Comparison of the effectiveness of MLD and LPG technique®

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Abstract

Background: This study compares Endermologie® — a new treatment for lymphoedema which involves mechanised massage — with manual lymphatic drainage (MLD). *Methods:* A single-blinded, randomised study compared the two techniques combined with compression bandaging to treat secondary arm lymphoedema post breast cancer treatment. The MLD group (n=20) and the Endermologie group (n=10) received treatment four times a week for four weeks. Measurements of arm and truncal fluid volumes, overall limb tissue volumes and subjective symptoms were taken at baseline, directly after the first treatment, at 24 hours, at the beginning and end of weeks 1, 2, 3 and 4 and at the one-month follow up. *Results:* Both groups had similar and significant reductions in whole arm volume, arm fluid and truncal fluid. There were also significant improvements in subjective heaviness, tightness, tissue hardness, limb size and range of movement at trial end compared with the baseline. Statistically significant softening occurred in the posterior thorax region. Both groups had a non-significant deterioration in all parameters at one-month follow-up, but none returned to baseline level. *Conclusions:* MLD and Endermologie are both beneficial for secondary arm lymphoedema. *Declaration of interest:* This trial was funded by LPG France and administered through Flinders Consulting Group. LPG had no influence except in the initial stages by advising on treatment protocols.

Key words

Randomised trial
Arm lymphoedema
Treatment comparison
Objective measurement

Breast cancer is a significant cancer in women and it has a number of treatment-related side-effects. Perhaps one of the most significant side-effects is lymphoedema of the breast, trunk or arm. A recent review has indicated that an average of 30% of women who undergo breast cancer treatment will develop secondary arm lymphoedema (SAL) (Williams et al, 2005). However, this rate varies between 3% to more than 44% according to a range of factors including the staging of the axilla, the amount of breast tissue removed, tumour location, radiotherapy and body mass index (BMI). A review of breast and trunk oedema also showed significant problems, with some studies indicating that 23% of patients experienced swelling even following sentinel node biopsy and almost 50% in patients who had node positive axillary clearance (Williams, 2005).

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Although techniques for cancer treatment are improving — especially regarding sentinel lymph node biopsy — and the use of radiotherapy is being reduced and targeted more efficiently, there will remain a cohort of women who will need to manage this distressing condition. There have been a number of therapies that have been established to help treat SAL and it is crucial that clinicians have a clear understanding of both established techniques and emerging therapies.

One new therapy is LPG technique® (Endermologie®) which was originally developed in France and is currently available in the private sector. This system delivers mechanical massage to the limb via two motorised, cylindrical skin rollers which pick up and massage the skin inside its treatment head. Pilot studies of this equipment have shown that it improves superficial lymphatic drainage (Bartolo and Allegra, 2001) and lymphatic transport capacity (Leduc et al, 1995), decreases fibrotic induration (Campisi et al, 2001) and functional discomfort (Guillot, 2001).

This study investigates the effects of this system compared with manual

lymphatic drainage (MLD), which is an established treatment for SAL and has been demonstrated to reduce micro-lymphatic hypertension (Franzeck et al, 1997), limb volume (Kriederman et al, 2002; Korpon et al, 2003) and pain (Johansson et al, 1998). It has also been shown to soften limb tissues (Piller and Harris, 2001; Williams et al, 2002) and improve emotional well-being (Williams et al, 2002).

Methods

The study was given ethical approval by the Flinders Medical Centre Clinical Research Ethics Committee, Adelaide, Australia and informed consent was obtained from each participant. Participants were recruited from the Flinders Medical Centre Lymphedema Assessment Clinic. Participants were required to have had clinically established lymphoedema for more than one year and have significant fibrotic induration in the lymphatic territories of the arm, related to previous breast cancer treatment (surgery ± radiotherapy ± chemotherapy) and a volume difference ≥200ml between the affected and unaffected arm as determined by perometry. Those who had underlying primary lymphoedema, recurrent cancer, current or recent cellulitis, or who had received active treatment in the past month were excluded from the trial.

Upon entry into the trial, each participant was randomised into one of two groups. The first group received MLD by a therapist trained in the Vodder method, while the second group received LPG therapy applied by an occupational therapist trained in the technique. The treatment time and protocol for each group is represented in *Table 1*. Both groups received the treatment four days a week for four weeks (16 treatment sessions in total).

Compression bandaging consisting of a gauze sleeve, high density foam rubber and 2–3 layers of short-stretch bandaging (similar to that recommended in the Best Practice guidelines [Lymphoedema Framework. *Best Practice for the Management of Lymphoedema*. International consensus, 2006]) was applied to the affected arm immediately after each treatment session. Participants were asked to wear the compression bandaging overnight and to fill in a log book, which recorded when the bandages were removed so that compliance could be monitored.

Table 1

Treatment time and protocol for manual lymphatic drainage compared with Endermologie

	MLD	LPG technique®
Treatment time	45 minutes	30 minutes
Total time	720 minutes	480 minutes
Treatment protocol	Bilateral neck, contralateral torso, ipsilateral torso, posterior thorax, upper arm, forearm, hand (if involved) and then reversed. Ipsilateral torso and clearance of the posterior thorax at the end of treatment. Firmer massage used for fibrotic induration where required	Ipsilateral to contralateral axilla, posterior thorax and lateral side, upper arm, forearm, hand (if involved) and then reversed. Clearance of the posterior thorax at the end of treatment. A slightly bigger treatment head was used on the thorax and upper arm, resulting in a greater surface area being massaged

Compression bandaging was not worn over the three days of non-treatment, as many of the participants lived alone and wearing bandaging would have severely restricted their ability to shower and undertake activities of daily living. At the end of four weeks of treatment each woman was encouraged to purchase a new compression garment for the affected arm, as this would fit the reduced arm and thus help to maintain the improvement, and to continue their usual self-maintenance techniques (skin care and self-massage) over the following month.

Measurement

Objective and reliable measurement of the limb parameters is crucial if treatment effect is to be accurately tested and validated (Piller, 2007). Measurements in this trial were taken using previously validated equipment, including multifrequency (5–500Hz) bioimpedance (Ward et al, 1997; Moseley and Piller, 2005) to measure arm and truncal fluid; opto-electronic perometry to measure arm volume (Leduc et al, 1992; Stanton et al, 1997) with the percentage change in actual oedema calculated according to Swedborg (1984); and tonometry (Clodius et al, 1976; Casley-Smith et al, 1993) to measure fibrotic induration in the lymphatic territories of the fore and upper arm and the posterior and anterior thorax. In all cases the contralateral arm was used as the control. A 10-point Likert scale (Lee et al, 2002) was used to rate participants' subjective reports of pain, heaviness, tightness, tissue hardness, range of movement and limb size.

Measurements were taken by an investigator who was blinded to the participants' treatment allocation. Measurements were undertaken at baseline, directly after the first treatment session, 24 hours after the first treatment session, at the beginning and end of each treatment week and at one-month post treatment.

Analysis

All data were analysed using SPPS (version 12.0). Both groups were evenly distributed in terms of arm volume at baseline, therefore the paired sample student T-test was used

Table 2

Characteristics of the MLD and Endermologie treatment groups

	MLD group (n=20)	Endermologie (n=10)	Significance of difference between groups
Age	46–79 years (62.3 ±10 years)	45–72 years (60.3 ± 7.6 years)	not significant (n.s.)
Surgery type			
Total mastectomy	5 (25%)	8 (80%)	n.s.
Partial mastectomy	15 (75%)	2 (20%)	0.586
Radiotherapy	14 (70%)	9(90%)	0.007
Co-morbidities			
Hypertension	11 (55%)	5 (50%)	n.s.
Type II diabetes	5 (25%)	2 (20%)	n.s.
Thyroid dysfunction	3 (15%)	1 (10%)	n.s.
Arthritis (in affected arm)	9 (45%)	2 (20%)	0.005
Lymphoedema			
Onset	35.5 months (+ 48.1 months)	24.2 months (+ 21.2 months)	n.s.
Worse in evening	12 (60%)	6 (60%)	n.s.
Worse in heat	13 (65%)	8 (80%)	n.s.

to analyse within group variables and the independent sample T-test was used to analyse between group variables, where $p<0.05$ is significant.

Results

Twenty women aged 46–79 years (62.3 ± 10 years) participated in the MLD group. Five (25%) of these women had undergone a total mastectomy, while 15 (75%) had undergone a partial mastectomy. Overall, 14 (70%) of the women received adjunct radiotherapy, with the average time to onset of lymphoedema being 35.5 months (± 48.1 months) after treatment cessation (*Table 2*). Ten women aged 45–72 years (60.3 ± 7.6 years) were treated with LPG technique. Eight (80%) of these women had undergone a total mastectomy, while two (20%) had undergone a partial mastectomy. The majority (90%) of the participants had received radiotherapy, with the onset of lymphoedema occurring 24.2 months (± 21.2 months) after treatment cessation (*Table 2*). The two groups were similar in terms of characteristics, except for the number of participants that had received radiotherapy — 70% of the MLD group compared with 90% of the LPG technique group (p=0.007) — and the number of participants who had self-reported arthritis in the affected arm — 45% of the MLD group compared with 20% of the LPG technique group (p=0.005) (*Table 2*).

Arm volume (measured by perometry)

Against a baseline measurement of 3145mls, in the MLD group a mean amount of 22ml (6%; p=not significant [n.s.]) reduction in whole arm volume was seen directly after the first treatment, 41ml (8%) reduction at 24 hours (p=0.039) and 80ml (9%) at the end of one week (p=0.000). Steady volume reductions occurred over weeks two and three, with an overall reduction at the end of the trial of 140ml (21%; p=0.000), (*Figure 1*). At the one-month follow-up there had been a slight volume increase of 34ml (8%; p=n.s.), but there was still a 106ml (15%; p=0.023) volume reduction compared with the baseline. The majority of the volume reduction was demonstrated to occur in the forearm, with an overall reduction at the end of trial of 129ml (19%: p=0.000). This area also increased in volume at the one-month follow-up, but did not return to the baseline level.

In the Endermologie group there was also a slight reduction in whole arm volume of a mean amount of 17.5ml (1.8%; p=n.s.) after the first treatment. This group also experienced statistically significant volume reductions after 24 hours (60ml; 6%; p=0.018), the end of week one (124ml; 13%; p=0.003), and over weeks two and three. The overall reduction at trial end was 186ml (22%; p=0.002), with a slight increase in volume of 44ml (4.4%; p=n.s.) at the one-month follow-up (*Figure 1*), with the overall reduction at this time (142ml; 17.5%) being statistically significant (p=0.002).

This group also experienced the majority of the volume reduction in the forearm, with a reduction of 138ml (14%; p=0.003) at the end of the trial. This area also increased slightly (60ml; 6%; p=n.s.) at the one-month follow-up.

Both treatment groups experienced similar reductions in whole arm volume over the trial duration and a slight volume increase at one-month follow-up. Although the whole arm volume and arm fluid reduction was greater in the LPG technique group (186ml compared with 129ml), the difference between the two groups was not statistically significant. A larger trial group may be needed to determine statistical significance.

Arm and truncal fluid (measured by bioimpedance)

There was also a reduction in arm fluid volume in the MLD group. At 24 hours this equated to a mean value

of 35ml (6%; p=n.s.), 120ml at one week (18%; p=0.005) and 165ml at the end of the trial (25%: p=0.003). At the one-month follow-up there was an increase of 30ml (3%; p=n.s) (*Figure 2*), with an overall volume reduction at this point of 135ml (18%, p=0.042). Interestingly, there was a slight increase in fluid in the truncal region directly after treatment and at 24 hours of a mean value of 5ml and 32ml (p=n.s.) respectively. After this time there were steady decreases in truncal fluid, with an overall reduction of 285ml (p=0.015) at trial end (*Figure 3*). There was a slight increase in truncal fluid at one-month follow-up of 20ml (p=n.s.), with the overall reduction being 265ml (p=0.042).

The LPG technique treatment group experienced an arm fluid reduction of 60ml (6%; p=n.s.) at 24 hours and of 116ml (12%; p=0.027) at the end of the first week. Steady reductions occurred over weeks two and three, with an overall statistically significant fluid reduction of 216ml (23%; p=0.014) at the end of the trial (*Table 2*). A fluid increase of 98ml (10%) occurred in the affected arm at the one-month follow-up. There was a slight, non-significant reduction in the truncal region initially at 24 hours and the end of the first week (20ml and 40ml respectively; p=n.s.). At trial end there was an overall reduction in truncal fluid of 290ml (p=n.s.), with a slight increase in this region of 78ml at one-month follow-up and overall truncal fluid reduction of 212ml.

The arm fluid reduction (along with the total arm volume reduction measured by perometry) was greater in the LPG technique group compared with the MLD group (216ml compared with 165ml at trial end), however, there was not a statistically significant difference between the two groups. Although there was a slight initial increase in fluid in the truncal region in the MLD group, the overall fluid loss was greater in this group and may indicate the greater time spent clearing the thorax region during the

Table 3

Changes in subjective parameters over trial duration in the MLD and LPG technique® groups

	MLD (p)	Endermologie (p)	B/W groups
Pain			
After first treatment	-1.0 (0.039)	-1.3 (n.s.)	Not significant at any time
After 24 hours	-1.2 (0.020)	-1.2 (n.s.)	
End of trial	-1.4 (0.023)	-1.7 (n.s.)	
One-month follow-up	+0.1 (n.s.)	+1.0 (n.s.)	
Heaviness			
After first treatment	-0.9 (0.033)	-1.4 (0.025)	Not significant at any time
After 24 hours	-0.4 (n.s.)	-1.6 (0.011)	
End of trial	-1.7 (0.009)	-3.2 (0.007)	
One-month follow-up	+0.3 (n.s.)	+1.1 (n.s.)	
Tightness			
After first treatment	-1.2 (0.015)	-1.9 (0.004)	Not significant at any time
After 24 hours	-1.1 (0.004)	-2.1 (0.016)	
End of trial	-2.2 (0.004)	-3.0 (0.001)	
One-month follow-up	+0.9 (n.s.)	+0.8 (n.s.)	
Tissue hardness			
After first treatment	-1.6 (0.001)	-1.1 (0.032)	Not significant at any time
After 24 hours	-1.6 (0.020)	-1.3 (0.028)	
End of trial	-2.6 (0.002)	-2.4 (0.011)	
One-month follow-up	+0.6 (n.s.)	+0.7 (n.s.)	
Arm temperature			
After first treatment	-1.0 (n.s.)	0.0 (n.s.)	0.002
After 24 hours	-0.6 (n.s.)	-0.4 (n.s.)	n.s.
End of trial	-1.2 (0.004)	-0.8 (n.s.)	n.s.
One-month follow-up	+0.6 (n.s.)	-0.1 (n.s.)	n.s.
Arm size			
After first treatment	-0.5 (0.029)	-0.4 (n.s.)	Not significant at any time
After 24 hours	-0.7 (n.s.)	- 0.7 (0.025)	
End of trial	-3.4 (0.000)	-2.4 (0.003)	
One-month follow-up	+1.2 (0.001)	+0.3 (n.s.)	
Arm range of movement			
After first treatment	-0.1 (n.s.)	0.0 (n.s.)	0.020
After 24 hours	-0.8 (0.046)	-0.1 (n.s.)	0.007
End of trial	-1.8 (0.006)	-2.2 (0.013)	n.s.
One-month follow-up	+0.4 (n.s.)	+0.9 (n.s)	n.s

(-) represent a reduction in the parameter (hence an improvement); (=) represent an increase in the parameter (hence a worsening)

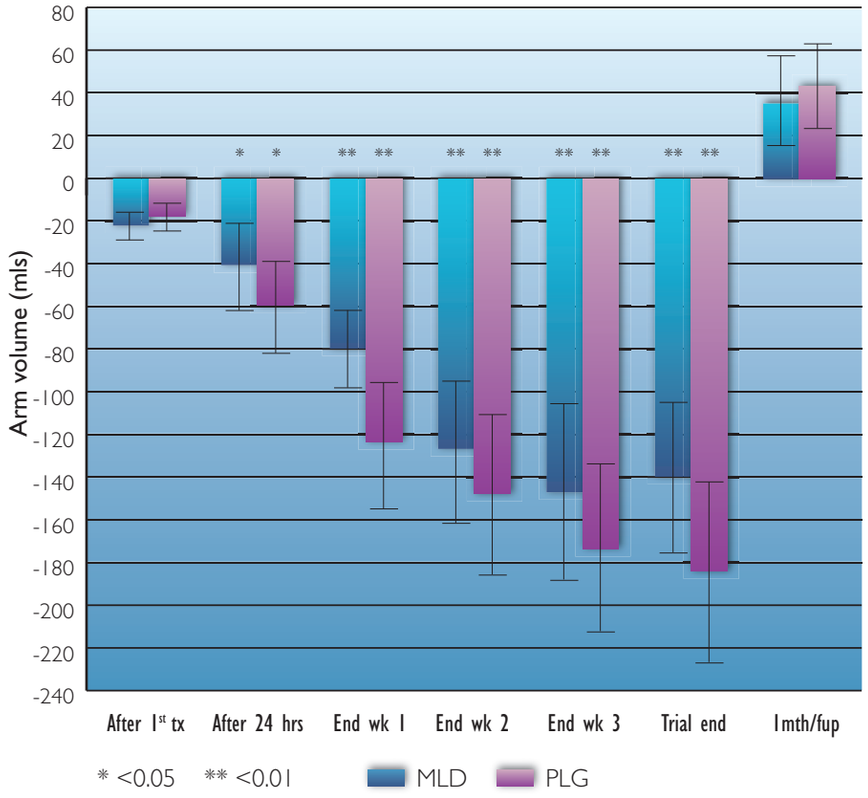

Figure 1. Whole arm volume change (as measured by perometry) after the first treatment, 24 hours, each treatment week, at trial end and at one-month follow-up (mean + standard error of the mean [SEM].

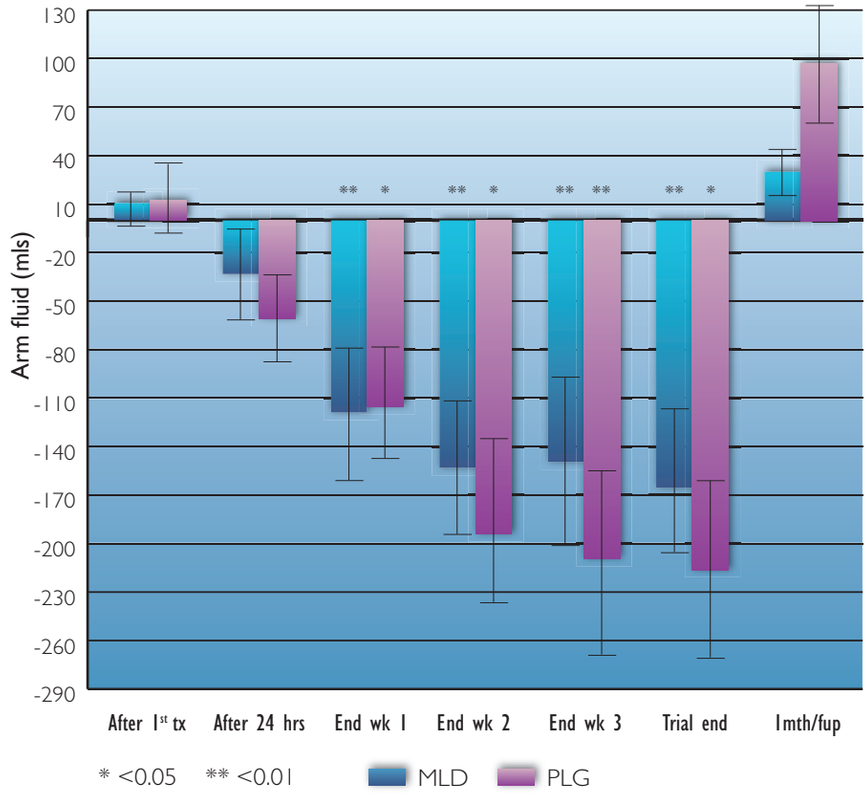

Figure 2. Arm fluid change (as measured by bioimpedance) after the first treatment, 24 hours, each treatment week, at trial end and at one-month follow-up (mean + SEM).

MLD protocol. It would appear that the reductions obtained by the MLD programme were better sustained at the one-month follow-up, with the LPG technique group experiencing a greater increase in whole arm volume, arm and truncal fluid over this time. Why this is the case is uncertain. Possibly a follow-up treatment at the two-week period during the intervening four-week period may have remedied this and the effect of this would be worth investigation.

Fibrotic induration (as measured by tonometry)

In the MLD group there was a tendency to soften but there was no statistically significant change in the forearm, upper arm or anterior thorax lymphatic territories. However, there was an improvement in the posterior thorax which was statistically significant (p=0.041) at the end of the trial compared with the baseline.

In the LPG technique group there was a tendency to soften in the forearm, anterior and posterior thorax territories, with the softening in the forearm territory being statistically significant (p=0.020) at trial end compared with the baseline. In both treatment groups, the tonometry of all the lymphatic territories showed a tendency to harden at the one-month follow-up, but this was not statistically significant.

The treatment groups experienced significant softening in different areas of the affected arm, with the MLD group experiencing it in the posterior thorax (with this improvement being statistically significant in comparison with the LPG technique group; p=0.020), and the LPG technique group experiencing a mean improvement in softening in the forearm region.

Subjective symptoms

The participants in the MLD group showed a perceived reduction in pain (p=0.039), heaviness (p=0.033), tightness (p=0.015) and tissue hardness (p=0.001) even after the

first treatment. These, along with limb temperature, perceived limb size and arm range of movement continued to improve during the trial, with all improvements being statistically significant at trial end ($p=0.05$; *Table 3*). The participants in the LPG technique group also reported statistically significant perceived reduction in heaviness ($p=0.025$), tightness ($p=0.016$) and tissue hardness ($p=0.032$) directly after treatment and had significant improvements ($p<0.05$) in both these and reported limb size and range of movement at trial end (*Table 3*).

Both groups rated other subjective parameters such as limb cramps and pins and needles low on the 10-point Likert scale and these underwent little change over the trial duration. There were recorded increases in the majority of subjective parameters at one-month follow-up, but no parameter returned to baseline level. In comparing the groups, the MLD group reported significant initial improvements in range of movement after the first treatment and at 24 hours compared with the LPG technique group ($p=0.020$ and 0.007 respectively). The MLD group also had significant improvements in limb temperature after the first treatment in comparison with the LPG technique group ($p=0.002$). After this time, both groups experienced similar reductions in the reported subjective parameters.

Compliance and adverse effects

Overall, 55% of the participants in both groups were completely compliant with wearing the compression bandaging, while 45% were slightly to moderately compliant (the bandaging was taken off early, i.e. not worn over the whole course of the day and evening). Both groups also experienced tiredness, increased urination and thirst after massage treatment (predominantly in the first week of treatment). Most complaints during treatment were related to the compression bandaging, with the majority of participants (90%) stating that it was uncomfortable and 20% stating it caused itchiness.

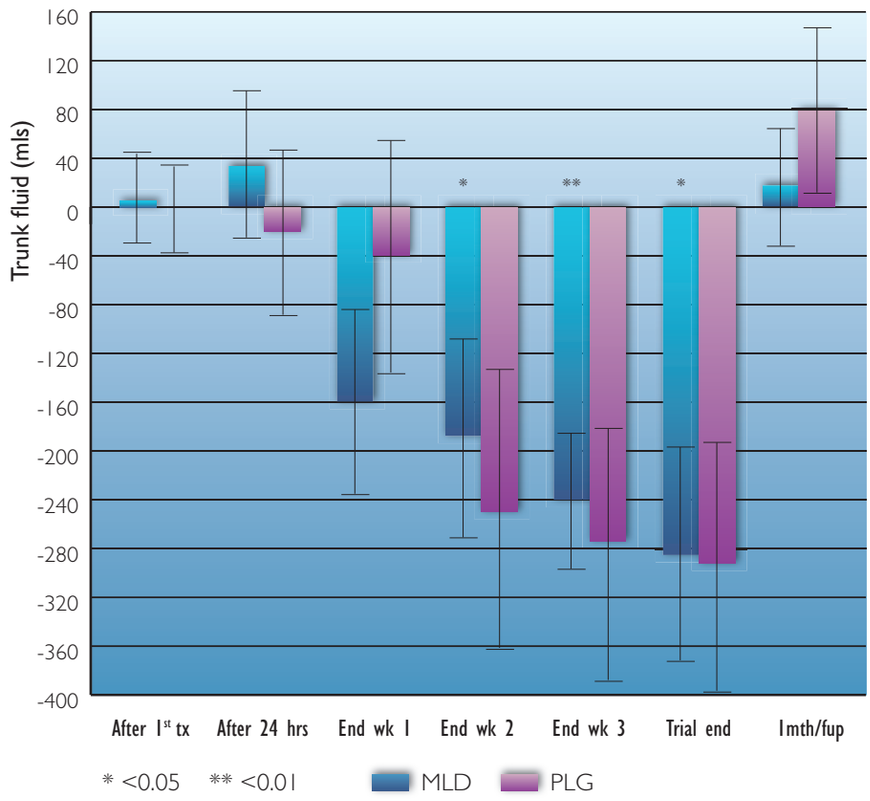

Figure 3. Trunk fluid change (as measured by bioimpedance) after the first treatment, 24 hours, each treatment week, at trial end and at one-month follow-up (mean + SEM).

Conclusion and recommendations

The gold standard treatment of MLD and the newer LPG technique treatment when combined with compression bandaging both resulted in a reduction in whole arm volume, arm and truncal fluid, a softening in specific lymphatic territories and improvements in subjective symptoms. The limb volume reduction in both groups is similar to those seen in other intensive massage and compression studies where both treatments were applied over two weeks (Piller et al, 1994) and four weeks (McNeeley et al, 2004). The majority of arm volume and fluid reduction occurred in the LPG technique group in the first two weeks of treatment, suggesting (along with established literature) that this would be the minimum treatment time.

It is interesting to note that the MLD group experienced greater (although not significant) decreases in truncal fluid over the trial and that this group had lesser increases at the one-month follow-up. This may be reflective of the different treatment protocol employed in the MLD group or of the larger sample size. An increased sample size in the LPG technique group would provide an answer to this question, but this was not possible in this initial study of the new technique.

For those clinicians looking to advise patients, the following recommendations may be useful:

- Both MLD and LPG technique plus compression bandaging applied over a minimum of two weeks (but preferably four weeks) are beneficial for the treatment of secondary arm lymphoedema
- The treatment time for LPG technique is shorter and will achieve a similar result in most objective and subjective parameters
- Some deterioration in this improvement is to be expected

over a one-month period, but self-massage and wearing a compression garment may minimise this deterioration
- Additional treatment(s) during the month after the intensive treatment period may reduce or eliminate the rebound effect and allow continuing improvement (although this does require further investigation)
- The education of the patient in terms of the importance of self-massage and compression therapy and an open dialogue between the therapist and patient plays an integral role in the overall treatment plan
- Both forms of massage (MLD and LPG technique), as well as the compression bandaging, must be applied by a trained therapist who has a good understanding of the pathophysiology of lymphoedema and who can monitor the response to treatment
- Using LPG technique to treat lymphoedema represents a new and effective option which can be used in place of, or alongside MLD, which is the current gold standard of treatment options of secondary arm lymphoedema. JL

Key points

- Both MLD and Endermologie plus compression bandaging applied over a minimum of two weeks (but preferably four weeks) are beneficial for the treatment of secondary arm lymphoedema.
- Endermologie has a 33% shorter treatment time than MLD.
- Bandaging is important to maintain good outcomes.
- Treatment effects can last for up to one month but some patient management is required to maintain gains of treatment.
- The education of the patient in terms of the importance of self-massage and compression therapy and an open dialogue between the therapist and patient plays an integral role in the overall treatment plan.

References

Bartolo M, Allegra C (2001) Microlymphatic system and LPG technique. Proceedings of the 14th World Congress of the 'Union Internationale de Phlebologie', Rome.

Campisi C, Boccardo F, Azevedo WF, Gomes CS, Couto EM, Napoli E, Zilli A, Maccio A (2001) LPG system in the treatment of peripheral lymphoedema: Clinical preliminary results and perspectives. *Euro J Lymphology* **9(34)**: 78

Clodius L, Deak I, Piller N (1976) A new instrument for the evaluation of tissue tonometry in lymphoedema. *Lymphology* **9**: 1–5

Franzeck UK, Spiegel I, Fischer M, Bortzler C, Stahel HU, Bollinger A (1997) Combined physical therapy for lymphedema evaluated by fluorescence microlymphography and lymph capillary pressure measurements. *J Vasc Res* **34**: 306–11

Guillot B (2001) Prospective study of the use of LPG technique in the treatment of cutaneous fibrosis induced by radiotherapy. XXII Congress National de Medecine Esthetique, Rome.

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

Korpon MI, Vacariu G, Schneider B & Fialka Moser V (2003) Effects of compression therapy in patients with lymphedema after breast cancer surgery. Annual Congresses of the American College of Phlebology, San Diego, California.

Kriederman B, Myloyde T, Bernas M et al (2002) Limb volume reduction after physical treatment by compression and/or massage in a rodent model of peripheral lymphedema. *Lymphology* **35**: 23–7

Leduc A, Bourgeois P, Leduc O (1995) LPG systems and lymphatic activity. Proceedings of the XV International Congress of Lymphology, Sao Paulo.

Leduc O, Klien P, Rasquin C et al (1992) Relability of a volume measuring device (Volumeter®) for human limbs. *Eur J Lymphology* **3**: 53–6

Lee JW, Jones PS, Mineyama Y, Zhang XE (2002) Cultural differences in responses to a Likert scale. *Res Nurs Health* **25**: 295–306

Lymphoedema Framework. *Best Practice for the Management of Lymphoedema*. International consensus. London: MEP Ltd, 2006

McNeely ML, Magee DL, Lees AL, Bagnell KM, Haykowsky M, Hanson J (2004) The addition of manual lymphatic drainage to compression therapy for breast cancer related lymphedema: A randomized controlled trial. *Breast Cancer Treat Res* **86(2)**: 96–105

Moseley A, Piller N (2005) Relationships between limb size and composition using objective measures. Their role in providing better treatment outcomes. Proceedings of the International Society of Lymphology XX International Congress of Lymphology, Brazil. *Lymphology* **39(suppl)**: 170–5

Piller N (2007) To measure or not to measure? What and when is the question. *J Lymphoedema* **2(2)**: 39–45

Piller NB, Harris R (2001) *Where does the fluid go? Objective measurement of fluid movement around the body using perometry and bio-impedance in two case studies of chronic primary and secondary lymphoedema*. Proceedings of the 4th Australasian Lymphology Association Conference, Australia: 85-91

Piller NB, Swedborg I, Wilking N, Jensen G (1994) Short-term manual lymph drainage treatment and maintenance therapy for post-mastectomy lymphoedema. *Lymphology* **27(suppl)**: 589–92

Stanton A, Northfield J, Holroyd B, Mortimer PS, Levick JR (1997) Validation of an optoelectronic limb volumeter (perometer). *Lymphology* **30**: 77–97

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

Ward L, Byrne N, Rutter K et al (1997) Reliability of multiple frequency bioelectrical impedance analysis: an inter-machine comparison. *Am J Human Biol* **9**: 63–72

Williams AF, Vadgama A, Franks A et al (2002) A randomized controlled crossover study of manual lymphatic drainage therapy in women with breast cancer-related lymphoedema. *Euro J Cancer Care* **11**: 254–61

Williams A, Franks PJ, Moffatt CJ (2005) Lymphoedema: estimating the size of the problem. *Pall Med* **19(4)**: 300–13