

Effective Treatment of Lymphedema of the Extremities

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Objective: To define the immediate and long-term volumetric reduction following complete decongestive physiotherapy (CDP) for lymphedema.

Design: Prospective study of consecutively treated patients.

Setting: Freestanding outpatient referral centers.

Patients: Two hundred ninety-nine patients referred for evaluation of lymphedema of the upper (2% primary, 98% secondary) or lower (61.3% primary, 38.7% secondary) extremities were treated with CDP for an average duration of 15.7 days. Lymphedema reduction was measured following completion of treatment and at 6- and 12-month follow-up visits.

Intervention: Complete decongestive physiotherapy is a 2-phase noninvasive therapeutic regimen. The first phase consists of manual lymphatic massage, multilayered inelastic compression bandaging, remedial exercises, and meticulous skin care. Phase 2 focuses on self-care by means of daytime elastic sleeve or stocking compression, nocturnal wrapping, and continued exercises.

Main Outcome Measures: Average limb volumes in

milliliters were calculated prior to treatment, at the end of phase 1, and at 6- to 12-month intervals during phase 2 to assess percent volume reduction.

Results: Lymphedema reduction averaged 59.1% after upper-extremity CDP and 67.7% after lower-extremity treatment. With an average follow-up of 9 months, this improvement was maintained in compliant patients (86%) at 90% of the initial reduction for upper extremities and lower extremities. Noncompliant patients lost a part (33%) of their initial reduction. The incidence of infections decreased from 1.10 infections per patient per year to 0.65 infections per patient per year after a complete course of CDP.

Conclusions: Complete decongestive physiotherapy is a highly effective treatment for both primary and secondary lymphedema. The initial reductions in volume achieved are maintained in the majority of the treated patients. These patients typically report a significant recovery from their previous cosmetic and functional impairments, and also from the psychosocial limitations they experienced from a physical stigma they felt was often trivialized by the medical and payor communities.

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EFFECTIVE treatment of chronic extremity lymphedema has eluded the medical profession for many generations. Physicians typically advise the use of limb sleeves or stockings and pneumatic pump devices for the treatment of this condition. Occasionally, diuretics are prescribed in the attempt to decrease the peripheral edema. In the most severe cases, patients may be advised to have either a surgical debulking procedure,¹⁻⁴ a tissue autotransplant,^{5,6} or, more recently, a microsurgical operation⁷⁻¹⁰ to alleviate the symptoms of lymphedema and to improve the quality of life. Most patients are advised to learn to live with the chronic swelling because an effective therapy is lacking.

As early as 1892, Winiwarter¹¹ suggested the use of lymphatic massage and bandaging to reduce the size of the swollen limb. This technique was revived in the 1950s by

Stillwell¹² at the Mayo Clinic and then lay dormant until Foeldi^{13,14} eloquently explained the rationale for this treatment in the 1970s. Foeldi stressed the importance of skin care, the necessity of eradicating infections, the beneficial effects of compression bandaging, and the need for remedial exercises. He also advocated the Vodder technique of lymphatic massage that is known as manual lymph drainage.¹⁵

Because the results of surgical intervention and pneumatic pumping for lymphedema are less than satisfactory, we began treating lymphedema patients by the Foeldi technique, also known as complete (or complex) decongestive physiotherapy (CDP), in 1989.

The purpose of this report is to evaluate the immediate and the longer term volumetric reductions of upper and lower lymphedematous extremities after a single course of CDP.

PATIENTS AND METHODS

STUDY POPULATION

Two hundred ninety-nine consecutively treated lymphedema patients were studied prospectively to determine the volumetric reduction in the affected limb immediately following a course of CDP and at 6- and 12-month follow-up visits. All of these patients were referred to our tertiary care center after complete medical evaluations in the primary facility had ruled out other causes of extremity swelling, particularly tumor recurrence or nodal metastases in patients with secondary lymphedema. If the diagnosis of lymphedema remained in question, we advised further vascular laboratory studies, lymphangioscintigraphy, or magnetic resonance imaging to evaluate the clinical condition. Since chronic venous insufficiency may contribute to the development of lymphedema over time, any suspected acute venous process was evaluated with doppler venous studies to rule out deep venous thrombosis. Only patients with unilateral lymphedema were included in this review. One hundred forty-nine patients had upper-extremity lymphedema; the other 150 patients had lower-extremity lymphedema. The age of the treated patients ranged from 3 to 84 years. Of the 299 lymphedema patients, 196 had previously been treated with unsatisfactory results using pneumatic pumps and elastic garments. Eight patients in this series had undergone 1 or more surgical procedures in the attempt to control the lymphedema.

Of the upper-extremity patients, 3 were cases of primary lymphedema and 146 were secondary (**Table 1**). Most of the latter group had received prior treatments for breast cancer. Of the lower-extremity patients, 93 were primary lymphedema cases and 57 were secondary (**Table 1**). Most of the primary cases could be categorized as lymphedema praecox. The secondary lower-extremity cases were mostly the result of treatment for malignant melanoma, lymphoma, cancer of the cervix uteri, or prostatic carcinoma. The causes of the secondary lymphedema cases are summarized in **Table 1**. The patient characteristics for upper- and lower-extremity lymphedema are presented in **Table 2** and **Table 3**.

TREATMENT PROTOCOL

Complete decongestive physiotherapy is a 2-phase, non-invasive therapeutic regimen that closely follows the Foeldi technique.¹⁶ During phase 1, daily therapeutic sessions, which include manual lymph drainage massage, multilayered inelastic compression bandaging, and meticulous

skin care, are employed.^{17,18} The course of phase 1 treatment varied from 4 to 25 days, with one or two 90-minute treatments on each day. The average patient required 15.7 days (**Table 2**) of treatment to reach a plateau of volume reduction in the affected limb. All patients received phase 1 CDP treatment in outpatient referral centers. There was a trend toward an increased number of treatments required for longer duration of the lymphedema, greater degree of fibrosis, and more extensive cancer treatments previously received; however, the differences in duration of CDP treatment did not achieve statistical significance (**Table 3**).

During phase 1, the patient and family members are taught the bandaging and exercise techniques. They are also educated regarding the essentials of skin and nail care. An in-depth seminar is provided to inform the patients of lifestyle adjustments necessary for continued control of this chronic ailment. Obese patients are advised to lose weight and are provided with special dietary instructions. A detailed description of the phases of CDP is presented in **Table 4**.

Phase 2 (maintenance phase) is then carried out by the patient and family at home. This consists of daytime surgical sleeve or stocking compression. In addition, nocturnal bandaging of the limb using inelastic multilayered bandage materials is employed. Remedial exercises are encouraged when the affected limb is wrapped (**Table 5**). A few patients also received weekly manual lymph drainage massage sessions from a family member.

EXTREMITY MEASUREMENTS

Limb volume was measured prior to and at the end of the phase 1 course of treatment. Standardized circumferential measurements were made at 7 specific locations on each limb: foot, ankle, lower calf, upper calf, knee, lower thigh, and upper thigh; or hand, wrist, lower forearm, upper forearm, elbow, lower arm, and upper arm. Volume was calculated using the truncated cone formula: $\text{Volume} = [\Sigma (x^2 + y^2 + xy)]/3\pi$; where x indicates distance from the tip of the cone to the base and y indicates the circumference of the cone at distance x . Errors that arise from this mathematical method of determining limb volume have been found to be negligible when compared with those from volumetric determination.^{22,23} Moreover, in our assessments, all post-treatment volumetric reductions were determined by comparison to the initial calculated baseline volume, therefore providing internal consistency.

Measurements were subsequently repeated at 6- and 12-month intervals. In some cases, the patient omitted the 6-month check-up while others were measured at both 6- and 12-month visits.

RESULTS

Lymphedema reduction averaged 59.1%±8.2% (mean±SD) after the phase 1 course of upper-extremity CDP and 67.7%±6.7% after lower-extremity treatment (**Table 6**). One hundred forty-five (97.3%) of the 149 patients with upper-extremity lymphedema demonstrated sustained improvement with long-term follow-up after CDP treatment (**Table 7**). All of the 150 patients treated for lower-extremity lymphedema had measurable improvements after phase 1 treatment and on follow-up visits (**Table 7**). With an average follow-up of 9 months, this improve-

ment was maintained within 95% of the initial volume reduction in 84% of compliant patients for upper extremities and in 82% of patients for lower extremities. Noncompliant patients (16% and 12% for upper and lower extremities, respectively) lost some of their initial lymphedema reduction (**Table 8**). Many patients were able to report significant recovery from their previous cosmetic and functional impairments. In particular, the incidence of cellulitis of the extremity afflicted with lymphedema decreased after treatment with CDP (**Table 2**). Clinical examples of such patients are shown in the **Figure**.

Primary and secondary lymphedema are progressive incurable conditions that have historically defied both medical and surgical attempts to effectively decompress the chronically swollen extremity. Patients with these disorders are typically shuttled between specialists, as the usual therapeutic recommendations, including compression garments, pneumatic pumps, and even radical sur-

gical procedures, often fail to adequately control their edema. Progressive soft tissue fibrosis, recurrent infections, and psychosocial problems eventually complicate the initial purely cosmetic affliction. Our experience in-

Table 1. Causes of Secondary Upper-Extremity and Lower-Extremity Lymphedema

Cause	No. of Patients
Upper-Extremity Lymphedema (n = 146)	
Breast cancer treatment	133
Lumpectomy, axillary node sampling, and radiation therapy	41
Mastectomy and axillary dissection	50
Mastectomy, axillary dissection, and radiation therapy	42
Melanoma, upper extremity	6
Other cancers	4
Subclavian vein thrombosis	2
Scalene node biopsy	1
Lower-Extremity Lymphedema (n = 57)	
Cervical cancer therapy	18
Deep venous thrombosis	8
Prostate cancer therapy	8
Melanoma, lower extremity	8
Other cancers	10
Vein harvesting or stripping	5

Table 2. Patient Characteristics in Upper-Extremity and Lower-Extremity Lymphedema*

	Upper-Extremity	Lower-Extremity
Mean ± SD age, y	60.2 ± 11.7	46.8 ± 17.4
Men	12	42
Women	137	108
Mean ± SD duration of CDP treatment, d	15.1 ± 4.1	16.3 ± 3.9
Prior use of pneumatic compression, No. of patients	96	100
Frequency of infection, No. per patient per year		
Pre-CDP treatment	1.10	
Post-CDP treatment	0.65	

*CDP indicates complete decongestive physiotherapy.

Table 3. Patient Characteristics in Upper-Extremity Lymphedema Following Breast Cancer Treatment

	Lumpectomy, Axillary Dissection, Radiation Therapy	Mastectomy, Axillary Dissection	Mastectomy, Axillary Dissection, Radiation Therapy
No. of patients	41	50	42
Mean ± SD age, y	56.2 ± 11.1	61.5 ± 10.4	63.8 ± 10.4
Mean ± SD duration of CDP treatment, d*	14.0 ± 4.1	15.0 ± 4.4	15.9 ± 3.6
Prior use of pneumatic device, No. of patients	25	31	29

*CDP indicates complete decongestive physiotherapy.

Table 4. Complete Decongestive Physiotherapy (CDP)

Phase 1 (Treatment)

Each CDP treatment consists of four steps:

1. Meticulous skin and nail care, including the eradication of any infection with antimicrobial therapy.
2. Manual lymph drainage is a massage technique that stimulates lymph vessels to contract more frequently and to channel lymphatic fluid towards adjacent, functioning lymphatic systems.¹⁹ Manual lymph drainage begins with compressive stimulation of the lymph vessels and lymph nodes in adjacent drainage basins (neck, contralateral axilla, ipsilateral groin, etc). In upper-extremity lymphedema, this is followed by sequential manual decongestion of the involved trunk, shoulder, arm, forearm, wrist, and hand. Lymphatic fluids from obstructed drainage regions are physically mobilized to drain toward the ipsilateral inguinal region and the contralateral thorax. Detailed descriptions of manual lymph massage and lymph drainage pathways can be found in prior publications by Casley-Smith.²⁰
3. Compression bandaging is performed immediately after manual lymph drainage. In upper-extremity lymphedema, bandages are applied sequentially from the distal phalanges to the axilla with progressive reduction in compressive pressure. Many layers of minimally elastic cotton bandages are applied with overlying foam rubber inserts to increase pressure in areas that are particularly fibrotic or to ensure distribution of uniform compression. The bandaging technique increases interstitial pressures without compromising vascular supply to the distal extremity. This effectively prevents significant reaccumulation of lymphatic fluid and prevents ultrafiltration of additional fluid into the interstitial space. Detailed descriptions of lymphedema bandaging have been described by Klose.²¹
4. The bandaged extremity is subsequently guided through a series of remedial exercises aimed at promoting muscle and joint motions within an enclosed space. These exercises can increase lymphatic fluid movement in available lymphatic channels aided by collateral drainage pathways.

Phase 2 (Maintenance)

1. Meticulous skin and nail care.
2. Surgical support garments (sleeves, gloves, stockings, or hosiery) are worn during the day. Upper-extremity lymphedema often requires compression class II to III while lower extremities use class III to IV.²⁰
3. Low stretch bandages are applied each evening and are worn overnight.
4. Fifteen minutes of specific lymphedema exercises are performed every morning while still dressed in compressive bandages. Muscle movements while bandaged can increase the volume and the pressure of lymphatic flow, which may eventually lead to formation of collateral lymphatic vessels. After the prescribed exercises, the patients wear the tailored daytime support garment that allows for superior mobility and thus functionality of the affected limb.

Table 5. Patient Guide to Full Spectrum of Remedial Upper-Extremity Exercises (Individually Tailored to the Severity of Lymphedema in the Affected Extremity)

- **Correct Posture:** Plant feet firmly on ground, straighten spine, and draw shoulders back.
- **Abdominal Breathing:** Inhale through nose, allow abdomen to protrude outward, and exhale through mouth slowly.
- **Shoulder Rotations:** Smoothly draw shoulders up toward ears then pull them back, down, and forward in a continuous circular motion.
- **Head Turns:** Slowly and smoothly turn head from center to left, back to center, and center to right and back. Do not use force; turn gently.
- **Neck Stretches:** Slowly and smoothly draw chin toward chest, raise head, and look toward ceiling. Repeat gently.
- **Shoulder Stretches:** Bend elbows and raise parallel to ground, draw elbows back squeezing shoulder blades together, and reverse motion to allow bent arms to cross in front of chest. Repeat.
- **Shoulder Shrugs With Breathing:** Inhale through nose while raising shoulders toward ears, follow by exhaling slowly through mouth and lowering shoulders.
- **Isometric Chest Press:** Clasp hands together in front of chest, raise bent arms parallel to ground, and push palms together. Hold, release, and repeat.
- **Fist Clenches:** Place hands on thighs, clench fists slowly, fully open fists, and spread fingers apart before clenching again.
- **Wrist Circles:** Begin with unaffected arm, rotate fist in small circles isolating movement to wrist only. Do the same with affected arm.
- **Turning Outstretched Arm:** Start with unaffected arm, raise in front parallel to ground, rotate palm outward then inward. Rest then repeat on affected side.
- **Breast Stroke:** Place palms together, push hands forward extending arms, separate hands drawing elbows back, and repeat as if swimming.
- **Elbow Circles:** Bend arms at elbow, draw small circles with point of elbows progressing into larger circles, and reverse direction spiraling down to small circles.
- **Breathing:** Pause and repeat previous breathing sequence.
- **Reach to the Sky:** Lift arms over head, alternately reach, and pull toward head.
- **Pot Stirring:** Clasp hand in front of abdomen, separate legs moderately, slowly simulate a circular stirring motion, reverse direction.
- **Isometric Chest Press:** Previously described.
- **Isometric Bicep Curl:** With hands clasped, simulate a bicep curling motion while resisting with the other hand. Switch sides and repeat. Do not hold breath. (There is no actual movement.)
- **Wrist Rotations With Hands Interlocked:** Clasp hands with fingers interlocked in front of chest, rotate wrists in a circular motion, and reverse direction.
- **Finger Dexterity 1:** Hands in prayer position, push matching fingers from side to side several times, move to next pair until all 5 pairs are worked; then in reverse order to starting point.
- **Finger Dexterity 2:** Hands in prayer position, separate matching pairs of fingers away from each other, progress to next pair, then reverse sequence to starting point.

icates that CDP lymphedema treatment is a precisely defined therapeutic intervention that is noninvasive, requires no medications, has essentially no risks, and yields more than 80% success after extended follow-up.

The initial patients included in this report were treated in 1989 and 1990 when no other US clinic was using the CDP method. The results observed in those first patients were consistent with those reported by Foeldi et al in 1989.¹⁹ The report by Casley-Smith and Casley-Smith²⁴ in 1996 discussed their observations in 628 swollen limbs and also showed good results. Boris et al²⁵ initially reported in 1993 on their results in 24

Table 6. Summary of Improvement in Lymphedema After CDP*

Upper-Extremity Lymphedema (n = 149)			
No. of patients	149		
Initial arm volume, mL	948.3 ± 560.1	...	
Initial post-CDP arm volume, mL	378.3 ± 227.2	...	
Post-CDP volume reduction, %	59.1 ± 8.2		P<.05
6-month follow-up arm volume, mL	433.4 ± 348.5	...	
6-month follow-up volume reduction, %	57.1 ± 14.3		P<.05
12-month follow-up arm volume, mL	437.1 ± 323.2	...	
12-month follow-up volume reduction, %	53.0 ± 16.9		P<.05
Lower-Extremity Lymphedema (n = 150)			
No. of patients	150		
Initial leg volume, mL	4169.8 ± 1798.2	...	
Initial post-CDP leg volume, mL	1371.9 ± 737.2	...	
Post-CDP volume reduction, %	67.7 ± 6.7		P<.05
6-month follow-up leg volume, mL	1463.1 ± 770.7	...	
6-month follow-up volume reduction, %	66.1 ± 8.2		P<.05
12-month follow-up leg volume, mL	1465.1 ± 756.5	...	
12-month follow-up volume reduction, %	65.2 ± 9.1		P<.05

*CDP indicates complete decongestive physiotherapy. All values are given as mean ± SD unless otherwise specified.

Table 7. Persistence of Lymphedema Reduction After Complete Decongestive Physiotherapy Treatments

	Upper-Extremity	Lower-Extremity
No. of patients in study	149	150
No. of patients with initial volume reduction	149	150
No. of patients with sustained improvement	145	150
6-month follow-up		
Minimal volume reduction, %	10.5	29.1
Maximum volume reduction, %	70.3	77.5
12-month follow-up		
Minimal volume reduction, %	6.0	22.7
Maximum volume reduction, %	82.2	76.3

Table 8. Noncompliance and Loss of Lymphedema Reduction*

Variable	Value
Upper-Extremity Lymphedema	
No. (%) of patients with noncompliance	24 (16)
Initial reduction after CDP, %	59.7 ± 9.0
6-month follow-up reduction, %	38.7 ± 25.8
12-month follow-up reduction, %	24.9 ± 24.9
Lower-Extremity Lymphedema	
No. (%) of patients with noncompliance	18 (12)
Initial reduction after CDP, %	68.7 ± 6.3
6-month follow-up reduction, %	54.2 ± 10.5
12-month follow-up reduction, %	55.0 ± 13.0

*CDP indicates complete decongestive physiotherapy. All values are given as mean ± SD unless otherwise indicated.

patients successfully treated in the United States. Recently, they published a larger series of 119 consecutive patients with lymphedema after 36 months of follow-up, demonstrating an average reduction of 63.8% in patients with 1 affected arm and 62.7% in those with 1 affected leg.²⁶



A, Secondary lymphedema after mastectomy and before complete decongestive physiotherapy (CDP) treatment. B, The same patient after 20 days of CDP treatment. C, Lower-extremity secondary lymphedema before CDP treatment. D, The same patient after 20 days of CDP treatment.

Complete decongestive physiotherapy requires a supervising physician to evaluate the patient, accurately diagnose the condition, rule out other causes of swollen limbs, and follow up the progress during treatment. Patients with complications of lymphangitis or cellulitis require treat-

ment of these problems before CDP is initiated. Patients with active cancer are also not treated unless this is done in conjunction with and at the behest of the oncologist.

Complete decongestive physiotherapy also requires a cadre of well-trained, certified CDP therapists

who are devoted to the method and have experience in treating lymphedema. The therapists who originate from Europe are licensed and certified by national boards of physiotherapy in each country. In the United States, however, they are trained by 2 certified instructors from the pioneering Foeldi Clinic, Hinterzarten, Germany. Each trainee receives 135 hours of instruction followed by a certifying examination administered by the Lerner Lymphedema Training Program, Boston, Mass. The curriculum structure is similar to the Vodder School of CDP in Austria. Lastly, successful CDP therapy requires in-house expertise in measuring and custom-fitting patients for the compression garments, which must fit comfortably if compliance is to be expected in phase 2 of treatment.

As with other lymphedema treatments, CDP does not cure; however, it is a method that affords excellent long-term control of the lymphedematous extremity. With the reduced lymphedema, the risks of infection and other lymphedema complications, such as fibrosis, skin ulceration, and extensive verrucous eruptions, are reduced, thereby permitting as normal a lifestyle as possible. With compliance during the phase 2 maintenance therapy, continued control of lymphedema and even further improvement can be expected. Complete decongestive physiotherapy is a highly effective treatment for both primary and secondary lymphedema. It can be accomplished without morbidity or mortality.

In today's environment of managed care, this form of therapy for lymphedema is increasingly recognized as an effective treatment and reimbursements are provided accordingly. The high level of competence and dedication required for the initial physiotherapy currently limit this form of treatment to a small number of specialized centers across the United States. Nevertheless, because the major component of CDP treatment is self-directed maintenance therapy, this form of treatment for lymphedema is cost-effective and should be more widely applied. In particular, there is no dependence on pharmacotherapy or need for sophisticated follow-up evaluations. Because of the excellent and sustained results provided by CDP, we suggest that chronic lymphedema is a condition for which pneumatic pumps or surgical treatments should no longer be the primarily recommended therapy.

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DISCUSSION

Daniel B. Walsh, MD, Lebanon, NH: I thank Dr Ko and his coauthors for bringing this treatment method for lymphedema to our attention. It appears that the only difference between the more commonly applied therapies and complete decongestive physiotherapy in the first week or two of treatment is the massage therapy. Is this not the case?

Can you give us some comparative data or at least some sense of how this method has changed your practice so that we might judge the specific improvement related to this treatment?

Most who deal with these patients know good results with standard methods are achievable with good patient compliance. Is your method a way to improve compliance rather than change physiology?

I am somewhat surprised that there is no difference between the response to the treatment of upper and lower extremities. The fibrosis caused by operation and radiation therapy would appear to cause much more severe lymphedema than the variable congenital abnormalities most commonly occurring in the lower extremity.

Robert M. Quinlan, MD, Worcester, Mass: About 20% of patients after axillary node dissection develop some type of

edema and patients treat it themselves. They elevate their arm. They don't do the repetitive exercise that they were doing before, and the edema resolves. There will be a smaller percentage, maybe 1%, who end up with significant edema, so there is an element of reversibility in these mild cases. You had two thirds of the patients who had pumps previously. In the one third that perhaps were better off, did they have a better result because they did not have chronic changes? I would anticipate that. Was that what you found? And if so, that would have an impact on when you would submit patients for consultation for this type of treatment.

Blake Cady, MD, Providence, RI: I think this is an exciting therapeutic technique since we've all been so frustrated with this through the years, but we have to remember that the best way to deal with a disability is try to prevent it, and the best way to prevent a good number of secondary lymphedemas is to eliminate dissections of the regional node basins, particularly in the axillae for breast cancer, which constitutes most of your patients. We have to continually remember that lymph nodes are indicators, not governors. They don't control outcome and removing them, unless you can feel them, is not therapeutic; it is only a diagnostic and prognostic tool. So, one of our jobs in breast cancer treatment and treatment of melanoma is to get rid of regional node dissections to prevent the very problem that you are faced with. I think we can do this with sentinel node biopsy, which just takes out a node or two, and at least confine the dissection to those that have positive nodes; keeping in mind that in this day and age if somebody walks in the door with breast cancer with a palpable axillary node they really have advanced disease and ought to be considered for induction chemotherapy—where you need to leave the node so you can see what the effect of therapy is.

My question is, do you have anything about the common factors of who gets edema later on? Is it the type of dissection? Is it the obesity? Is it the number of nodes harvested or anything else that will give us clues about that?

William W. Babson, Jr, MD, Plymouth, Mass: I wonder why the authors decided not to continue the nonelastic compression for the second phase when it was quite successful in the first phase.

Dr Ko: In addition to the first 2 weeks of the manual lymph drainage, there are a number of differences that readily distinguish the complete decongestive physiotherapy from the commonly applied bandaging/compression techniques. The phases of complete decongestive physiotherapy include treatment of lymphatic congestion and maintenance of lymphatic decompression as the 2 distinct end points. The treatment phase consists of (1) meticulous skin and nail care, including the eradication of any infection with the use of antibiotics; (2) manual lymph drainage, which is a massage technique that stimulates lymph vessels to contract more frequently and channels lymph and edema fluid towards adjacent, functioning lymph systems; and (3) compression bandaging, which is done immediately after manual lymph drainage. Bandages are sequentially applied from the most distal extremity with maximal pressure progressing to the most proximal with minimal pressure. The bandaged patient is next guided through a series of remedial exercises with the muscles and joints functioning within a closed space that may help to increase lymph flow in all available lymph channels and in collateral pathways. The maintenance phase consists of (1) continued meticulous skin and nail care; (2) surgical support garments that are worn during the day while low stretch bandages are applied each evening and are worn overnight; and (3) a short sequence of specific exercises that is done each morning while still bandaged. Therefore, in addition to the manual lymph drainage massage, there are many components of the complete decongestive physiotherapy that may account for the dramatic results observed.

The results that we have presented suggest that the initial improvements of complete decongestive physiotherapy are sustained with prolonged follow-up. Recent reports by Boris et al in *Oncology* describing the persistence of lymphedema reduction after noninvasive complex lymphedema therapy or complete decongestive physiotherapy also support our findings. Currently, at our institution, after all the other causes of extremity swelling have been ruled out by careful medical evaluations and the diagnosis of lymphedema is confirmed, our initial therapy for lymphedema is complete decongestive physiotherapy.

Dr Walsh, your comments on whether these patients have good results because of improved compliance rather than changed physiology is very important. Most of our patient population has tried all other modalities of therapy for their chronic ailment. There are those who have even attempted surgical interventions. The fact that they are frustrated with their functional disability has made them a very motivated group of patients. Therefore, it is easier to enroll them in our complete decongestive physiotherapy program and to prescribe a detailed lifestyle modification that includes meticulous bandaging techniques and continued exercise requirements. The dramatic improvements observed in the initial phase of complete decongestive physiotherapy intuitively suggest that the manual lymph drainage does play a role in the physiology of lymphedema decompression. However, it would be pertinent to conduct randomized study comparing a full course of complete decongestive physiotherapy vs complete decongestive physiotherapy without manual lymph drainage to fully elucidate the relative contributions of the massage component.

Although the fibrosis caused by operations and radiation therapy for the treatment of breast cancer would appear to cause much more severe lymphedema than the congenital abnormalities most commonly occurring in the lower extremity, the response to complete decongestive physiotherapy is not different. This may suggest that there are vast lymphatic reserves that may open with the manual decompressive technique of complete decongestive physiotherapy. Moreover, once the initial response is obtained, the maintenance phase of complete decongestive physiotherapy is independent from those physiological constraints associated with fibrosis.

Dr Quinlan has made a very valid observation that there is an element of reversibility in mild cases of secondary lymphedema associated with axillary node dissection. Our patient population, who has used pneumatic pumps in two thirds of the cases, does not suggest the degree or the duration of the lymphedema. Often it is the practice of the referring physician or surgeon that determines the modality of treatment for lymphedema. The failure of pneumatic devices does not suggest that there is a chronic component to the lymphedema. In particular, many patients have used these devices shortly after initial symptoms of extremity swelling. Unfortunately, the experience of using a pneumatic pump is uniformly dismal in the treatment of lymphedema; therefore, in our opinion, it should not be recommended as an effective form of therapy.

I fully agree with Dr Cady's comments on the preventive strategies for eliminating the potential etiologies of secondary lymphedema. In our study, we have tried to isolate factors such as axillary lymph node sampling, radiation therapy, lumpectomy, and modified mastectomy to see whether any of these is predictive for the duration of the complete decongestive physiotherapy (phase 1) required for initial lymphedema reduction. There were no statistically significant differences observed in our patient cohort. We have not examined the potential common factors that may be responsible for the development of lymphedema such as obesity, type of dissection, and number of nodes harvested. These and other components will form an integral part of our continuing analysis of complete decongestive physiotherapy for lymphedema.