

Justification of the role of rehabilitation assistance in lymphedema of the upper extremities based on foreign experience (a literature review)

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Abstract

Purpose. Lymphedema is a chronic condition of the lymphatic system that results from impaired lymphatic drainage. In adult practice, secondary lymphedema, which arises as a consequence of the treatment of oncological diseases, notably breast cancer, is predominant. One of the most common types is upper limb lymphedema. This condition is characterized by swelling, a sensation of heaviness in the limb, pain, and limited range of motion. According to various statistics, regardless of the chosen treatment methods, edema develops in 10% to 80% of breast cancer patients. The issue of timely rehabilitation for patients with lymphatic edema of the extremities remains relevant due to the widespread prevalence of this condition and its severe complications.

Material & Methods. General scientific: analysis, synthesis, generalization. The search was conducted in electronic databases PubMed/MedLine, PEDRo, International Clinical Trials Registry Platform, Cochrane Library.

Results. The rehabilitation program for lymphedema was developed quite a long time ago, and today there are many rehabilitation methods. However, discussions about the main components of oncological rehabilitation are still ongoing. Clinical studies from different countries of the world were included in the review. A total of 10 completed studies and one ongoing study were analyzed. The most points on the PEDRo scale were obtained by studies related to physical exercises and various elements of complex therapy. Two studies scored an overall score of 8 out of 10, five studies scored 7 out of 10, and the other studies scored 6, 5, and 4, respectively.

Conclusion. In recent years, the number of studies on the topic of lymphedema is increasing. New and established rehabilitation methods are being tested in research. There is a tendency to use only proven and effective means and methods of rehabilitation.

Keywords: lymphedema, physical exercises, manual lymphatic drainage, bandaging.

Introduction

Lymphedema is a chronic disorder of lymph circulation within lymphatic vessels due to their damage. Lymphatic load exceeding its transport capacity is the cause of lymphedema (Lawenda et al., 2009). According to the codes of the In-

ternational Classification of Diseases, lymphedema belongs to the following sections: Other non-infectious diseases of lymphatic vessels and lymph nodes (189.0 – lymphedema, not classified elsewhere; lymphangiectasia), Postmastectomy lymphedema syndrome. Elephantiasis. Oblitera-

tion of lymphatic vessels caused by mastectomy (197.2), and Hereditary lymphedema or congenital lymphedema (Q82.0) (ICD-10). The chronic course of the disease leads to progressive swelling, which, in turn, reduces healthy blood flow to tissues, hinders wound healing, and increases the risk of tissue infection (Lawenda et al., 2009).

Lymphedema is considered incurable, so the only physiological way to reduce swelling is by removing excess plasma proteins from tissues through the lymphatic vessels. E. Vodder developed a method of manual lymphatic drainage, later validated by J. Asdonk, who determined the indications and contraindications for this technique. The next step was the integration of manual lymphatic drainage, physical exercises, skin care, and limb bandaging into a comprehensive anti-edema physical therapy program developed by M. Földi. Specialized centers for the treatment of lymphedema first emerged in Europe and then spread to the United States and Canada. Over the years, researchers and scientists such as J. Asdonk, M. Földi, A. Gregl, E. Kuhnke, S. Kubik, J. Casley-Smith, E. Vodder, A. Leduc, and others have made invaluable contributions to the search for and development of methods and treatments for lymphedema (Lee, 2008; Norton & Zuther, 2012; Morgan, 2008).

As part of the American Lymphedema Framework Project, a survey of professionals working with patients suffering from lymphedema was conducted. Physical therapists reported that in 80% of cases, secondary lymphedema was the reason for patients seeking their care. The majority of respondents were physical therapists and occupational therapists who indicated that they use complex decongestive therapy (CDT) (Anderson et al., 2019). This is a type of intervention aimed at reducing swelling. According to a review of the literature, the most commonly used approach is comprehensive decongestive therapy, also known as combined physical therapy or comprehensive anti-inflammatory physical therapy. Research demonstrates the effectiveness and success of this therapy. In European countries, this therapy has been applied since the 1970s, and in the United States, since the 1980s. Another form of rehabilitation intervention for lymphedema is complex anti-edema therapy (CAET). It involves a two-stage or two-phase intervention program. CAET includes manual lymphatic drainage, bandaging, physical exercises, skin care, compression garments, and self-management programs (Norton & Zuther, 2012; Morgan, 2008).

Regardless of the therapy's name, it consists of two distinct phases of intervention. The primary goal of the first, intensive phase is to reduce swelling, restore daily activities, and prevent infection. It is recommended to have five sessions

per week throughout 3 to 4 to 6 weeks, but for maximum symptom relief, it may require 8 weeks or more. The second phase aims to optimize and maintain the results achieved in the first phase and, if possible, improve the dynamics of swelling reduction. Patients receive guidance on self-monitoring methods, skin care, compression therapy, self-massage, weight control, and the specifics of performing exercises for lymphedema. In the second phase, patients independently monitor their condition, and typically, after 6 to 9 months, a specialist evaluates the therapy and may adjust the program as needed (Morgan, 2008; Thiadens et al., 2010).

Oncological diseases are the most prevalent in the world, but the increased survival rates after cancer can be attributed to advanced technologies and the progress of medicine. Nevertheless, the proportion of patients experiencing complications after oncological diseases is steadily rising worldwide. This raises the question of what combination of physical therapy tools and methods is the most effective, as an optimal approach to organizing rehabilitation will lead to efficient resource allocation, reduce the economic burden, and improve the quality of life for patients (Muñoz-Alcaraz et al., 2020).

Purpose of the study is to analyze approaches to the rehabilitation of patients with lymphedema of the upper extremities through the analysis of evidence-based literature.

Material and methods

General scientific methods including analysis, synthesis, and generalization were employed. The search was conducted using keywords in reputable electronic databases, including PubMed/MedLine, PEDRo, the International Clinical Trials Registry Platform, and the Cochrane Library. The search results were limited to publications from 2017 to 2022. In the database, 349 scientific studies were found using the keywords. Out of these, 84 studies were analyzed. Ten studies that met the inclusion criteria were included in the analysis. Inclusion criteria for the review randomized clinical trials (RCT), quasi-randomized trials, crossover randomized controlled trials, pilot studies, and other clinical research with publications in the English language, focusing on the topic of upper extremity lymphedema and/or breast cancer-related lymphedema (unilateral and/or bilateral). Exclusion criteria involved studies related to the prevention of lymphedema or publications in languages other than English.

Results

The management of lymphedema differs worldwide (Anderson et al., 2019). Therefore,

Table 1. Evaluation of research according to the PEDRo scale

Nº	Author, year	EC*	1	2	3	4	5	6	7	8	9	10	In general
1	Ligabue M. et al., 2019	-	+	+	+	-	-	+	+	+	+	+	8/10
2	Kilbreath S. et al., 2020	+	+	+	+	-	-	+	+	+	+	+	8/10
3	Torres-Lacomba M. et al., 2020	+	+	+	+	-	-	+	+	-	+	+	7/10
4	Deacon R. et al., 2019	+	+	+	+	-	-	+	-	+	+	+	7/10
5	Omar M. et al., 2020	+	+	+	+	-	-	+	+	-	+	+	7/10
6	Sen E. et al., 2021	+	+	+	+	-	-	+	+	-	+	+	7/10
7	Tantawy S. et al., 2019	-	+	+	+	-	-	+	+	-	+	+	7/10
8	Forner-Cordero I. et al., 2021	+	+	-	+	-	-	+	+	-	+	+	6/10
9	Bahtiyarca Z. et al., 2019	-	+	-	+	-	-	+	-	-	+	+	5/10
10	Pasyar N. et al., 2019	-	+	-	+	-	-	+	-	-	+	+	5/10

* Eligibility criteria; 1 – Random allocation; 2 – Concealed allocation; 3 – Baseline comparability; 4 – Blind subjects; 5 – Blind therapists; 6 – Blind assessors; 7 – Adequate follow-up; 8 – Intention-to-treat analysis; 9 – Between-group comparisons; 10 – Point estimates and variability.

clinical studies from various countries around the world were analyzed. The review included 10 completed studies and one ongoing study (Table 1). The quality of the studies was assessed using the PEDRo scale. During the analysis of the studies, factors considered included whether subjects were randomized into control and experimental groups and whether blinding of assessors occurred in the study. If the studies did not meet the specified criteria, their results were considered less reliable and subject to doubt (Guyatt et al., 1993). Such studies were not included in the review and were excluded during the analysis. Among the analyzed studies, two had an overall score of 8 out of 10, while the other studies received scores of 7, 6, 5, and 4, respectively.

In the study by Ligabue et al. (2019) intervention period 1 month. There were two intervention groups in the study EG¹ (manual lymphatic self-drainage + self-bandaging + physical exercises) and CG² (standard CDT care). In the experimental group, after 6 months, pain decreased by 70% from 4 to 2 on the pain scale. In the majority of patients in the experimental group (50%), the swelling decreased by 230 ml. Assessment methods include Numerical Pain Rating Scale (NPRS) and arm asymmetry (Excess Limb Volume (ELV).

In the study by Kilbreath S. et al. (2020) experimental group contained combined aerobic and resistance training program. The control group was without exercise. EG a significant reduction in symptom severity. Both groups had significant reductions in symptoms and physical performance by the end of the 12-week intervention period. Assessment methods include bioimpedance spectroscopy, Lymphedema Symptom Intensity and Distress Survey (LSIDS) questionnaire and EORTC BR23 questionnaire (European Organisation of Research and Treatment Collaboration Quality of Life Breast Cancer Module), and ultrasound.

1 experimental group
2 control group

All participants had the same intervention, except for the bandaging in the study by Torres-Lacomba M et al. (2020). After 3 weeks of study the most effective were simplified multilayer bandages (59.5%, IQR = 28.7) and cohesive bandages (46.3%, IQR = 39). In all groups, there was a reduction in the circumference. Assessment methods include volume of the limb measurement (perimeter), evaluation of the comfort of the dressing on a numerical scale from 0 to 10: 0 – comfortable, 10 – very uncomfortable.

Research Deacon R. et al. (2019) was ongoing from July 2014 to February 2016. There were two groups. Group 1 (low-speed aquatic exercise Ai Chi+diaphragmatic breathing+ymph node massage) and Group 2 (conventional aquatic exercise +lymph node massage, diaphragmatic breathing+ warm ups+ stretches+ small component of aerobic activities+cool down period). The results of the study were that 72% of Group 1 had a reduction in arm circumference immediately after the intervention compared to 28% of the Group 2. The volume of lymphedema decreased for Group 1 compared to Group 2 by 140 ml immediately after the intervention, but the difference was not maintained 1 hour after the intervention There were no differences between the groups in terms of bioimpedance. Assessment methods include arm volumetry, bio-impedance, and feedback form.

The study by Omar et al. (2020) was ongoing for 8 weeks (three times a week). No statistically significant changes in relative volume and DASH were observed. Assessment methods include limb Volume Measurement, symptoms of pain, severity and tension – visual analog scale (VAS), measurement of active shoulder range of motion (ROM), disabilities of the arm, shoulder, and hand (DASH) questionnaire, daily self-assessment (Adherence to Exercises and Compression Garment).

Methods research by Sen et al. (2021) includes circumference measurements, visual an-

alogue scale (VAS), Quick Disabilities of Arm, Shoulder, and Hand (Quick-DASH) questionnaire, Lymphoedema Functioning, Disability and Health questionnaire (Lymph-ICF). After 3 weeks excessive hand volume was reduced in both the Group 1 CDT³ (compressive multilayer bandaging + exercise training + MLD⁴ + one-session educational program) (56.3%, $p < 0.001$) and ST⁵ (compression multilayer bandaging + exercise training + one-session educational program) (54.8%, $p < 0.001$) groups. The VAS discomfort and severity scores showed better improvement in Group 1 (CDT) than in Group 2 (ST) ($p = 0.015$ and $p = 0.014$). However, there was no significant difference in post-intervention changes in VAS edema scores ($p = 0.074$) between the groups. The Quick-DASH and Lymph-ICF scores were significantly reduced in the groups.

In the study by Tantawy et al. (2019) girth, SPADI scores, dynamometry and all aspects of quality of life were significantly improved in group 1 (kinesio taping + home exercise programme) at the end of the intervention ($P < 0.05$) compared with group 2 (pressure garment + home exercise programme). The intervention period of the study 3 weeks.

There were several groups studied by Forner-Cordero et al. (2021): group 1 (manual lymphatic drainage + intermittent pneumatic compression + bandaging); group 2 (pneumatic lymphatic drainage with the Lymphapress Plus device + intermittent pneumatic compression + bandaging); group 3: (intermittent pneumatic compression + bandaging). Period of study 4 weeks. Reduction in circumference in all groups, one month after therapy, the results were maintained and no differences were found between the groups.

Research Bahtiyarca et al. (2019) intervention period 5-6 weeks. There were two groups in the study: CB⁶ group (intensive phase of CDT: MLD, compression bandaging + information about lymphedema + skincare + physical exercises) and CB/SLD⁷ group (intensive phase of CDT without MLD, including self-lymphatic drainage + compression bandaging information about lymphedema + skincare + physical exercises). The circumference in both groups achieved at the end of treatment did not change after 6 months. DASH Q scores ($p < 0.001$) and SF-36 physical and mental subscale scores ($p = 0.004$ and $p < 0.001$) at the end of treatment and six months after treatment were significantly different from baseline in both groups. HADS scores did not differ significantly.

In the study by Pasyar et al. (2019) intervention period 8 weeks. At 4 weeks post-intervention, there was a significant difference between

the intervention (yoga exercises + standard therapy) and control groups (standard therapy) on the EORTC QLQ-C30 role functioning subscale ($P = 0.03$). However, the other four functional scales of the EORTC QLQ-C30 were similar between groups ($P > 0.05$). At 8 weeks after the intervention, a significant difference was found between the groups in physical and emotional functioning of the EORTC QLQ-C30 ($P < 0.05$). There was no significant difference between the groups in the reduction of upper limb edema at 4 and 8 weeks after the intervention ($P > 0.05$).

Discussion

Comprehensive conservative treatment for lymphedema is effective (Greene & Goss, 2018; Mercier et al., 2019; Patel et al., 2015). Regardless of the names of the interventions, all programs include manual lymphatic drainage, as it is an essential component. However, it should not be applied in isolation in the treatment of lymphedema but rather as one of the components in an individualized program. A session typically requires a minimum of 45 to 60 minutes, depending on the size of the limb or body part and the severity of symptoms. There are several methods of manual lymphatic drainage (M. Földi, J. Casley-Smith, E. Vodder, A. Leduc), each with its own advantages. Self-manual lymphatic drainage or simple lymphatic drainage is a simplified form that can help maintain the results of manual lymphatic drainage. Patients themselves, their family members, or caregivers can apply self-manual lymphatic drainage massage after being taught the techniques by a physical therapist (Morgan, 2008).

The question of intervention effectiveness is raised by Bahtiyarca et al. (2019) study. Because the therapy involves a combined effect, there are not enough studies that have evaluated the effectiveness and contribution of each individual component. The authors claim that manual lymphatic drainage, which should be applied before compression therapy, should be considered time-consuming and expensive. Therefore, the study proposes adding self-manual lymphatic drainage to the therapy and indirectly assessing its impact. It was found that adding self-manual lymphatic drainage to the treatment did not affect the functions of the upper extremities. Compression therapy provides a significant reduction in swelling during the intensive phase of complex decongestive therapy. However, self-manual lymphatic drainage does not offer an additional advantage in treatment. According to the PEDRo scale, the study received a score of 5 out of 10.

The short-term effectiveness of manual lymphatic drainage was investigated in Sen et al.'s study. Standard therapy, which consisted of multi-

3 complex decongestive therapy

4 manual lymphatic drainage

5 standard therapy

6 compression bandaging

7 self-lymphatic drainage

layer compression bandaging and exercise, was compared to comprehensive therapy with manual lymphatic drainage. Both approaches were found to be effective in reducing swelling, increasing joint mobility, and improving the quality of life. Therefore, manual lymphatic drainage does not have an advantage or additional effect. However, when it comes to improving subjective symptoms such as heaviness and discomfort, the use of manual lymphatic drainage in the initial phase of complex decongestive therapy may have an additional benefit (Sen et al., 2021).

Forner-Cordero et al. (2021) also analyzed optimal approaches to lymphedema treatment. Performing manual lymphatic drainage requires qualified professionals who are proficient in the technique, and it consumes a significant amount of time, making it one of the most costly components of therapy. In a randomized controlled trial, it is suggested that periodic pneumatic compression and bandaging in the intensive phase of therapy are not inferior to the classical approach based on the principle of trimodality, which includes manual lymphatic drainage, intermittent pneumatic compression, and bandaging. According to the PEDRo scale, the study received a score of 6 out of 10.

External compression (bandaging or pneumatic compression) complements any exercise program developed for each patient. Compression is not intended to "squeeze out" fluid from the limb but rather acts as a counterforce to muscular activity, thus creating higher pressure on tissues during contractions. This provides the most potent stimulus for lymphatic drainage. Compression also restricts capillary filtration, opposing capillary pressure and thus reducing swelling from excessive fluid overload. Compression is not effective without physical exercises (Thiadens et al., 2010). As low-intensity resistance exercises (or low-intensity resistance training) do not exacerbate lymphedema or worsen symptoms, they instead reduce swelling, leading to increased joint mobility. It was also found that resistance exercises are effective whether they are combined with compression garments or not (Omar et al., 2020).

Since the elasticity of the skin is partially lost in lymphedema, hydrostatic pressure on the tissues must be maintained with external support (external compression). This support should be continuous until the reduction in volume stabilizes (Morgan, 2008).

Bandaging is an important step within the framework of complex decongestive therapy. The results of the study by Torres-Lacomba et al. (2020) showed that simplified multilayer bandaging was the most effective in reducing swelling. Kinesio tape was the most comfortable but the

least effective in reducing swelling. The simplified multilayer bandage is more effective in reducing swelling and more convenient than traditional multilayer bandaging.

In the study by Tantawy et al. (2019) the use of kinesio tape in lymphedema is discussed. The authors recommend replacing compression garments with kinesio taping. Patients performed the same home exercise programs, with the group using kinesio taping showing significant improvements in reducing limb circumference, dynamometry values, and shoulder pain index, as well as improved quality of life compared to the group receiving compression garments. However, in contrast to this study, another single-blinded controlled pilot study, which was not included in the review, contradicts this idea, indicating that kinesio taping cannot replace bandaging (Smykla et al., 2013).

In the study by Ligabue et al. (2019) a program was developed and tested to enhance the effect of complex decongestive therapy. Women in the experimental group were taught self-manual lymphatic drainage and self-bandaging techniques, breathing exercises, mobilization exercises, muscle strengthening exercises, treatment for muscle contracture, and an understanding of the changes that occur in lymphedema. The developed program for self-complex decongestive therapy demonstrated its effectiveness and can be used to enhance complex decongestive therapy or as self-management.

According to Lee et al. (2011) and Morgan (2008), physical exercises, as one of the components of therapy, improve lymphatic drainage and stimulate the circulatory system. It is well known that physical exercises and movement are crucial for lymphatic drainage. Exercises enhance cardiovascular function, muscle strength, functional capacity, and endurance. A combination of resistance exercises, aerobic activities, and endurance training can be beneficial in addressing lymphedema and helping patients with mobility limitations.

An additional element recommended for lymphedema management is yoga. According to the study, practicing yoga does not reduce swelling in lymphedema, but it should be used when the intervention's goal is symptom reduction. Yoga sessions can improve functional performance and quality of life, as demonstrated by randomized controlled studies (Pasyar et al., 2019).

Aquatic therapy exercise offers therapeutic effects on a swollen limb due to hydrostatic pressure. In the study by Deacon et al. (2019) patients were offered water exercises using the Ai Chi method to reduce pain and swelling. In contrast to regular water exercises, they performed exercises according to the Ai Chi method. Ai Chi

is done in deep water in rhythm with breathing. It's a slow, relaxing, and gentle exercise routine. There were no additional benefits to Ai Chi water exercises, and the immediate effect of these exercises disappeared within an hour.

Ali et al. (2021) found that aqua therapy-resistance exercise programs can provide additional benefits when combined with other physical therapy methods, specifically reducing swelling and pain intensity, which, in turn, helps increase the range of motion.

It has been proven that a combined aerobic and resistance training program is safe for women with lymphedema. Confirmation of this can be found in the study by Kilbreath et al. (2020), where a 12-week combined aerobic program with strength exercises not only did not exacerbate lymphedema but was also more effective in reducing lymphedema symptoms compared to standard care.

Ongoing research is proposing new concepts for lymphedema treatment. These studies aim to design new cost-effective approaches, do not require extensive resources, and improve patients' daily activity. For example, Muñoz-Alcaraz et al. (2020) introduced a new activity-oriented proprioceptive antiedema therapy (TAPA) as an alternative to comprehensive anti-lymphedema therapy. The study emphasizes the social integration of patients with breast cancer-related lymphedema during rehabilitation, as it should include not only physical therapy but also occupational therapy. Functional abilities, patient needs, and limitations in daily activities affect a patient's quality of life. This research is still ongoing. The costs associated with the new program are expected to be half of those of traditional therapy and more effective in reducing swelling, but, according to the PedRo scale, the study overall received only 4 out of 10 points.

In addition to conservative treatment for lymphedema, there are also surgical and other methods. However, surgical interventions will not completely eliminate the consequences of lymphedema. Rehabilitation is needed not only for patients with lymphedema who are not suitable for surgery but also for those both before and after surgical procedures. Most studies focus on the role of each individual means or physical therapy method within the treatment of lymphedema or investigate the combined effect or addition of a new additional means to an established program to enhance the existing effect. Many studies often address the issue of the economic feasibility of a program, its effectiveness, and the impact of interventions on a patient's overall quality of life. Since lymphedema is a chronic condition, treatment strategies need to be oriented towards the management of chronic diseases (Damstra, 2011;

de Sire et al., 2022).

The development and creation of modern rehabilitation programs for lymphedema are based on foreign experience, taking into account the region's specific characteristics, and standardization will allow for an increase in the effectiveness of conservative treatment, which, in turn, will fully meet the needs of this group of patients (Greene & Goss, 2018).

Conclusions

In recent years, the number of studies on the topic of lymphedema has been increasing. These studies focus on developing new and evaluating established rehabilitation methodologies aimed at preventing the progression of this condition. Since rehabilitation is the best way to control and manage lymphatic swelling, there is a consensus on the use of only evidence-based and effective rehabilitation means and methods. The analyzed studies aimed to determine the role and assess the effectiveness of each individual element of comprehensive therapy.

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Author's contribution

Conceptualization, S.K. and O.B.; methodology, S.K. and O.B.; check, S.K. and O.B.; formal analysis, S.K., O.B., A.H, A.V., M.H; investigation, S.K. and O.B.; data curation, S.K. and O.B., A.H; writing –rough preparation, S.K. and O.B., M.H.; writing –review and editing, M.H., A.H, A.V.; supervision, A.V.; project administration, S.K. All authors have read and agreed with the published version of the manuscript.

Supplementary Information

Article details

The online version available at
[https://doi.org/10.15391/prrht.2025-10\(1\).04](https://doi.org/10.15391/prrht.2025-10(1).04)

Conflict of interest

The authors declare that there is no conflict of interest.

Funding Statement

This article didn't receive financial support from the state, public or commercial organizations.

Received: November 26, 2024; Accepted: February 15, 2025

Published: February 28, 2025

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