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CHANGES IN LYMPHATIC FUNCTION AFTER COMPLEX PHYSICAL THERAPY FOR LYMPHEDEMA

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ABSTRACT

Twenty-two extremities of 19 lymphedema patients (6 arms, 16 legs) were treated by 2 weeks of complex physical therapy (CPT) and self home maintenance therapy (bandage/ wearing of elastic garment and exercise). In addition to the clinical response of volume reduction before and 3 months after CPT, we analyzed the functional changes of the peripheral lymphatic system by use of lymphoscintigraphy (LS).

Before CPT, the main LS findings of lymphedema included dermal backflow (100%), absent or faintly visualized regional lymph nodes (95.5%), presence of collateral lymphatic vessels (68.2%), and no or barely visualized lymphatic vessels (27.3%). LS findings suggesting improved lymphatic function after CPT were a decrease in dermal backflow (72.7%), an increase in radioisotope uptake by lymphatic vessels (27.3%), and an increase in radioisotope uptake by lymph nodes (9.1%). 81.8% of limbs showed improved lymphoscintigraphic findings and no change in 9.1%. In the others (9.1%), LS findings appeared worse. There was, however, no correlation between LS "improvement" and the amount of limb volume reduction.

Several non-operative treatment methods are recommended for peripheral lymphedema. Among them complex physical therapy (CPT), a technique involving manual manipulation, bandage-wrapping compression, remedial exercises, and use of a low-stretch elastic garment has been the most successful (1,2). The main therapeutic advantages of CPT that have been proposed include opening of collateral lymphatic drainage pathways, stimulated pumping by deep lymphatic drainage pathways, and breaking down of excess fibrous tissue. Földi (2) reported preliminary findings in 10 patients with primary and secondary lymphedema that showed improved functional changes after a 4-week course of CPT using lymphoscintigraphy. These included a shortened arrival time with improved tracer uptake in regional lymph nodes, visualization of lymph nodes that were not seen before CPT, and decreased dermal backflow. Because 4-weeks of CPT as outlined by Földi and others (1,2) poses several practical and logistical problems, we modified CPT to a 2-week outpatient program and examined lymphoscintigraphic findings before and after CPT and correlated the findings with volume reduction in the lymphedematous limb.

MATERIALS AND METHODS

Subjects

Twenty-two extremities of 19 lymphedema patients (mean age 46.0 ± 14.0 yrs)

TABLE 1
Demographics of Patients

Variables	N	n
Male	2	2
Female	17	20
Primary	4	4
Secondary	15	18
Unilateral	16	16
Bilateral	3	6
Upper limb	6	6
Lower limb	13	16

N = Number of patients; n =Number of limbs

were studied and the demographics of the patient population are shown in *Table 1.* Nineteen patients were studied including 3 with bilateral leg lymphedema and 6 with unilateral upper extremity lymphedema. Four had primary and 15 had secondary lymphedema.

Treatment

A single physical therapist performed the 2-week CPT program which included 1 hour of manual lymph drainage, multilayered bandaging with non-stretch bandages and specific remedial exercises 5 times per week. During the treatment period, there was no restriction on activities of daily living. After 2 weeks of CPT, patients continued the self-maintenance treatment program including one month bandaging, two month wearing of the high compression stocking, exercise and skin care at home.

Clinical Evaluation

Limb volume was serially checked by using an optoelectric volumeter (Volometer®, Bösl, Germany). Percentage volume reduction (PVR) (1) was calculated after 3 months. PVR(%) = [(F-NF) - (I-NI)] x 100 / (I-NI) where F = post-treatment volume, lymphedema limb; NF = post-treatment volume, normal limb; I = pre-treatment volume, lymphedema limb; NI = pre-treatment volume, normal limb.

In 6 legs of 3 patients with bilateral leg lymphedema, the volume differences (PVD) was calculated instead of PVR: PVD(%) = (F-I) x 100 / I where F = post-treatment volume; I = pre-treatment volume.

Lymphoscintigraphy

Lymphoscintigraphy (LS) was performed before and 3 months after CPT. Two mCi Tc-99m antimony sulfide colloid for each extremity (total 4mCi) was injected subcutaneously on the dorsum of foot or hand in the interdigital spaces. Static images were obtained in each patient within 2 minutes, at 30 minutes, 1 hour, and 2 hours after injection. Imaging areas included bilateral injection sites, distal and proximal extremities, regional lymph nodes, abdomen and pelvis to incorporate liver, paraaortic and iliac lymph node chains. Standardized exercise for leg or arm was done.

Qualitative image interpretation was done by a single experienced nuclear medicine physician. The criteria examined included evaluation of the lymph nodes (well-, barely-, or non-visualized), lymphatic vessels (well-, barely-, or non-visualized, presence of collateral vessels), and evidence of dermal backflow. If the visual interpretation was equivocal, semiquantitative tracer migration analysis was performed before and after assessment of the images. Scintigraphic images were stored on computer fixed discs and were retrieved afterwards for data analysis involving selection of regions of interest defining the regional lymph nodes, lymphatic vessels, or dermal backflow. For each area, the percentage uptake was corrected for the physical decay of

TABLE 2
Lymphoscintigraphic Findings Before Treatment

		n	%
Lymph node (regional)	Non-visualized	9	40.9
	Barely visualized	12	54.5
	Well visualized	1	4.5
Dermal backflow	Present	22	100
Lymphatics	Non-visualized	5	22.7
	Barely visualized	1	4.5
	Well visualized	1	4.5
	Collaterals	15	68.2

n = Number of limbs

TABLE 3
Lymphoscintigraphic Findings After Treatment

		n	%
Lymph node (regional)	Increased	2	9.1
	Decreased	2	9.1
	No change	18	81.8
Dermal backflow	Increased	4	18.2
	Decreased	16	72.7
	No change	2	9.1
Lymphatics	Increased	6	27.3
	Decreased	1	4.5
	No change	15	68.2

n = Number of limbs

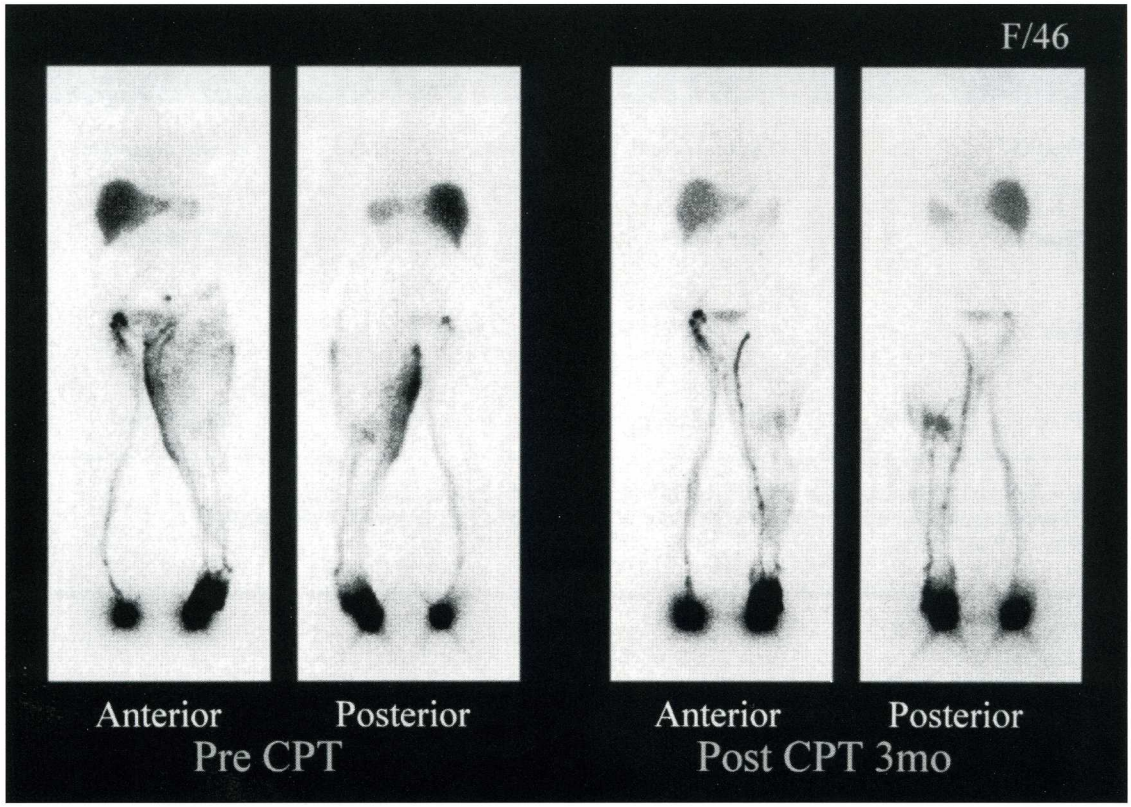

Fig. 1. Lymphoscintigraphy of 46-year old woman with post-hysterectomy lymphedema before and after CPT. Decreased dermal backflow and increased radiotracer uptake of left main lymphatic vessels are seen.

radioisotope, normalized for the injected dose, and a change of the ratio to the normal contralateral extremity was recorded.

RESULTS

Clinical Outcome

Based on the percent limb volume reduction (PVR), we divided the clinical responses to CPT into 3 groups: good response (PVR $\geq$ 30%), fair (15% $\leq$ PVR <30%) and poor response (PVR <15%).

LS Findings of Lymphedematous Limb

Before treatment (Table 2)

Axillary lymph nodes of patients with upper limb lymphedema or ilioinguinal lymph nodes of patients with lower limb lymphedema were not visualized in 9 limbs (40.9%), barely visualized in 12 limbs (54.5%). Lymphatic vessels were not visualized in 5 limbs (22.7%), barely visualized in one limb (4.5%). Also, 15 limbs (68.2%) showed collateral lymphatic circulation. Dermal backflow was detected in all lymphedematous limbs (100%).

After treatment (Table 3)

Increased tracer uptake by lymph nodes was observed in 2 limbs (9.1%) and one demonstrated lymph nodes not visualized

TABLE 4
Clinical Response and Lymphoscintigraphic Change

Grade*	n	Decreased DB	Increased LN uptake	Increased L uptake
Good	9	9/9 (100%)	0/9 (0%)	4/9 (44.4%)
Fair	4	2/4 (50%)	0/4 (0%)	0/4 (0%)
Poor	9	5/9 (55.6%)	2/9 (22.2%)	2/9 (22.2%)

n = Number of limbs; DB = Dermal backflow; LN = Lymph node; L = Lymphatic
*Percentage volume reduction (PVR); Good = PVR ≥ 30%; Fair = 15% ≤ PVR <30%; Poor = PVR <15%.

before treatment. In the other two limbs, tracer uptake by lymph nodes was decreased.

Six limbs (27.3%) showed increased uptake by lymphatics or newly visualized lymphatic vessels. Decreased uptake in lymphatic vessels was observed in one patient (4.5%). A decrease in dermal backflow was the most common LS finding (72.7%) after treatment *(Fig. 1)*. Four limbs (18.2%) revealed increased dermal backflow but in two, uptake of lymph nodes in lymphatic vessels was increased.

Correlation Between Clinical and LS Findings (Table 4)

Regarding limb volume reduction, 9 limbs showed good, 4 limbs fair, and 9 limbs poor results. We considered any one or more of the following LS findings as improvement after treatment: 1) increased uptake by regional lymph nodes or detection of lymph nodes not previously visualized; 2) increased tracer uptake of lymphatic vessels or the appearance of lymphatic vessels not previously visualized; and 3) decreased dermal backflow. Eighteen limbs showed LS improvement; 9 had good clinical outcomes, 2 were fair, and 7 had a poor result after treatment. Nine limbs that were classified as having fair or poor clinical outcomes also showed similar findings of LS "improvement." Overall, there was no significant correlation between the clinical outcome and the LS improvement ($p>0.05$, Mantel-Haensel Chi-Square).

DISCUSSION

Lymphedema represents an abnormal accumulation of tissue proteins, edema fluid, and chronic inflammation within an extremity due to low output failure of the lymphatic circulation. Patients with lymphedema have symptoms that include local discomfort, impaired limb function, and an unsightly appearance. Although many treatment methods exist for lymphedema, a cure is not currently available and treatment often remains frustrating for both the patient and physician. Complex physical therapy (CPT) or complex decongestive therapy is a program that consists of meticulous skin care, manual lymph drainage, remedial exercises,

bandage-wrapping, and wearing of compression stockings (1,2,6). We have used pneumatic compression, compression garments, intensive CPT and occasionally operative therapy in our clinic for the last 3 years. Because a 4-week CPT program has practical and logistical considerations, is very time-consuming and expensive, patient compliance often poor, and most reduction of lymphedema occurs after the initial 7-10 days of CPT (7), we reduced the duration of intensive CPT to 2 weeks.

In our study, the clinical outcome based on the amount of limb volume reduction was not as successful compared with previous reports (1,2). This difference may relate to 1) patient factors, that is, different clinical stage of lymphedema (almost all our patients were in clinical stage II or III), and compliance; 2) therapy factors, that is the skill of the therapist as well as therapy time and duration; and 3) a different formula of limb volume calculation. Despite these differences, our patients overall had consistent limb improvement after CPT.

LS was introduced by Sherman and Ter-Pogossian in 1953 (8), and it now has been advocated as the preferred diagnostic test for peripheral lymphedema (4,5,10,11). Unfortunately, there are still considerable differences among clinics as to the optimal radiopharmaceutical, testing times, and analysis methods. Ter et al (9) described LS findings using Tc-99m antimony trisulfide colloid in patients with suspected lymphedema. They considered any one or more of the following patterns of lymphatic drainage as abnormal: 1) lack of tracer migration from the injection site, 2) delayed transport from the injection site, 3) dermal backflow, 4) large collateral lymph vessels, 5) non-visualization of lymphatics on the involved side with no or barely detectable lymph nodes, 6) cross-over filling of retroperitoneal nodes secondary to proximal obstruction and a collateral lymphatic circulation. We confirmed these findings with dermal backflow as the most consistent abnormal finding.

Until now, LS evaluation of treatment in lymphedema has rarely been described (2,12,13). Földi (2) reported a shortened arrival time of tracer and greater uptake in the regional lymph nodes, demonstration of lymph nodes which were not visualized before CPT, and diminished dermal backflow by dynamic lymphoscintigraphy. In our study, the commonest finding after treatment was a decrease in dermal backflow. Increased isotope uptake of the lymphatic system of the ipsilateral treated limb was only occasionally observed. Accordingly, dermal backflow may be the most useful finding to evaluate changes of lymphatic function before and after treatment. On the other hand, in 4 limbs (18.2%) of our patients, there was an increase in dermal backflow, although in two the tracer uptake by lymph nodes and lymph vessels actually increased. Ketterings and Zeddeman (13) described that lymph capillaries were able to absorb more of the injected radionuclude as reflected as an increase in transit activity with a reduction of limb volume and intralymphatic pressure after non-operative treatment. Accordingly, an increase in dermal backflow but with increased uptake by the lymphatic vessels is not necessarily indicative of worsening lymphatic function. There was, however, no statistically significant correlation between the amount of limb volume reduction and the LS "improvement," results which are similar to those previously reported (12,14).

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