

Original Article**The effect of mechanical lymph drainage accompanied with heat on lymphedema**

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Abstract

BACKGROUND: Thermotherapy has been indicated by some researchers as a treatment for lymphedema. A study comparing temperatures demonstrated that a temperature of 40°C significantly increased the transportation of lymph compared to other temperatures assessed. The aim of this study was to evaluate the possible benefits of mechanical lymph drainage accompanied with heat in the treatment of lymphedema of the lower limbs.

METHODS: In a cross-over randomized study, the effect of heat on lymph drainage was evaluated in the treatment of leg lymphedema. The study, performed in the Godoy Clinic in São Jose do Rio Preto, Brazil, involved seven patients (two males and five females) with leg lymphedema. The patients' ages ranged from 18 to 79 years old with a mean of 48.5 years. The subjects underwent a total of 38 assessments including 19 evaluations of mechanical lymph drainage alone and 19 combined with thermotherapy. Heat was applied using an electric blanket which was wrapped around the legs of the patients. The volume of legs was evaluated by water plethysmography before and after treatment sessions. The paired t-test was used for statistical analysis with an alpha error of $p = 0.05$ being considered as acceptable.

RESULTS: No statistically significant differences were evidenced between mechanical lymph drainage alone and lymph drainage combined with thermotherapy.

CONCLUSIONS: There was no obvious synergic effect in the immediate post-treatment period when heat was combined with mechanical lymph drainage in the treatment of lymphedema.

KEYWORDS: Thermotherapy; Lymphedema, Mechanical Lymph Drainage.

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Clinical management has been recommended as the main approach to lymphedema over the last few years.¹⁻³ Complex physical therapy was developed by Földi as a group of therapies including lymph drainage, bandaging, myolymphokinetic exercises and hygienic care.¹

Other forms of treatment, such as thermotherapy, have been suggested by some researchers who have employed different ways to apply heat.⁴⁻⁷ One study assessing electro-magnetic diathermy in the treatment of lymph-

phedema detected that this technique does not increase the flow of lymph, but accelerates the venous return.⁵ Another study comparing temperatures of 4°C, 24°C, 30°C and 40°C demonstrated that temperature does indeed interfere in motility within the lymphatic system. It also showed that a temperature of 40°C significantly increased the transportation of lymph compared to other assessed temperatures.⁸

The aim of this study was to evaluate whether an association of heat with mechanical lymph drainage would be beneficial in the re-

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duction of volume by comparing lower limbs with and without lymphedema.

Methods

In a cross-over randomized study, the effect of heat with mechanical lymph drainage was evaluated in the treatment of leg lymphedema. The study, performed in the Godoy Clinic in São Jose do Rio Preto, Brazil, involved seven patients (two males and five females) with leg lymphedema. The patients' ages ranged from 18 to 79 years old with a mean of 48.5 years. All the patients were clinically diagnosed with lymphedema which was confirmed by lymphoscintigraphy. The subjects were submitted to standardized mechanical lymph drainage utilizing the RAGodoy® system. This system is a new apparatus of mechanical lymph drainage that uses dorsiflexion of the feet to passively simulate movements of the limb. A total of 38 evaluations were made, 19 with mechanical lymph drainage associated with heat (associated treatment) and 19 at normal room temperature (standard treatment). Both the lymphedematous and normal limbs of all patients were submitted to treatment sessions (1 session of 60 minutes once a week) and all patients underwent the associated treatment and standard treatment on different days. Heat was applied employing an electric blanket wrapped around both legs. The temperature of the limbs during the associated treatment assessment remained between 37.3°C and 40.2°C. The cutaneous temperature before treatment varied from 31°C to 31.3°C. The temperature of the skin during the associated treatment was controlled using a digital thermometer. The room temperature was maintained at about 22°C. Measurement of the volume of the limbs

was made using water plethysmography before and after treatment sessions. The difference in volume was measured in grams using calibrated digital scales with an accuracy of 1 gram. For statistical analysis (PAD analysis software), the matched t-test was used with a $p < 0.05$ being considered as significant.

Results

No significant difference was observed between treatment with and without heat in lymphedematous (Table 1) and normal limbs (Table 2). There were non-significant reductions in volume in both cases ($p = 0.28$ and 0.11 , respectively).

Discussion

This study demonstrated that there was no significant difference between reductions in limb volume resulted by treatment with associated heat and mechanical lymph drainage and mechanical lymph drainage alone. For the lymphedematous limbs, the reduction of volume tended to be higher (-62 grams) when only lymph drainage was utilized than when it was associated with heat (-38 grams). However, this difference was not significant. There was also a reduction in volume with normal limbs. For normal limbs submitted to mechanical lymph drainage without heat, the reduction was -68 grams. On the other hand, lymph drainage associated with heat led to a drop of -44 grams. Again, there was no significant difference between the two treatment modalities. Comparing the reduction of the normal limbs (-68 grams) with that of the lymphedematous limbs (-62 grams) utilizing mechanical lymph drainage alone, a small, insignificant difference was observed. A non-significant difference was detected while comparing the reductions in

Table 1. Shows the number of evaluations, the mean loss in the volume, standard deviation and p-value in limbs with lymphedema

	RA Godoy + heat	RA Godoy	Difference
Patients	19	19	
X	-38.579	-62.000	-23.421
SD	95.736	93.305	91.847

P = 0.2810

X = mean; SD = Standard deviation

Table 2. Shows the number of evaluations, the mean loss in the volume, standard deviation and p-value in normal limbs

	RA Godoy + heat RA Godoy		Difference
Patients	19	19	
X	-44.000	-68.316	-24.316
SD	66.882	52.953	63.269

P = 0.1112

X = mean; SD = Standard deviation

volumes of normal limbs (-44 grams) and lymphedematous limbs (-38 grams) using the associated treatment. This may be explained by the vasodilation caused by heat and the consequent increase in the venous intravascular volume of the limb, interference in the permeability of the capillaries, and increases in the cell interstitial volume or in capillary filtration.⁹

A study evaluating the orthostatic position indicated that the magnitude and pattern of changes in calf volume during the early phase of orthostatic stress are modulated by changes in venous distensibility and blood flow in the skin during thermal loading.^{10,11} Comparing the flow in normal human leg during venous stasis, and muscle activity with or without localized heat, increases of 83% was and 117% were detected using two hours of muscle activity and two hours of muscle activity with the legs immersed in warm water, respectively. However, the flow dropped to 50% with venous stasis. Thus, there was an increase in the lymphatic flow in the three experiments with a pronounced increase as a result of heat. There were inverse relations between the flow and protein concentration as well as enzymes.¹² The increase in flow with heat was associated with a reduction in the concentration of proteins which could suggest increased fluid in the cellular interstice, greater capillary arterial filtration and consequently greater hydration of the interstice leading to the formation of less concentrated lymph. Although this study evaluated the association between heat and lymphedema treatment in the immediate post-treatment period, the repercussions should be

assessed over a longer period. In addition, heat may increase the lymph flow but however for it to be effective in the treatment of lymphedema there must be an increase in the removal of protein from the cellular interstice.

The lack of consensus in relation to thermotherapy as a coadjuvant procedure in the treatment of lymphedema suggests a need for further studies in order to identify the real importance of this form of therapy in patients with lymphedema. Future studies might define the ideal temperature, the position of the patients during treatment with heat as well as other associated types of treatment.

The slight reduction in the volumetry in this present study occurred in limbs with edema and normal limbs. One limitation of this study is that the evaluation was performed immediately after the treatment while a long-term evaluation may provide extra data. However, it seems that there are differences between the two approaches. The reduction in the volume of normal and lymphedematous limbs with a greater variation in the affected leg suggests that there is an accumulation of physiological fluids which may be reduced by drainage.

Conclusion

Heat, as an adjuvant form of treatment, did not demonstrate any synergic effects in the immediate post-treatment period of volume reduction in limbs affected by lymphedema or normal limbs. A long-term follow-up is required to define the importance of this approach in the treatment of lymphedema.

Conflict of Interests

Authors have no conflict of interests.

Authors' Contributions

All authors contributed to all phases of the study.

References

1. Lamprou DA, Damstra RJ, Partsch H. Prospective, randomized, controlled trial comparing a new two-component compression system with inelastic multicomponent compression bandages in the treatment of leg lymphedema. *Dermatol Surg* 2011; 37(7): 985-91.
2. Casley-Smith JR, Boris M, Weindorf S, Lasinski B. Treatment for lymphedema of the arm--the Casley-Smith method: a noninvasive method produces continued reduction. *Cancer* 1998; 83(12 Suppl American): 2843-60.
3. Godoy JMP, Braile DM, Godoy MFGA. Thirty-month follow-up of the use of a new technique for lymph drainage in six patients. *European Journal Vascular Endovascular Surgery* 2002; 3: 91-3.
4. Ohkuma M. Treatment of peripheral lymphedema by concomitant application of magnetic fields, vibration and hyperthermia: a preliminary report. *Lymphology* 2002; 35(2): 87-90.
5. van d, V, Kempenaers F, Vermijlen S, Van WC, Kerckhofs E, Bossuyt A, et al. Electromagnetic diathermia: a lymphoscintigraphic and light reflection rheographic study of leg lymphatic and venous dynamics in healthy subjects. *Lymphology* 2000; 33(1): 12-8.
6. Campisi C, Boccardo F, Tacchella M. Use of Thermotherapy in Management of Lymphedema: Clinical Observations. *Int J Angiol* 1999; 8(1): 73-5.
7. Liu NF, Olszewski W. The influence of local hyperthermia on lymphedema and lymphedematous skin of the human leg. *Lymphology* 1993; 26(1): 28-37.
8. Yasuda A, Ohshima N. In situ observations of spontaneous contractions of the peripheral lymphatic vessels in the rat mesentery: effects of temperature. *Experientia* 1984; 40(4): 342-3.
9. Abraham P, Leftheriotis G, Desvaux B, Saumet M, Saumet JL. Diameter and velocity changes in the femoral vein during thermal stress in humans. *Clin Physiol* 1994; 14(1): 15-21.
10. O'Morchoe CC, Jones WR, III, Jarosz HM, O'Morchoe PJ, Fox LM. Temperature dependence of protein transport across lymphatic endothelium in vitro. *J Cell Biol* 1984; 98(2): 629-40.
11. Yamazaki F, Okuno C, Nagamatsu S, Sone R. Effects of whole-body and local thermal stress on hydrostatic volume changes in the human calf. *Eur J Appl Physiol* 2002; 88(1-2): 61-6.
12. Olszewski W, Engeset A, Jaeger PM, Sokolowski J, Theodorsen L. Flow and composition of leg lymph in normal men during venous stasis, muscular activity and local hyperthermia. *Acta Physiol Scand* 1977; 99(2): 149-55.