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Influence of complex descongestive physical therapy associated with intake of medium-chain triglycerides for treating upper-limb lymphedema

Influência da fisioterapia complexa descongestiva associada à ingestão de triglicerídeos de cadeia média no tratamento do linfedema de membro superior

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Abstract

Objective: To investigate the influence of complex decongestive physical therapy (CDP) in association with diet therapy using medium-chain triglycerides (MCT), as an intervention in cases of upper-limb lymphedema. **Methods:** The lymphedema was evaluated by measuring circumferences, volumes, skin folds and whole-body water content. Feelings of discomfort, pain and heaviness in the arms were evaluated using a visual analog scale. Ten women who had undergone mastectomy and presented upper-limb lymphedema homolateral to the surgery participated in this study. Their mean age was 65.9 ± 10.4 years and their mean body mass index (BMI) was 26.8 ± 3.0kg/m^2. After nutritional evaluation, they were randomly divided into two groups: the Control Group (n= 5), which underwent physical therapy treatment consisting of CDP (classical massage, manual lymphatic drainage, compression taping and skincare) three times a week, for four weeks; and the MCT Group (n= 5), which underwent the same physical therapy protocol with the addition of daily diet therapy consisting of intake of MCT, for four weeks. **Results:** At the end of the intervention, analysis of the circumference and volume measurements showed significant differences between the groups ($p \leq 0.05$), with a greater reduction in lymphedema in the MCT Group. There were no significant differences in the skin fold measurements or whole-body water content. The feeling of heaviness in the arms after the intervention was significantly less in the MCT Group ($p \leq 0.05$), compared with before the intervention. **Conclusion:** Physical therapy treatment together with diet therapy with intake of MCT in women with upper-limb lymphedema following surgery and breast cancer treatment was effective in reverting this condition.

Key words: lymphedema; complex decongestive physical therapy; diet therapy; medium-chain triglycerides.

Resumo

Objetivo: Verificar a influência da utilização da fisioterapia complexa descongestiva associada à dietoterapia com triglicerídeos de cadeia média (TCM) como forma de intervenção no linfedema de membro superior (MS). **Métodos:** Para a avaliação do linfedema, foram utilizadas cirtometria, volumetria, pregas cutâneas e quantidade de água corporal total. A Escala Visual Análoga (EVA) foi utilizada para avaliar as sensações de desconforto, peso e dor no MS. Participaram deste estudo dez mulheres mastectomizadas com linfedema de MS homolateral à cirurgia, com idade média de 65,9 ± 10,4 anos e índice de massa corpórea (IMC) de 26,8 ± 3,0kg/m^2 que, após avaliação nutricional, foram divididas aleatoriamente em dois grupos: Grupo Controle (n= 5), submetido ao tratamento fisioterapêutico constando da terapia complexa descongestiva (massagem clássica, drenagem linfática manual, bandagem compressiva e cuidados com a pele) três vezes na semana, durante quatro semanas; Grupo TCM (n= 5), submetido ao mesmo protocolo fisioterapêutico somado ao tratamento dietético diário com ingestão de TCM, por quatro semanas. **Resultados:** Ao final da intervenção, a análise da cirtometria e da volumetria mostraram diferenças significativas entre os grupos ($p \leq 0,05$), com maior redução do linfedema no Grupo TCM. Não houve diferença significativa nos valores das pregas cutâneas e da quantidade de água corporal total. A sensação de peso no membro superior, antes e após a intervenção, foi significativamente menor ($p \leq 0,05$) no Grupo TCM. **Conclusões:** O tratamento fisioterapêutico somado à dietoterapia com ingestão de TCM em mulheres portadoras de linfedema de MS pós-cirurgia e tratamento de câncer de mama foi efetivo na involução desta condição.

Palavras-chave: linfedema; fisioterapia complexa descongestiva; dietoterapia; triglicerídeos de cadeia média.

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Introduction

Follow-up for breast cancer patients after adjuvant treatment is important because complications may occur, such as chest wall adherences, restrictions on shoulder movements, pain, hypoesthesia and, particularly, upper-limb lymphedema[1]. When the lymphatic vessels are removed or damaged, the lymphatic transportation is damaged and the lymphatic fluid accumulates in the interstitial spaces of the tissue around the affected site. This extends to the upper limbs on the affected side and characterizes lymphedema[2].

To evaluate lymphedema, a variety of measurements are used, such as circumference measurements[3], volumetry[4] and multiple frequency electrical bioimpedance[5]. These enable predictions regarding the degree of lymphedema in the affected limb[6] and make it possible to choose the most appropriate intervention[7]. Electrical bioimpedance is used to estimate the quantities of liquid in body compartments and has been applied in investigating fluid volumes in limbs presenting lymphedema[8,9]. The triceps and biceps skinfolds are nutritional indicators that can be used to investigate the malleability of the skin and the consistency of lymphedema[10].

Among the interventions for treating lymphedema, complex decongestive physical therapy[4] stands out. This includes procedures such as manual lymphatic drainage (MLD)[11], compressive bandaging (CB)[12] or elastic restraint, pelvic floor exercise programs and skin care[2].

Biochemical analyses of human lymphedema show the presence of high proportions of long-chain triglycerides (LCTs) with a high content of kilomicrons[13]. Changes in the quantities of LCTs in the lymph fluid may alter the composition of the fluid, thus leading to decreased flow and pressure in the lymphatic system, thereby diminishing its overload[13,14]. Medium-chain triglycerides (MCTs) with six to 12 carbons are absorbed directly into the bloodstream because, differently from long-chain fatty acids, they are not incorporated into kilomicrons[15]. After passing through the enterocytes, they reach the portal circulation and are transported to the liver by albumin, without going through the lymphatic system[16].

Soria et al.[13] described the use of MCTs, corresponding to 58% of the total fat consumed, as a substitute for LCTs for patients with idiopathic lymphedema. They showed that there was a significant reduction in the circumference measurement of the affected limb after four months of an LCT-free diet in association with physical therapy treatment.

Because lymphedema is a frequent complication following breast cancer and results in the loss of functional abilities and esthetic deformities[17], new forms of interventions in association with the conventional techniques are needed in order to reduce the presence of lymphedema. Therefore, the present study had the objective of investigating the influence of using classical massage, manual lymphatic drainage and compressive bandaging in association with consumption of MCTs as a means of intervention for lymphedema cases.

Methodology

After obtaining approval (on June 9, 2005) from the Research Ethics Committee of the School of Pharmaceutical Sciences of UNESP in Araraquara, State of São Paulo (case no. 01/2005), 16 women with upper-limb lymphedema were recruited and sent to the UNIARA Physical Therapy Clinic. The participants were selected by means of individual interviews explaining the objectives, duration and procedures of the study. Cases of metastasis, phlebitis, acute-phase erysipelas and dyslipidemia were excluded. All the participants signed a consent statement, in compliance with National Health Council resolution no. 196/96. After beginning of the study, three women were found to demonstrate erysipelas in the affected upper limb, two were unavailable for carrying out the weekly protocol and one terminated her participation.

This study, which was blind and randomized, was conducted on 10 women of a mean age of 65.9 ± 10.4 years and a BMI of 26.8 ± 3.0, who had homolateral upper-limb lymphedema subsequent to breast cancer surgery and axillary lymphadenectomy. Among these patients, seven underwent quadrantectomy and three had modified radical surgery. There was an equal prevalence of breast laterality and affected upper limb: half of the breast cancer sample involved the right side and the other half, the left side. All cases needed axillary emptying up to level III. With regard to postsurgical treatment, eight patients needed more than 30 radiotherapy sessions and only two had less than 28 applications, while six patients underwent six chemotherapy sessions and four had between seven and 12 applications. The lymphedema appeared within one year in five patients, while two of them reported lymphedema between one and three years after surgery and the other three patients presented this between three and five years after their breast cancer treatment.

The participants were allocated alternately into two groups according to when they were sent to the clinic: the control group (n= 5) underwent physical therapy treatment for lymphedema, three times a week for four weeks, the MCT group (n= 5) underwent physical therapy treatment, three times a week with daily dietary consumption of MCT oil, for the same period. The MCT Group was instructed to use the MCT oil (Triglyceryl CM®) as their main source of dietary fat, representing around 50-60% of total lipid consumption. The control group used corn oil as their fat source, which mostly contains LCTs, with trace quantities of MCTs. None of the participants knew which group they were in,

but they were aware that they were using one or another of the provided oil sources. To monitor their consumption, they were asked, while following the protocol, to make periodic records so that each participant's nutritional intake could be followed up.

The data collection consisted of bilateral upper-limb circumference measurements, at the beginning of each session, at predefined fixed points[18]. Volumetry was performed on the upper limbs before and after the interventions, by immersing the limb in a volumetric column, with water leveled up to the middle third of the arm. The liquid that overflowed out of the column was measured in order to obtain the volume of the limb. The electrical bioimpedance was measured using specific total body water apparatus (Biodynamics, model 310) to generate a 50 kHz electric current that measured the total quantity of body water. Feelings of discomfort, heaviness and pain in the affected upper limb were obtained using a visual analog scale (VAS), before and after the experiment.

The body weight was obtained with the volunteers in a standing position, at the center of the base of a duly calibrated platform balance, with as little clothing as possible. Their height was measured using a tape measure attached to a wall, with the patient standing against the wall, without shoes, with heels together, vertebral column upright, arms extended next to the body and with the head aligned. The triceps skinfold was measured using a skinfold adipometer positioned on the posterior face of the arm, at the midpoint between the superolateral edge of the acromion and the olecranon. The biceps skinfold was measured on the anterior face of the arm, one centimeter above the location marked for the triceps skinfold measurement, with the palm of the patient's hand turned to the front[5]. The dietary profile was obtained from the food frequency questionnaire, in which the patients described their frequencies of intake; their daily, weekly and monthly food consumption; and by the 24-hour dietary recall record, with descriptions of all food and drinks consumed within 24 hours[19] in homemade measures.

The treatments for the affected upper limb consisted of applications, at each session, of various types of classical massage with the use of superficial and deep sliding maneuvers, for the whole upper limb, followed by compression maneuvers[20]. Manual lymphatic drainage was performed in accordance with the maneuvers of Leduc and Vodder[1,21], starting with evacuation and ending with capture[11,21]. Compressive bandaging was performed after manual lymphatic drainage and was maintained for a period of at least 10 hours. The upper limb was first wrapped with tubular mesh, followed by protective sponge. Elastic bandages of width five cm were wrapped around the fingers and the hand. Bandages of an eight cm width were overlaid on the wrist region and the proximal third of the forearm. Bandages of a 10 cm width were wrapped over these, up to the level of the axillae, leaving the elbow region free to maintain functionality of the limb[2].

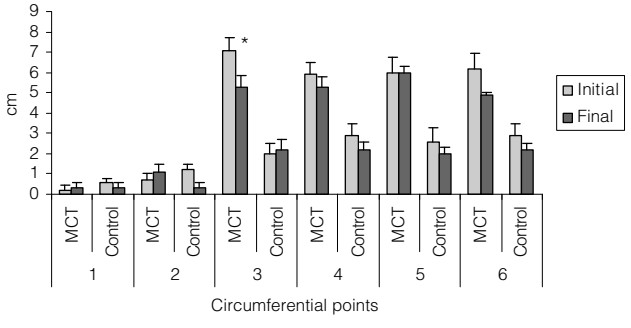
The parametric data was analyzed using Student's t test and the nonparametric data using the Mann-Whitney test and the Wilcoxon matched pairs test, with $p \leq 0.05$.

Results

Figure 1 illustrates the mean values for the differences in circumference measurements between the affected and healthy upper limbs of the MCT group, gathered at the beginning and end of the study protocol, in comparison with the mean values for the differences in these measurements between the affected and healthy limbs of the control group. Statistically different values at $p<.03$ could be seen from analyses of the reduction in the differences in circumference measurement between the involved and healthy limbs of the MCT group, in relation to the same measurements for the control group. This demonstrated that, in the forearm region, there was a greater reduction ($p \leq 0.05$) in the MCT group, i.e., more pronounced decreases in lymphedema in the patients of this group.

Figure 2 shows the volumetry for the upper limbs, comparing the mean reductions in volume differences between the two limbs (affected and healthy) and between the groups, at the end of the intervention. From this, it can be seen that there was a greater reduction in the MCT group, at the end of the treatment ($p \leq 0.05$). The mean values for the control group were negative, meaning that there was an increase in the differences in volume between the affected and healthy limbs of the participants in this group. Hence, in the end, there was an increase in lymphedema for this group.

Comparisons of the reduction in skinfold thicknesses in the affected upper limb (Figure 3) showed that there were no significant differences in the final values between the groups.



*p≤ 0.05.
Point 1: the metacarpophalangeal joints of the second to fifth fingers; Point 2: an imaginary line going through the metacarpophalangeal joint of the first finger; Point 3: 10 cms below the olecranon; Point 4: 6 cms below the olecranon; Point 5: 6 cms above the olecranon; Point 6: 10 cms above the olecranon.

Figure 1. Comparisons between the mean differences in circumference measurements of the affected and healthy upper limbs of the two groups, before and after the intervention.

Regarding the total body water quantities found by electrical bioimpedance, comparisons of the mean reduction in body water between the groups, after the intervention, did not show any significant differences, as seen in Figure 4.

From the patients' subjective feelings about their lymphedema found through the VAS, Figure 5 shows that there was a statistically significant decrease ($p \leq 0.05$) in the degree of discomfort for both groups, comparing the initial and final values for each group. Regarding feelings of arm heaviness, only the MCT group presented a significant decrease ($p \leq 0.05$) at the end of the intervention. There were no differences in the feelings evaluated between the two groups.

Discussion

Lymphedema develops from an imbalance between the lymphatic demands and the system's capacity to drain the lymph. Since high molecular weight proteins that are extravasated to tissue interstices are solely absorbed by the lymphatic system, if this system loses its drainage capacity because of the destruction or obstructions of the lymph ducts at some point, this causes stagnation of the lymph in the vessel and subsequent extravasation back to the interstices[22]. It also results in a combination of factors such as obesity. Studies have reported that the patient's age and whether the surgery was on the dominant or nondominant side were not statistically associated with the development of edema[23]. However, Freitas et al.[24] noted that there were significant relationships between lymphedema frequency and the weight and age of the patients. In the present study, the patients demonstrated a mean BMI of 26.8 and classified as being pre-obese[5], which proved to be an important factor in establishing lymphatic edema.

The skin is responsible for superficial absorption of the lymph fluid and skincare is essential to lymph therapy procedures[20]. Classical massage was shown to be effective in the present study, since it assisted in reducing the lymphedema.

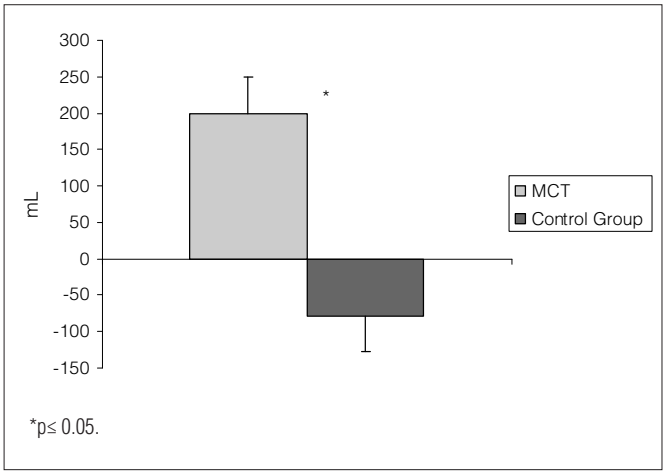


Figure 2. Comparisons between the mean reductions in volume difference (ml) in the affected and healthy upper limbs, for the two groups, at the end of the treatment.

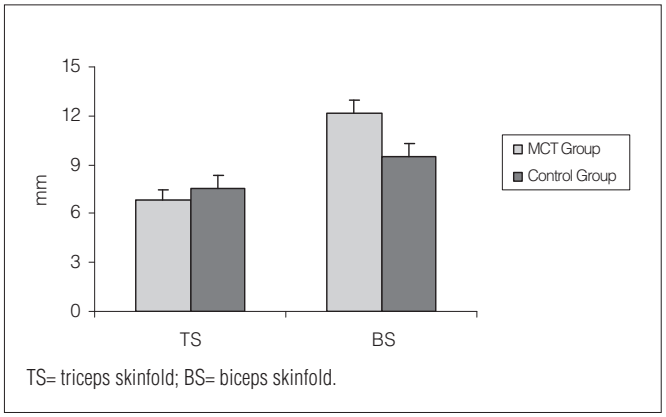


Figure 3. Comparisons between the mean reductions in skinfolds in the affected upper limbs, at the end of the treatment.

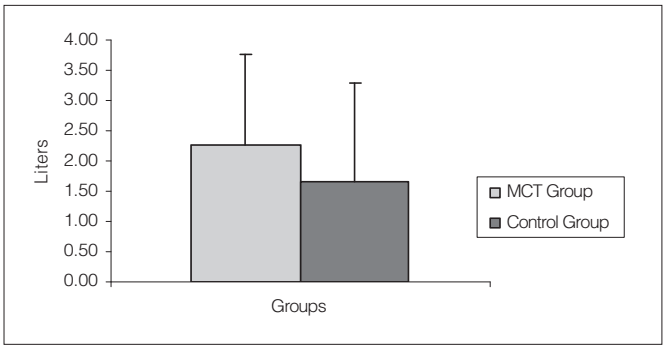


Figure 4. Comparisons between the mean reductions in the quantities of body liquid in the two groups, at the end of the intervention.

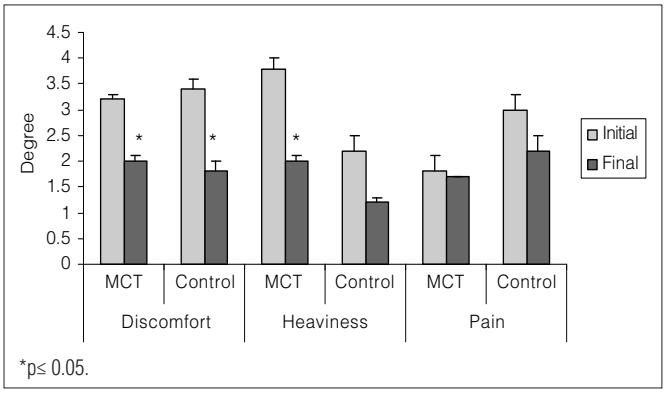


Figure 5. Comparisons between the degrees of feelings shown by the VAS, before and after the intervention. For discomfort: Degree 1: no discomfort; Degree 2: slight discomfort; Degree 3: moderate discomfort; Degree 4: a lot of discomfort; Degree 5: severe discomfort. For heaviness in the affected limb: Degree 1: no heaviness; Degree 2: slight heaviness; Degree 3: moderate heaviness; Degree 4: heavy; Degree 5: very heavy. For pain in the affected limb: Degree 1: no pain; Degree 2: slight pain; Degree 3: moderate pain; Degree 4: severe pain; Degree 5: unbearable.

Manual lymphatic drainage is used to drain the excess liquids that bathe the cells and maintain the hydric equilibrium of the interstitial spaces[21]. The technique used in the present study enabled reductions in the circumference and volume of the affected limb in the MCT group, thus reinforcing the importance of this procedure for decreasing lymphedema. Manual lymphatic drainage may be indicated together with other treatments, so that it is possible to contain the edema at a comfortable level, reduce the pain and fibrosis and also bring relaxation and provide a feeling of well-being[25]. In our study, there was a general improvement in the subjective feelings in the upper limb affected by lymphedema.

Compressive bandaging has been shown to be an effective resource, because it increases the lymphatic absorption and flow achieved through prior manual lymphatic drainage[26]. In the present study, there were significant decreases in the lymphedema in the patients who had MCT intake in addition to the physical therapy interventions.

With regard to electrical bioimpedance, it is known that its results vary according to the tissue that is being measured. It can thus be said that the values obtained were directly proportional to the body fat percentage. In addition to body fat and lean mass evaluations, this method establishes the quantity of body water and is therefore an important follow-up tool for patients with pathological conditions of increased extracellular liquid[27]. The bioimpedance study by Cornish et al.[28] indicated that there was higher precision in calculating body water volumes using segmental body impedance, rather than taking the body as a whole. In the present study, this examination was not done segmentally, and therefore it was not possible to obtain definitive conclusions from evaluating the lymphedema. Nonetheless, it was shown to be important for nutritional evaluation of the patients. Thus, more studies are needed using segmental bioimpedance to evaluate lymphedema.

The biceps and triceps skinfold measurements did not indicate any direct relationships with the conventional methods for lymphedema evaluation, since these are traditionally nutritional indicators. According to Shills et al.[29], indirect calculation of body composition by measuring the subcutaneous fat in the skinfolds is the method most used in such investigations. Skinfold measurements have the purpose of estimating total body fat, because there is a relationship between localized fat deposited under the skin and body density[30]. Measurement of these folds was used here in an attempt to investigate improvements in skin malleability and the consistency of the lymphedema.

In agreement with the results from Soria et al.[13], the use of MCT by patients with lymphedema was shown to be effective, considering that in the present study there were significant reductions in the circumference measurements and volume of the affected limb, in comparison with the group control, thus signifying a decrease in the lymphedema in the patients who used MCT as additional therapy.

MCTs, which are rich in medium-chain fatty acids, are hydrolyzed by pancreatic lipase action and are absorbed in the duodenum more rapidly than are long-chain fatty acids. According to Yokocama and Fagundes[31], a low-fat diet that is rich in MCTs must be used for individuals with intestinal lymphangiectasia and consequent lymphatic insufficiency, in order to decrease accumulations in the lymph ducts and reduce the pressure in these dilated vessels. MCTs are not esterified or absorbed in the intestinal lymphatic system and chest duct, but enter directly into the portal system: hence the reason for their use. Alcauza and César[32] used MCT as a diet therapy method among women with upper-limb lymphedema and obtained positive results, with reductions of the clinical symptomatology.

In the present study, it could be seen that the use of MCTs as a means of lymphedema treatment was satisfactory, since the patients who used MCT as a nutritional supplement demonstrated significant improvements compared with the control patients. This also leads us to wonder whether the lipid diet of vegetable oil that was administered in the control group might have constituted a contributory factor for non-regression or even increased lymphedema because that diet was composed of long-chain fatty acids. After absorption of these fatty acids derived from vegetal oil, they leave the intestine in the form of triglycerides through the lymph ducts, incorporated in kilomicrons and transported by the lymphatic system. By increasing the overload in a lymphatic system that is already compromised, this may come to negatively influence the involution of the lymphedema. Therefore, the present study draws attention to the fact that ordinary diets that are rich in long-chain fatty acids may not be ideal for people with lymphedema, and suggests that further studies in this area are needed.

In conclusion, physical therapy treatments with the addition of dietary therapy consisting of MCT intake among women with upper-limb lymphedema following mastectomy was effective for the involution of this condition. Further studies are needed in order to investigate the importance of interdisciplinary therapies for treating this condition.

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