Comparison between Two Different Physical Programs in Management of Lymphedema

Alaa A.M. Hassan, PT.D.
Department of Physical Therapy for Cardiopulmonary Disorders and Geriatrics, Faculty of Physical Therapy, Cairo University.

ABSTRACT

Background: *Conservative treatment for lymphedema aims to reduce and control the amount of swelling in an affected limb, as well as to restore the function and cosmesis. Physical therapy interventions for lymphedema have included the use of elastic compression garments; the use of compression pumps; limb elevation; manual lymphatic drainage; active, isometric, and resistance exercises; and ultrasound. The purpose of the present study was to compare the effect of two different physical programs in the management of patients with chronic secondary lymphedema of the lower limb.* ***Methods:*** *Forty male patients with chronic secondary lymphedema of one lower limb were randomized either to an intermittent pneumatic compression (IPC) group or to a manual lymphatic drainage (MLD) group for twelve weeks of management. Limb volume and girth were assessed before and after the management in both groups.* ***Results:*** *Limb volume and girth reduced significantly in both groups, but the reduction was more pronounced in the IPC group than in MLD group.* ***Conclusion:*** *Both IPC and MLD are effective in reducing the volume and girth of the affected limb, but IPC is superior to MLD.*

Key words: *Chronic Secondary Lymphedema, Intermittent Pneumatic Compression, Manual Lymphatic Drainage, Limb Volume, Limb Girth.*

INTRODUCTION

When the delicately balanced lymphatic system is damaged, it may be unable to transport fluid, because there is a build-up of protein that attracts more fluid and results in a build-up of lymph fluid in the subcutaneous tissues[1,2]. The excess fluid causes edema in the arms and legs, and less frequently, in the trunk or genitals. Stagnant protein-rich lymph causes tissue channels to increase in size and number, which reduces oxygen availability, interferes with wound healing and predisposes the individual to infection[3,19].

Primary lymphedema results from congenital defects in the lymphatic system. Secondary lymphedema is acquired due to obstruction or interruption of the lymphatic flow at the site of the lymph nodes[25]. Lymphedema can occur in acute and chronic forms. The acute form includes the mild, immediate, short-term swelling that accompanies all surgery and many injuries, such as a sprained ankle. The chronic form includes chronic swelling that often occurs after surgery due to axillary or pelvic lymph node dissection, phlebitis or other surgical complications, swelling from insect bites, and due to radiation[13].

Physical impairments caused by lymphedema include pain, increased limb girth, increased limb volume, decreased strength, decreased range of motion, and impaired function[14,26]. There is also a psychological morbidity associated with lymphedema that can include social isolation, depression, and even suicidal ideations[8,25].

The treatment program that has been used in management of lymphedema is known as complex decongestive physiotherapy (CDP)[13,21]. This method includes skin care, gentle massage known as manual lymph drainage, and the use of compression bandages or garments[8,19,20].

The sequential, multichambered pneumatic compression pumps produce a linear pressure wave from distal to proximal portions of the limb that reduces the tendency of fluid to collect in the limb and reduce limb swelling[9,17]. It has been demonstrated that pneumatic compression produced a reduction in lymphedema volume that was 18 % greater than the reduction produced by elastic compression[8,21].

Breathing exercises have been used as a standard component of lymphedema management. The rationale for this is that the main lymphatic trunks lead to the thoracic duct through which their contents empty into the large veins above the level of the heart. Unless the main lymphatic trunks become emptied, they act as a static reservoir into which the peripheral lymphatics drain with difficulty. The clearance of central lymphatics is essential before peripheral maneuvers are taken to increase lymphatic drainage. Breathing acts by increasing flow from the lymphatic system into the venous system through the thoracic duct[15].

In lymphedema, a tape measure is used to measure limb girth or circumference, or a volumeter is used to measure the volume of the arm[7,19]. Water volumetry works on the principle of immersing the limb to be volumetrically assessed in a volumeter, which consists of a plexiglas box filled with water. When the limb is immersed, the displaced water spills out into a graduated receptacle[10,18]. Volume measurement by water displacement is considered the gold standard for estimating the volume of an irregular shape[13].

Manual lymphatic drainage (MLD) is a specific form of manual massage that is primarily directed at normally draining lymph node regions to 'siphoning' or 'milking' lymph away from congested areas and therefore complementing attempts to improve drainage 'upstream' generated by muscle pumps[8,15]. Pain and altered sensations attributed to the stretching of the skin or heaviness of the limb can be significantly improved through a modified course of manual lymphatic drainage and lymphoedema bandaging[26,27].

The purpose of the present study was to compare the effect of both intermittent pneumatic compression therapy and the manual lymphatic drainage in the management of patients with chronic secondary lymphedema of the lower limb.

MATERIALS AND METHODS

Patients

Forty male patients with a mean age + standard deviation 54. 79 + 4.8 years, had chronic secondary lymphedema of lower limb and referred from a surgeon, were randomized to receive either intermittent pneumatic compression therapy or manual lymphatic drainage. The patient characteristics are shown in Table (1).

Inclusion and Exclusion Criteria

Patients were eligible for inclusion if they presented with chronic secondary lymphedema of the lower limb, which was defined as the presence of an increase 20% in the volume of the swollen limb compared with the volume of the contralateral, normal lower limb. For this reason, patients with bilateral disease were excluded. Volume was assessed

by the water-displacement volumetry, as described below. Evidence of bilateral lymphedema, metastatic disease in the involved limb, active clinical infection, massive edema of the limb secondary to congestive heart failure, concurrent neurologic symptoms, ischemic vessel disease or severe arteriosclerosis, deformity of the limb, and skin changes (e.g. dermatitis, gangrene, recent skin graft, and especially cellulites and deep-vein thrombosis) constituted the exclusion criteria.

For both groups, a written informed consent was obtained from all participants. The study was carried-out in Al-Qurain Central Hospital, Sharkiya Governorate, Egypt.

Table (1): Clinical Characteristics of Patient Groups at Baseline.

Characteristic	IPC Group	MLD Group	P Value
Number	20	20	-
Age (years)			
Mean + SD	53.8±4.7	55.8±3.9	NS (0.239)
Range	40-60	40-60	
Duration of edema (month)			
Mean + SD	31.1±42.3	37.6±21.8	0.026
Range	3-72	3-68	
Excess limb volume (%)			
Mean + SD	41.1±32.8	43.5±24.5	NS (0.373)
Range	20-100	22-86	

Values are expressed as mean + SD, SD: Standard deviation, IPC: Intermittent pneumatic compression, MLD: Manual lymphatic drainage, NS: Non significant
$P < 0.05$ = significant

Measurements and Assessments

Assessment of limb volume and circumference were performed for the affected limb for each patient in both groups at the time of enrollment and subsequently at the end of the study after 12 weeks. Both volumetric and circumferential measurements were taken by the examiner.

Tank volumetry: water-displacement volumetry was used to quantitate limb volume prior to study. Each affected limb was immersed fully extended to the base of the patella in water-filled tank. The displaced fluid was collected and measured in milliliter. The response to the therapeutic intervention was quantified as the absolute reduction in the limb volume.

Girth Measurement: By using a non-elastic tape measure, with the tape held firm but not compressing the tissue, the following protocol was used for measuring the circumference of the affected limb: the measurement was taken at 20 centimeters distance below the center of the patella.

Treatment Procedures

Breathing exercise (active cycle of breathing) was performed by each patient in both groups at the beginning of the session for fifteen minutes. Active cycle of breathing (consisted of breathing control, thoracic expansion exercises, and forced expiration technique) was performed as eight sets and

each set performed four / minute with one-minute rest between sets.

Each treatment session in both groups lasted for one hour and followed by application of compression garment to be worn on a daily basis, the sessions were performed three / week. Patients were instructed to wear their fitted compression garments and to elevate the limb whenever possible.

Group (I) Program

Intermittent sequential pneumatic compression of the foot, calf and thigh was used; it was applied to the treated limb in the elevated position with a multi –chamber pneumatic sleeve gradient-sequential pneumatic pump (Sequential Circulator 2004; BioCompression Systems Inc.). A presetting pressure of 40 – 50 mmHg was used. The pressures delivered by the sequential gradient system differ by approximately 10 mmHg between each chamber. The higher pressures are delivered to the distal chamber. Each therapy session included compression therapy for 45 minutes.

Group (Ii) Program

Manual lymphatic drainage was based on the concept of emptying the truncal regions first to give the lymph from the periphery somewhere to go. Only then was the limb massaged. The proximal region of the limb was always cleared first, and then the massage was extended distally. Starting at the distal end and attempting to push the lymph into the unemptied, proximal regions was contraindicated. Once a plateau in the reduction was reached, the later massage concentrated on enlarging collateral lymphatics linking obstructed lymphotomes to normal ones. Massage of the deeper lymphatics and/or lymph nodes was done to stimulate fluid drainage from the limb. Each therapy session included manual lymphatic drainage for 45 minutes.

Statistical Analysis

Statistical analysis was performed with Superior Performing Software Systems (SPSS-PC, version 10.0 statistical software). Results at the beginning and the end of the study period were compared. Intragroup differences were compared by paired "t" testing and intergroup differences by unpaired "t" testing. A value of $P < 0.05$ was considered statistically significant.

RESULTS

An overall reduction in girth and volume was seen in each affected limb in both groups without cutaneous, neurologic, or muscular complications.

Twenty patients were randomized to Group I (intermittent pneumatic compression), and twenty patients were randomized to Group II (manual lymphatic drainage). There was no significant difference either in the limb volume or limb girth between both groups before treatment, but there was a significant diffrenece between both groups after treatment ($P < 0.05$). After twelve weeks of treatment, there was a significant reduction in the limb volume in both groups. The mean limb volume was 311.10 ± 268 mL and it decreasesd to 217.77 ± 372 mL for Group I ($P < 0.05$). While in Group II, the mean limb volume was 304.98 ± 262 mL and it decreased to 243.54 ± 306 mL ($P < 0.05$) (Table 2 & Fig. 1).

Table (2): Means of limb volume (mL) in both groups before and after twelve weeks of treatment.

Variable	IPC Group (n = 20)		MLD Group (n = 20)	
	Pre	Post	Pre	Post
Limb Volume (mL)	311.10 ± 268	217.77 ± 372	304.98 ± 262	243.54 ± 306

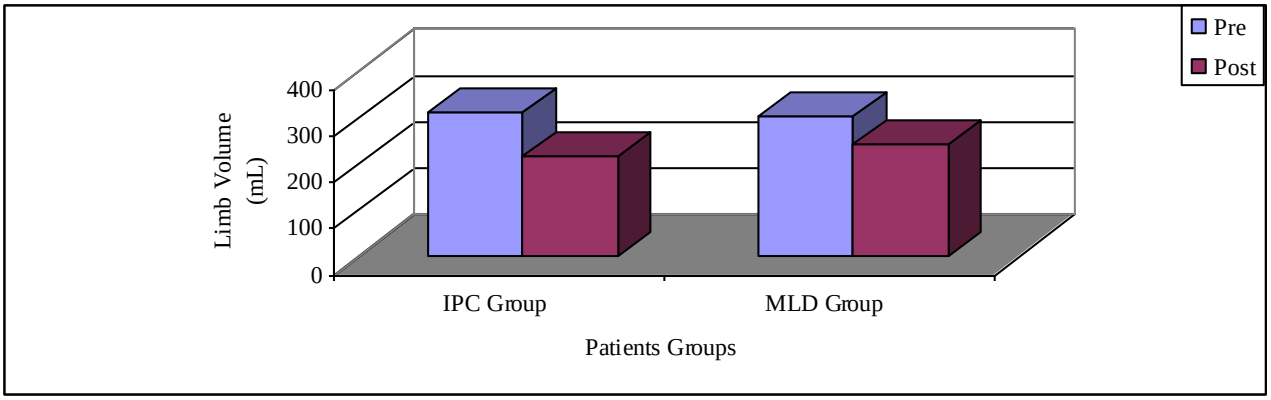

Fig. (1): Means of limb volume in both IPC and MLD groups before and after twelve weeks of treatment.

After twelve weeks of treatment, there was a significant decrease in the girth of the edematous limb in both groups. The mean limb girth was 60.02 ± 7.1 cm. and it decreased to 51.3 ± 2.4 cm. in Group I ($P < 0.05$). In Group II, the mean limb girth was 58.9 ± 1.4 cm. and it decreased to 53.0 ± 0.9 cm. ($P < 0.05$). (Table 3 & Fig. 2).

Table (3): Means of limb girth (cm) in both groups before and after twelve weeks of treatment.

Variable	IPC Group (n = 20)		MLD Group (n = 20)	
	Pre	Post	Pre	Post
Limb Girth (cm)	60.02±7.1	51.3±2.4	58.9±1.4	53.0±0.9

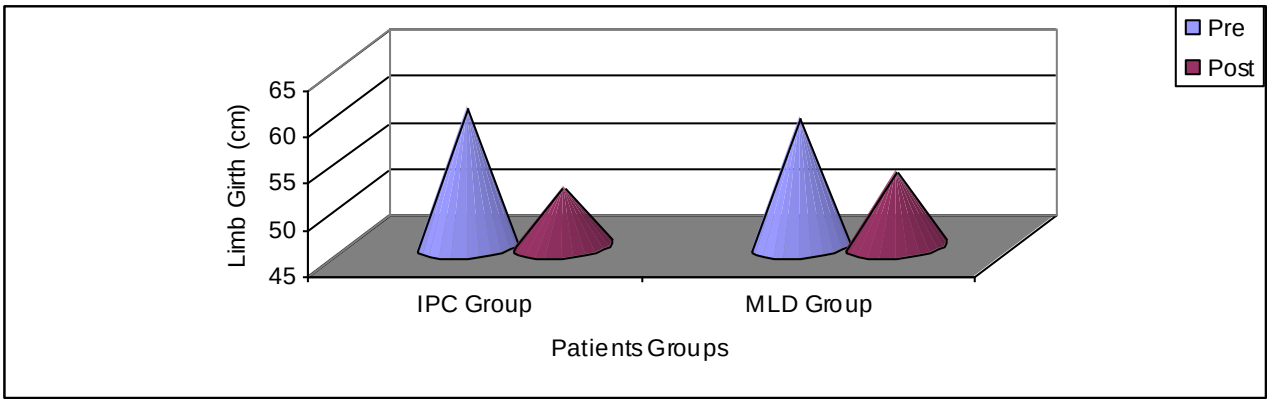

Fig. (2): Means of limb girth in both IPC and MLD groups before and after twelve weeks of treatment.

DISCUSSION

Lymphedema can result in functional limitations and psychological morbidity. Once at risk for developing lymphedema or being diagnosed with lymphedema, a person is cautioned to avoid things such as excessive use of the involved limb, restriction of blood flow to and from the involved limb, puncture wounds, and elective surgeries to the involved limb. No known cure exists for lymphedema, and it is unresponsive to most therapeutic interventions. The results of this investigation suggested that intermittent pneumatic compression provides an enhancement of lymphatic drainage and it can be used safely and effectively for the treatment of patients with lymphedema. The result also suggested that manual lymphatic drainage is effective in treatment of lymphedema, but the pneumatic compression is superior to manual lymphatic drainage in lymphatic drainage as seen by the significant reduction in both the volume and the girth of the edematous limb.

Intermittent pneumatic compression (IPC) devices have local effects (decrease lymphatic and venous stasis by increasing lymphatic and venous blood flow) and systemic effects (increasing systemic fibrinolysis). IPC serves the dual purpose of optimizing the action of the muscles as lymph pump and preventing further swelling. It can also help promote lymph flow and increase protein reabsorption as a result of muscle contraction. Furthermore, it appears to have little effect on muscle tissue breakdown, since levels of creatine phosphokinase (CPK), aldolase and serum glutamic-oxaloacetic transaminase (SGOT) were reported to be within normal limits after compression[24].

Because of the disturbed lymph drainage in lymphedema, the equilibrium in the normal tissue homeostasis collapses, protein-rich fluid accumulates in the tissue spaces, the colloid-osmotic pressure rises and all these events favor ultrafilteration (the fluid leaving the arterial side of the capillaries). By raising the tissue (interstitial) pressure by means of an external force (the pneumatic compression), one reduces the effective ultrafilteration pressure, less fluid accumulates and less fluid has to be removed from the tissue spaces and the lymphedema improves[2].

Additional softening and breakdown of the fibrotic tissue is obtained by pneumatic compression that will cause a localized pressure increase in the affected area. Muscular activity further acts upon the fibrotic areas, loosening and breaking up accumulated deposits of scar and connective tissue. Therefore, pneumatic compression is applied to improve the function of the muscle and joint pumps[6,11].

Compression pumps are designed to promote venous and lymphatic circulation, and remove edema from the extremity by progressively moving fluid in a distal to proximal direction. The effect of the mild intermittent pressure is to increase interstitial pressure, thereby driving intercellular fluid into the venous capillary system. So, intermittent pneumatic compression provides an enhancement of the therapeutic response as well as in the maintenance of volume reduction. The therapy is well tolerated and remarkably free of complications[21,23].

It has been suggested that during inspiration there is a drop in intrathoracic pressure and an increase in intra-abdominal pressure with consequent movement of lymph from the abdominal to the thoracic cavity. During expiration, the increase in intrathoracic pressure causes lymph to be expelled through the thoracic duct into the upper thorax. Deep inspiration has been demonstrated to drop the

pressure in the inferior vena cava immediately above the diaphragm[25].

Manual lymphatic drainage may produce a mild pressure gradient acting to remove edema from the limb. It also may stimulate inherent mechanisms within the limb to aid in the removal of lymphatic fluid[1,12].

Compression garments help in reducing and/or maintaining lymphedema by decreasing the amount of interstitial fluid, preventing lymph back flow and enhancing the muscle pump action by providing an inelastic barrier for the muscle to work against[4,5,16,22,26].

Conclusion

An effective intermittent pneumatic compression program is superior to manual lymphatic drainage program in management of lymphedema. It can alleviate some of the consequences of chronic untreated lymphedema, such as edema, warty, and prevent the fibrotic changes in the lymphedematous tissues. It can also improve the quality of life by enabling patients to wear ready-made rather than custom-made clothes and shoes and by helping to prevent complications that may require hospitalization.

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الملخص العربي

مقارنة بين برنامجين مختلفين للتدريبات الطبيعية لمعالجة الاستسقاء الليمفاوي

أجريت هذه الدراسة علي أربعين مريضاً من مرضي الاستسقاء الليمفاوي المزمن في الأطراف السفلية. و قد تم تقسيمهم إلي مجموعتين متساويتين ، المجموعة الأولي وقد تم استخدام جهاز الهواء المضغوط المتقطع معهم والمجموعة الثانية قد تم استخدام طريقة التصريف اليدوي للسائل الليمفاوي معهم . وكان الهدف من هذه الدراسة هو عمل مقارنة بين كل من تأثير جهاز الهواء المضغوط المتقطع و طريقة التصريف اليدوي للسائل الليمفاوي في حالات الاستسقاء الليمفاوي المزمن في الأطراف السفلية . وقد تراوحت أعمار هؤلاء المرضي (وكانوا جميعهم من الرجال) أربعين إلى ستين عاماً كما تم أخذ إقرار كتابي بالمعرفة والموافقة علي الاشتراك في الدراسة من كل منهم.
وقد استغرقت الجلسة الواحدة لكل من المجموعتين مدة ستين دقيقة وبمعدل ثلاثة جلسات أسبوعياً لمدة أثني عشر أسبوعاً . وقد تم قياس كل من حجم ومحيط الأطراف السفلية لكل المرضي في المجموعتين قبل بداية الدراسة وكذلك مرة أخري في نهاية الأثنى عشر أسبوعاً .
وأظهرت النتائج وجود تحسن ذو قيمة معنوية في كل من حجم و محيط الأطرف السفلية في كلا المجموعتين و لكن هذا التحسن كان بنسبة أعلي في مجموعة جهاز الهواء المضغوط المتقطع. وهذا يعني أن استخدام جهاز الهواء المضغوط المتقطع يؤدي إلي تحسن ملحوظ في كل من حجم و محيط الأطراف السفلية في مرضي الاستسقاء الليمفاوي المزمن في الأطراف السفلية .