines and then rested supine for 45 min without treatment. She was then measured four times during a 30 min period after the rest period. This approximated the conditions of the MLD treatment program but with out the actual treatment.

Results

Case 1 (left-sided secondary leg lymphedema patient)

Tonometry (Table 1)
These figures indicate that the MLD program softened the tissues at all positions measured on the lymphedematous limb. It also indicates a similar but not so great an effect on the supposedly normal contralateral limb. Not withstanding this latter effect, the differences in tissue softness between the limbs were much less post-treatment than they were pre-treatment.

Bio-impedance (Table 2)
These figures indicate that MLD resulted in a reduction in total fluids not only in the massaged lymphedematous limb but also in the apparently normal contralateral one. Given that there is likely to be little effect on the intracellular fluids most of this movement is hypothesized to be extracellular. The fluid removal was accompanied by a concomitant increase in total fluids in the arms and trunk. The sum of the fluid removed from the legs (320 ml) does not equal the amount deposited in the arms and trunk (230 ml) presumably due to the current ability of the equipment to measure only to two decimal points for changes in the fluid measured in liters. Certainly however, the measurement error was less than the changes detected.

Perometry (Table 3)
There were concomitant slight reductions in circumference at each of the measured positions.

These figures support the findings from bio-impedance studies but tend to show a slightly lower reduction in what presumably may be extracellular fluids from the limbs. In total this was 263 ml.

Case 2 (left-sided primary lymphedema patient)

Tonometry (Table 4)
These figures indicate that MLD softened the tissues at all measured positions on the affected limb. They also indicate a similar but not so great an effect on the supposedly normal contralateral limb.

Bio-impedance (Table 5)
These figures indicate that MLD resulted in a reduction in total fluids not only in the massaged lymphedematous limb but also in the apparently normal contralateral one. Given that there is likely to be little effect on the intracellular fluids most of this movement is likely to be extracellular. The removal there was accompanied by a concomitant increase in total fluids in the arms and trunk. The sum of the fluid removed from the legs (270 ml) does not equal the amount deposited in the arms and trunk (410 ml) presumably due to the current ability of the equipment to measure only to two decimal points for changes in the fluid measured in liters.

Perometry (Table 6)
These figures support those above collected from the bio-impedance equipment. Perometry indicated a total volume reduction in both legs of 286 ml while bio-impedance indicated a 270 ml reduction. As with bio-impedance, perometry showed a reduction in the non-massaged limb.

Case 3 (left-sided, secondary arm lymphedema patient)

Tonometry (Table 7)
No discernable patterns were observed after treatment of the lymphedematous limb. In reality, great differences are not expected after such a short treatment regimen; however, there is a possibility that will be explored in the larger trial, that the MLD massage pattern does break up the networking of the collagenous fibers and thus through this mechanism, allow the extracellular fluids to flow more freely.

Table 1 Tonometry: results (Case 1: secondary leg lymphedema; greater values equal softening of tissues)

	LE pre	NO pre	Diff	LE post	NO post	Diff
Ant. thigh	6.7	7.8	−1.1	8.6	8.2	+0.4
Post thigh	7.6	8.4	−0.8	8.4	8.8	−0.4
Calf	4.9	5.7	−0.8	6.7	5.8	+0.9

MLD softened tissues at all positions on both limbs. Differences post-treatment were much less than pre-treatment.

Table 2 Bio-impedance: results (Case 1: secondary leg lymphedema)

Fluid level pre- and immediately post-measurement

	Pre (l)	Post (l)	Difference (ml)
R. arm	1.63	1.65	+20
L. arm	1.61	1.62	+10
Trunk	14.40	14.60	+200
R. leg	4.77	4.62	−150
L. leg (LE)	5.09	4.92	−170

Reduction in fluid level in affected and normal (untreated) limb. Correlation with perometry findings. Increase in trunk fluid indicates displacement from legs.

Table 3 Perometry: results (Case 1: secondary leg lymphedema)

Volume changes pre- and immediately post-treatment

	Lymphedema leg (ml)	Normal leg (ml)	Total (ml)
Whole limb:	−150	−130	−280
Below knee:	4	−77	

Largest reduction in thigh. Significant reduction in normal (untreated) limb.

Table 4 Tonometry: results (Case 2: primary leg lymphedema; greater values equal softening of tissues)

	LE pre	NO pre	Diff	LE post	NO post	Diff
Ant. thigh	6.2	6.1	+0.1	7.2	6.6	+0.6
Post thigh	5.7	5.0	+0.7	5.9	5.1	−0.8
Calf	3.2	6.1	−2.9	5.4	6.8	−1.4

MLD softened tissues at all positions on both limbs. Differences post-treatment were much less than pre-treatment.

Table 5 Bio-impedance: results (Case 2: primary leg lymphedema)

Fluid level pre- and immediately post-measurement

	Pre (l)	Post (l)	Difference (ml)
R. arm	2.06	2.13	+70
L. arm	2.03	2.07	+40
Trunk	17.20	17.50	+300
R. leg	6.35	6.20	−150
L. leg (LE)	7.24	7.12	−120

Reduction in fluid level in affected and normal (untreated) limb. Correlation with perometry findings. Increase in trunk fluid indicates displacement from legs. Total increase in arms and trunk more than displaced from legs.

Table 6 Perometry: results (Case 2: primary leg lymphedema)

Volume changes pre- and immediately post-treatment

	Lymphedema leg (ml)	Normal leg (ml)	Total (ml)
Whole limb	−131	−155	−286
Below knee	−80	−74	

Largest reduction below knee in affected leg. Significant reduction in normal (untreated) limb.

Bioimpedance (Table 8)

In terms of segmental fluids and their removal, the greatest reduction in the lymphedematous limb occurs immediately after massage with a gradual return to pre-treatment values by 20 min after massage cessation.

Interestingly the normal arm shows a similar pattern. (Table 9)

Slight changes in fluid levels are seen but not as great as when the patient was treated with MLD. Little variation in fluid volume is seen in the normal untreated limb.

Perometry (Table 10)

Immediately post-treatment the normal limb showed a slight increase in its volume over pre-treatment values, perhaps indicating some movement of fluids from the treated lymphedematous limb into the normal one. Within 10 min of the completion of the massage however the normal limb also showed a reduction in volume, to less than the pre-treatment value.

Taking the lymphedematous limb alone the massage resulted in a 308 ml (6.8%) volume reduction in the limb. Ten minutes after the massage had ceased there was a further 50 ml reduction, after 20 min another 35 ml, but 30 min post-treatment there was a 42 ml volume increase over the 20- min reduction. Maximum percentage reduction was 8.7% at 20 min post-treatment.

Taking the normal limb into account, massage had a significant effect in removing 339 ml of volume from the whole of the lymphedematous limb (this amounts to 32% of the difference in volume between the normal and lymphedematous limb). However within 30 min almost 39% of the achieved reduction had returned with this refilling occurring gradually and evenly over this period. After 30 min post-treatment the reduction percentage was 20%. This perhaps provides evidence for the need to provide some form of external support (compression bandaging or garment) after massage (Table 11).

Two months after the initial treatment, the patient was remeasured using the perometer. Only a slight fluctuation (maximum less than 6%) was seen in the change in volume when comparing the normal and treated arms, immediately after the rest phase of 45 min and over a subsequent 30-min measuring period.

Discussion

There has been some discussion in the literature about the possibility that once one section of the body is

Table 7 Tonometry: results (Case: 3: secondary arm lymphedema; greater values equal softening of tissues)

	LE pre	NO pre	Diff	LE post	NO post	Diff
Fore arm	4.3	5.7	−1.4	3.9	6.3	−2.4
Upper arm	6.8	6.0	+0.8	7.0	8.8	−1.8
Anterior thorax	7.7	9.2	−1.5	7.6	8.5	−0.9
Posterior thorax	3.4	3.2	+0.2	3.2	5.4	−2.2

No discernable patterns emerged after treatment.

Table 8 Bio-impedance: results (Case 3: secondary arm lymphedema)

Fluid level pre and immediately post measurement (volumes are in ml)

	Pre	Post	10 min	20 min	30 min
Affected arm	2170	2020	2080	2180	2250
Change		−150	−90	+10	+80
Normal arm	1420	1320	1350	1400	1420
Change		−100	−70	−20	0
Diff. LE-normal	750	700	730	780	830
Trunk	14,300	13,700	13,900	14,200	14,400

Greatest reduction seen in lymphedema arm immediately after MLD. Gradual return to pre-treatment level after 20 min.

Table 9 Bio-impedance: results (control; Case 3: secondary arm lymphedema)

Fluid level pre- and immediately post-rest (volumes are in ml)

	Pre	Post	10 min	20 min	30 min
Affected arm	2190	2130	2220	2230	2200
Change		−60	+30	+40	+10
Normal arm	1420	1430	1390	1390	1400
Change		+10	−30	−30	−20
Diff. LE−NO	770	700	830	840	800

No trunk measurements taken. Greatest reduction seen in lymphedema arm immediately after rest (but 60% less than when treated).
Procedure confounding factors affecting very limb reacts at rest with time separation between initial study and control (7 weeks).
Little change in normal arm.
Gradual return to pre-treatment level after 20 min.

Table 10 Perometry: results (Case 3: secondary arm lymphedema)

Volume changes pre- and immediately post-treatment (ml)

		LE arm	NO arm	Total	% change
Pre-treatment		4541	3494	1047	0
Post-treatment	0 min	4233	3525	708	32
Post-treatment	10 min	4183	3447	736	30
Post-treatment	20 min	4148	3369	779	26
Post-treatment	30 min	4190	3351	839	20

Slight increase in normal arm after 10 min. Largest % change compared to normal, shown immediately after treatment. Largest reduction in affected arm, shown 20 min. after treatment.

affected by lymphedema that other sections (particularly the contralateral limb) are affected as well (Pecking et al. 1983, Foeldi et al. 1989). The results of this study support this hypothesis since improvements in extracellular fluid content and tissue softness were observed for each of the case studies in the contralateral limb as well as in the lymphedematous one (excepting the arm patient). Of course it may be that these three studies were in some way abnormal in terms of lymphatic drainage but this was not examined. However, the multi-frequency bio-impedance analysis output indicated that the fluid distribution was within the normal range in the ''normal'' limb. This is an exciting area which remains to be investigated.

There has also been some evidence of the ability of lymphatic massage to facilitate fluid movement through the superficial lymphatic system via inguinal-axillary anastomoses to the lymph systems of the axillary area (Piller et al. 1998). The information collected from the In-body bio-impedance machine indicates that this may be so since there were slight (presumably transient) increases in total fluids in both arms when the legs were treated. As would be expected, there were rather significant accumulations (200–300 ml) of additional fluid transiently in the trunk in both case studies involving treatment of the legs.

In all three case studies the MLD was concentrated on the left lymphedematous limb; however, there were similar although not so marked changes in the right, apparently normal limbs. This suggests an interlinkage of the lymphatic system and in one way supports the current knowledge about the anastomotic connections between the lymphatic territories. It also suggests that a problem in one part of the lymphatic system may manifest itself remotely. However when the cause of the problem is removed (i.e. of poor entry into the lymphatics, poor flow along them, or inadequate clearance into a lymph node) then the system can

Table 11 Perometry: results (Control; Case 3: secondary arm lymphedema)

Volume changes pre- and immediately post-treatment (ml)

		LE arm	NO arm	Total	% change
Pre-treatment		4430	3226	1204	0
45-min rest	0 min	4413	3234	1179	2
Post-rest	10 min	4367	3235	1132	6
Post-rest	20 min	4499	3217	1202	0
Post-rest	60 min	4414	3274	1140	5

Slight increase in normal arm after 10 min. Largest % change compared to normal, shown 10 min post-rest. Largest reduction in affected arm, shown immediately after rest.

correct itself in other parts of the body.

In two of the cases, post-MLD tonometry showed a softening of all sites of measurement but this was most pronounced in the calf area of the lymphedematous legs. However, softening also occurred in the major lymphatic territories of the anterior thigh and in the posterior thigh watershed area. In both cases there were reductions in the range of 2–3% in the volume of the normal and affected limb subsequent to MLD. While this is a small reduction it must be remembered that these patients were receiving the best currently available treatment and were well educated in terms of caring and managing their limbs. Also this was the outcome from a single treatment session. We expect (and there is evidence from other studies: Hutzschenreuter et al. 1991, Hutzschenrenter & Herpertz 1993, Boris et al. 1997) that a series of treatments achieves a cumulative result in terms of limb improvements.

These case studies, using a range of modern fluid, fiber and volume change detection equipment indicate that a single session of the Dr Vodder method of MLD has a relatively quick and clinically significant effect on limb fluid distribution and tissue softness. The study results do show that the effect of even a single MLD massage can be measured. The control study on the arm lymphedema patient indicates that without treatment, there is little change in fluid volume and extracellular fluid content of the affected and non-affected limbs. It is proposed to undertake a longer term longitudinal study of the effect of MLD in combination with other supporting treatment such as bandaging and garments in a more strictly controlled environment where there is no need for the patient to move from the supine to standing position for some measurements and to make multiple objective measures at each stage of the process. Normally a patient receives a number of massage and bandaging sessions not a single MLD session without bandaging, as was tested here.

Conclusion

Three objective techniques of tonometry to assess tissue softness, multi-frequency bio-impedance to assess total and extracellular fluids and perometry to assess volume and circumference changes were used to objectively assess the effect of a single session of MLD on a patient with primary leg lymphedema, a patient with secondary leg lymphedema, and a patient with secondary arm lymphedema.

A single session of MLD has been shown to have what appears to be a significant clinical effect on the total fluid levels (mainly represented by extracellular fluids) in the massaged and affected lymphedematous limbs. Also recorded was a softening of the tissues of all of the major lymphatic territories.

Surprisingly there were also reductions in the total fluid levels of the apparently normal, contralateral limb even though the MLD massage was not performed here. Post-MLD measurements demonstrated that there were concomitant increases in the total fluid content of the trunk area in both cases of leg lymphedema and a slight increase in fluids in the arms.

A follow-up controlled pilot study is proposed to test the effect of multiple MLD sessions in combination with the normal line of other support including bandaging and garments.

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