RESEARCH PAPER

Types of Intervention in Breast Cancer-Related Lymphedema: A Comprehensive Systematic Review of Treatment Efficacy and Safety

Shirley Karamukalil Baby Siju[1*], Monika Rani[2]

[1]Research Scholar, Department of Physiotherapy, Chitkara School of Health Sciences, Chitkara University, Punjab – 140401. Corresponding author.

[2]Associate Professor, Department of Physiotherapy, Chitkara School of Health Sciences, Chitkara University, Punjab – 140401

ABSTRACT

Background: Breast cancer-related lymphedema (BCRL) is a chronic complication causing limb swelling, pain, and functional impairment.

Objective: To evaluate the efficacy and safety of conservative, exercise-based, surgical, and adjunctive interventions for BCRL.

Methods: A systematic review following PRISMA 2020 guidelines (PROSPERO: CRD420261299610) was conducted across major databases up to February 2026. Randomized and non-randomized controlled trials were included, and findings were synthesized narratively using SWiM due to heterogeneity.

Results: Thirteen studies were included. Complex Decongestive Therapy showed consistent short-term reduction in limb volume and improved function and quality of life. Exercise interventions were safe and enhanced physical function without worsening edema. Surgical approaches demonstrated significant and sustained benefits in advanced cases. Adjunctive modalities showed potential but limited evidence.

Conclusion: CDT and exercise remain primary management strategies, while surgery is effective for advanced cases. Standardized, high-quality research is needed to strengthen evidence and guide clinical practice.

Keywords: NA

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INTRODUCTION:

Lymphedema relating to breast cancer, known as breast cancer-related lymphedema (BCRL), is a long-term and most often progressive disorder first induced by interruption of lymphatic transport after breast cancer therapy particularly axillary lymph node dissection and radiotherapy.[1,2] It is depicted by build-up of protein-saturated interstitial fluid, which causes limb edema, fibrosis, deposition of adipose tissue, repeated infections, pain and functional impairment.[1,3] The oncological treatments, the follow-up time, the diagnostic threshold, and methods of measurement show a variety in the incidence of BCRL reported between about 3 per cent and more than 60 per cent.[1,4] This inconsistency has significantly reduced the comparability of cross-studies and synthesis of intervention results.[4,5]

In addition to volumetric alterations, there are high musculoskeletal and functional sequelae related to BCRL such as decreased shoulder range of motion, rotator cuff pathology, decreased muscle strength, and upper-limb dysfunction.[6,7] Imaging-based research shows that the prevalence of shoulder pathology amongst patients with chronic lymphedema is high, and the duration of the disease is strongly related to tendon degeneration and the severity of pain.[6] The impairments lead to long-term disability, psychological distress and clinically significant decreases in health-related quality of life (HRQoL), making BCRL one of the heaviest long-term complications of breast cancer survivorship.[3,6]

The mainstay in the management of BCRL is conservative therapy with Complex Decongestive Therapy (CDT) being generally considered a normal care [8]. CDT is provided in form of manual lymphatic drainage (MLD), compression therapy, exercise, skin care and structured patient education, but in phases of intensive and maintenance [8,9]. It has continually been shown that in the short term, clinical trials and observational studies have shown that limb volume and

pain, functional, and HRQoL are reduced [8,10]. Nonetheless, the proportionate role of each CDT component is indistinct. Specifically, randomized trials that examined the additive reimbursement of MLD in conjunction with compression and exercise have showed mixed or restricted advantages, and thus the persistent confusion on the best mix protocols or not [11].

It is the shift in the paradigm of exercise-based interventions in the management of BCRL. In the past, patients were recommended to limit the activities of the upper limbs because it was believed that exercise would increase lymphatic load [12]. Later physiological research has shown that skeletal muscle contraction improves the lymph propulsion through extrinsic pumping processes, which is a mechanistic explanation of therapeutic exercise [13]. Randomized controlled trials have since reported no worsening of limb volume with the use of resistance training, aerobic exercise, and combined exercise programs which are linked with clinically significant increases in strength, physical functioning, and HRQoL [14,15]. Mind-body and flexibility-based modalities, such as Pilates-based interventions, have also proven to have positive effects on functional capacity, fatigue, and psychosocial outcomes but the comparative effectiveness to other modalities of exercise has not been well defined yet [16].

Operations have become significant adjunctive or alternative therapies to patients with advanced disease or refractory disease. Physiological interventions, including lymphovenous anastomosis (LVA) and vascularized lymph node transfer (VLNT), seek to replace the lymphatic drainage by circumventing or reconstructing damaged lymphatic routes [17,18]. Reductive interventions, such as suction-assisted lipectomy and debulking surgery, are aimed at the irreversible adipofibrotic alterations of late-stage lymphedema [17,19]. According to recent cohort studies and outcome analysis, combined or staged surgical methods may be used to attain significant limb volume reduction, reduced infection rates, and better patient-reported outcomes especially in patient with advanced-stage BCRL [17-19]. However, the diversity in patient selection, disease staging, outcome measurement, and postoperative management restricts the conclusive findings on the comparative efficacy and safety of the long-term.

Other physical agent modalities, such as low-level laser therapy, intermittent pneumatic compression, and extracorporeal shockwave therapy are suggested as the add-ons to the conventional conservative care [8,10]. Although other studies show possible advantages in edema reduction and tissue properties, the data is not consistent and these modalities are not commonly studied in the context of multimodal treatment in the framework of standardized studies [10]. In the same way, patient education and self-management techniques are becoming more and more acknowledged as necessary parts of the long-term disease control, but their independent impact on the long-term clinical outcomes is not well measured [8,11].

The existing systematic reviews are largely limited to one type of intervention- most often exercise or surgical intervention- and are often limited by the lack of congruency in defining lymphedema and non-standardized outcome measures [4,5,14]. As a result, no detailed synthesis has been done to compare the entire range of conservative, exercise-based, surgical, and adjunctive intervention in a unified and clinically significant model.

Thus, this systematic review will attempt to conduct a rigorous comparison and evaluation of the efficacy and safety of interventions in breast cancer-related lymphedema. In particular, the review aims to: (i) review the evidence of conservative physical therapy interventions, such as individual and combined elements of CDT; (ii) review the effects of aerobic, resistance, and flexibility, yoga, and hydrotherapy-based exercise interventions; (iii) review the clinical outcomes of physiological and reductive surgical procedures; (iv) determine whether there is added value of adjunctive physical agent modalities; (v) review the role of patient education and self-management interventions; and (vi) critically review the methodological quality and existing research gaps, To this end, the following research question underlies the review: Among patients with breast cancer related lymphedema, how the conservative, surgical and adjunctive interventions impact on limb volume reduction, physical functioning and health related quality of life in comparison to conventional care, placebo or alternative care?

MATERIALS AND METHODS

Study Design

The systematic review was performed in the framework of the Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA) 2020. The prospective registration of the review protocol was done in the International Prospective Register of Systematic Reviews (PROSPERO) with the registration number CRD420261299610.

The review was created to critically review and synthesize evidence on the effectiveness and safety of conservative, exercise-based, surgical, and adjunctive interventions to breast cancer-related lymphedema (BCRL). Since it was expected that there would be clinical and methodological heterogeneity among the different types of interventions, outcome measures, and study designs, a systematic narrative synthesis strategy was to be used in line with the Synthesis Without Meta-analysis (SWiM) reporting guidelines. Pre-specification of meta-analysis was not done because of the anticipated heterogeneity in the mechanisms of interventions, disease stage, and outcome reporting.

Eligibility Criteria and Selection of Evidence

The systematic review used peer-reviewed English articles with no publication date limits, which investigated adult breast cancer patients who had developed secondary upper-limb lymphedema as a result of primary treatment (surgery and/or radiotherapy), and studies that provided the volume/size of limbs or quality of life outcomes measured using validated tools. The eligible interventions included conservative (complex decongestive therapy, manual lymphatic drainage, compression, bandaging, exercise therapy, skin care, patient education), surgical (lymphovenous anastomosis, vascularized lymph node transfer, liposuction, debulking), and adjunct physical modalities (low-level laser therapy, intermittent pneumatic compression, shockwave therapy, Kinesio taping, electrotherapy, myofascial release, acupuncture), and no limits were imposed on comparator conditions.

They concentrated on randomized and non-randomized controlled trials only, but left out case series, case reports, reviews, editorials, and studies focusing on primary lymphedema, non-breast malignancies, or purely pharmacological therapies and the searches were performed in the MEDLINE, Embase, Cochrane CENTRAL, CINAHL, Scopus, and LILACS databases. Further searches were found using a reference list, forward citation search and manually searching the relevant trial registries. Published works were only taken into consideration. Table 1 shows the complete search strategy.

Table 1: Electronic Database Search Strategy

Database	Search Terms (Core Concepts Combined Using Boolean Operators)	Coverage
MEDLINE (PubMed)	(“breast cancer” OR “breast neoplasms”) AND (“lymphedema” OR “lymphoedema”) AND (“complex decongestive therapy” OR “manual lymphatic drainage” OR exercise OR surgery OR “lymphovenous anastomosis” OR “vascularized lymph node transfer” OR “low level laser therapy” OR “intermittent pneumatic compression”)	Inception to Feb 2026
Embase (Ovid / Embase.com)	EMTREE terms and free-text equivalents for breast cancer, lymphedema, conservative therapy, exercise, surgical and adjunctive interventions	Inception to Feb 2026
CENTRAL	Controlled trials involving BCRL interventions	Inception to Feb 2026
CINAHL	Nursing and allied health literature on BCRL rehabilitation	Inception to Feb 2026
Scopus	Broad multidisciplinary search using title/abstract/keyword fields	Inception to Feb 2026
LILACS	Latin American and Caribbean health literature	Inception to Feb 2026

Study Selection:

The records retrieved in the electronic searches were all imported into reference management software and the duplicates were eliminated. Two reviewers set against the established eligibility criteria screened titles and abstracts. Potentially eligible studies were located and independently evaluated with regards to inclusion by retrieving the full-text articles. The discrepancies were overcome by discussion and consensus. A PRISMA flow diagram was used to record the selection of the study given in Fig 1.

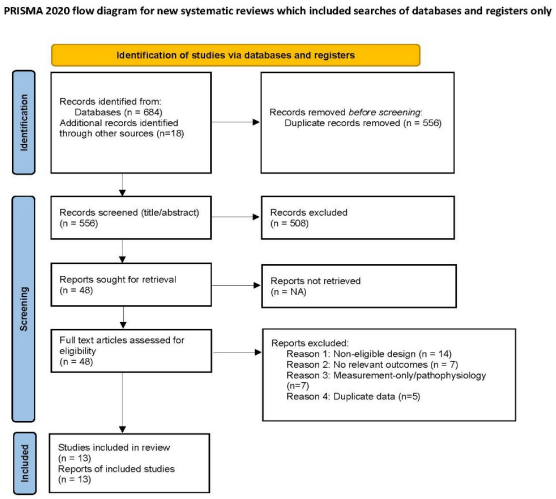

Figure 1. PRISMA 2020 flow diagram of study selection.

Flow diagram illustrating the identification, screening, eligibility assessment, and inclusion of studies in this systematic review of interventions for breast cancer–related lymphedema. Thirteen studies were included in the qualitative synthesis.

Data Extraction:

Data extraction was conducted through a standardized and pilot tested data extraction form, which was designed based on the objectives of the review. One reviewer retrieved the data of all the studies included and a second reviewer checked the extracted data against the data retrieved by the first reviewer to confirm its accuracy and completeness.

The information that was extracted was:

- Characteristics of the study: author(s), the year of publication, country, study design.
- Characteristics of participants: sample, age, sex, cancer treatment history, stage and duration of lymphedema.
- Intervention information: type, components, dosage, frequency, duration and interventions being single or multimodal.
- Outcome measures: volume limb measurement procedure, functional results, quality-of-life measures, and follow-up time.
- Important results: direction and magnitude of effects of treatment.
- Methodological features: randomization processes, allocation covering, blinding, and attrition.

Missing data were not contacted, as per the registered protocol used by the authors to study.

Synthesis Methods:

A narrative synthesis was performed within each category of intervention in the form of-

Quality and design of the study.

Characteristics of intervention (type, dosage, duration and delivery)

Practices in outcome measurement.

Direction of effect and direction of consensus of treatment effects.

Vote counting was employed by direction of effect to establish patterns across the studies where suitable, especially where the secondary outcome of interest is the burden due to the symptoms and patient-reported satisfaction. This was done in a careful manner and was combined with the quality of the study and sample size. No formal test of statistical heterogeneity was done because the test of statistical pooling was not carried out.

Handling Risk of Bias in Synthesis:

The interpretation of the findings was based on risk of bias assessments (RoB-2 with randomized and ROBINS-I with non-randomized studies), but they were not applied as exclusion criteria. More interpretive emphasis was placed on the studies that were considered to be of low or moderate risk of bias and the results of the studies with serious or critical risk of bias, were examined with necessary caution.

There were no sensitivity analyses of the risk of bias or study design, which is consistent with the narrative synthesis methodology outlined in the protocol.

Evaluation of Reporting Bias and Certainty of Evidence:

In line with the protocol registered, formal evaluation of the reporting bias (e.g. funnel plot analysis) was not conducted because of the lack of meta-analysis.

On the same note, certainty of evidence was not graded by GRADE or other such systems.

Presentation of Results:

The synthesis results are given in the Results section in a descriptive format with the help of summary tables, which summarize the characteristics of the study, intervention, outcome measures, and central findings. The intervention effects are presented comparatively in and across the synthesis groups to show the consistencies, differences, and gaps in the evidence.

RESULTS:

Study Selection and Characteristics –

The systematic search yielded a diverse collection of evidence that includes conservative physical therapy, exercise interventions, surgery, adjunctive modalities, and observational studies in context. Owing to high levels of variability in intervention mechanisms, outcome measures, and study designs, the synthesis of

results was done narratively in line with the previously outlined SWiM framework. Out of the 13 studies selected according to the inclusion criteria, the grouping was made based on the type of intervention according to Tables 2-5.

CDT-Based Interventions and Conservative Physical Therapy:

Efforts to assess conservative physical therapy programs with predominant use of Complex Decongestive Therapy (CDT) were found with 50-160 participants (Table 2). Randomized controlled trials and prospective or retrospective observational studies were the types of study designs.

Throughout the observational studies, CDT showed a significant short-term decrease in limb volume or circumference. A four-week Phase 1 CDT program led to statistically significant decreases in arm circumference and pain, increase in muscle strength, functional disability, and health-related quality of life (HRQoL) in a prospective observational study of 50 women. Similar results were provided by a before-after study with 80 participants, where significant changes to the volume of limbs were recorded with the increases in EQ-5D-5L and QuickDASH scores.

Contrary to this, randomized controlled trial evidence showed that there was doubt about the additive value of manual lymphatic drainage (MLD). In a big randomized controlled trial comparing guideline based care with and without MLD, there was no significant decrease in incidence of breast cancer related lymphedema with the inclusion of MLD after six months. A retrospective review of intensive CDT protocols implied that frequency of MLD led to the reduction of weekday volumes in the short term but volume recovery was seen during non-treatment periods. On the whole, consistent short-term positive effects of conservative interventions based on CDT were noted in terms of limb volume reduction and functional outcome, but the independent effect of MLD in the studies was not relevant.

Exercise-Based Interventions and Mechanistic Evidence:

The interventions associated with exercise were studied through the randomized controlled trials and were backed by the mechanistic evidence of physiology (Table 3). The sample sizes were between small experimental cohorts and medium-sized RCTs.

Resistance, aerobic, Pilates-based exercise programs were evaluated in randomized trials to show no deterioration in the volume of limbs, and clinically significant improvement in physical functioning, endurance, fatigue, and quality of life. A comparison of resistance and aerobic exercise modalities trial reported both methods to be safe in people with breast cancer-related lymphedema and strength and quality-of-life variables improved without edema worsening. To the same extent, an RCT on the effect of Pilates-based exercise indicated that it was associated with large improvements in walking capacity, fatigue, depression, and HRQoL compared with home exercise.

These clinical results were also supported by mechanistic evidence of experimental physiological work that established that dynamic muscle contractions augmented the rate of lymph clearance three- to six-fold over rest levels. Although not aimed at determining clinical effects, the findings have biological plausibility to the noted safety and functional effects of exercise in the management of lymphedema. Exercise-based interventions in general were always linked to functional and quality-of-life improvements and did not show negative outcomes on limb volume.

Surgical Interventions:

Two cohort studies examined surgical procedures of moderate to advanced lymphedema of the breast due to cancer (Table 4). The size of samples used was between 87 and 158, and the follow-up period was at least six and up to twelve months. Physiological and reductive surgeries in combination showed significant and prolonged volume loss in the limbs. In a study with a big size, liposuction and subsequent lymphovenous anastomosis (LVA) led to a significant decrease in the difference in volume between the affected and unaffected limbs, as well as to the decrease in the incidence of cellulitis and the need to use compression garments.

Relative studies of combined surgical methods showed varying outcome data based on the type of procedure. The amount of volume that was reduced with suction-assisted lipectomy and LVA was the highest, and vascularized lymph node transfer (VLNT)-based models used showed more patient-reported outcomes and bioimpedance results. Regardless of these variations, any of the surgical methods produced significant edema reduction and patient satisfaction. None of the studies mentioned any significant safety issues in major procedure, but because of differences in patient selection, disease stage, postoperative regimen, and so on, one could not easily compare the results across the modes of surgery.

Adjunctive Modalities, Measurement studies, and Contextual evidence:

Table 5 summarizes adjunctive physical agent modalities and contextual evidence. A randomized trial

between low-level laser therapy, kinesio taping, and MLD showed that all groups had significant limb volume reduction, with kinesio taping showing better results than MLD on some of the functional and quality-of-life outcomes.

The outcome assessment studies, which focused on the methodological measures, showed a high level of agreement between manual tape measuring and the analytic morphometric methods which provide the validity of the outcome measures of clinical trials which have involved the use of tape-based limb measurements. In observational studies of musculoskeletal and functional outcomes of lymphedema, there was a high incidence of shoulder pathology, with years of arm swelling highly related to rotator cuff tears and functional deficiency. Further cross-sectional data showed that upper-limb disability was found to have stronger outcomes related to quality of life as compared to the volume of the limb alone. These results make it clear that the functional and patient-reported outcomes, in addition to volumetric measures, should be included in assessing the efficacy of interventions.

Summary of Findings:

Conservative CDT-based therapies and surgery-based interventions across categories of interventions showed a consistent limb volume reduction, whereas exercise-based interventions increased physical functioning and HRQoL, but without worsening edema. There is some evidence of the potential additive effects of adjunctive modalities, but not enough. There was a lot of heterogeneity in the study designs, outcome measures, and delivery of interventions that not only discouraged a quantitative synthesis but also suggested the use of standardized definitions and core outcome sets in future studies.

Table 2. Conservative Physical Therapy and CDT-Based Interventions

Author (Year)	Study Design	Sample (n)	Intervention	Comparator	Duration	Limb Volume Outcome	Function / QoL Outcome	Key Findings
Kuzmanović & Mustur (2025)	Prospective observational	50	Phase 1 CDT (MLD, compression, exercise, education)	None	4 weeks	Significant reduction in arm circumference ($p = 0.002$)	↓ pain (VAS); ↑ strength (MMT); ↓ QDASH; ↑ WHOQOL-BREF	CDT significantly improved edema severity, motor strength, functional ability, pain, and QoL
Kavak & Ünver (2024)	Before–after study	80	CDT (MLD, compression, exercise, skin care, education)	None	3 weeks	Significant reduction in limb volume ($p < 0.001$)	Improved EQ-5D-5L, QuickDASH, frailty scores	CDT reduced limb volume and frailty while improving function and QoL
Devoogdt et al. (2011)	RCT	160	Guidelines + exercise + MLD	Guidelines + exercise	6 months	No significant difference in BCRL incidence	Not primary outcome	Addition of MLD did not confer preventive benefit beyond exercise

								and education
Kasseroller & Brenner (2024)	Retrospective analysis	61	CDT with intensive MLD	CDT without weekend MLD	3 weeks	Greater weekday volume reduction	Not assessed	Intensive MLD contributed to short-term decongestion during CDT

Table 3. Exercise-Based Interventions and Mechanistic Evidence:

Author (Year)	Study Design	Sample (n)	Exercise Modality	Comparator	Duration	Limb Volume Outcome	Function / QoL Outcome	Key Findings
Buchan et al. (2016)	RCT	41	Resistance vs aerobic exercise	Active comparator	12 weeks	No worsening of limb volume	↑ strength, endurance, QoL	Both exercise modalities were safe and improved function
Eyigor et al. (2010)	RCT	52	Pilates + home exercise	Home exercise only	8 weeks	Not primary outcome	↑ 6MWT, ↓ fatigue, ↓ depression, ↑ QoL	Pilates significantly improved functional capacity and QoL
Havas et al. (1997)	Experimental physiology	8	Dynamic vs isometric contractions	Rest	Acute	↑ lymph clearance 3–6-fold	Not assessed	Muscle contraction enhances lymph propulsion (mechanistic support)

Table 4. Surgical Interventions for Breast Cancer-Related Lymphedema:

Author (Year)	Study Design	Sample (n)	Lymphedema Stage	Surgical Intervention	Follow-up	Limb Volume Outcome	Additional Outcomes	Key Findings
Chang et al. (2023)	Prospective cohort	158	ISL II–III	Liposuction + LVA	≥6 months	Mean volume difference reduced from	↓ cellulitis; ↓ compression dependence	Combined approach produced a rapid and sustained

						838 mL to 44 mL		volume reduction
Myung et al. (2023)	Retrospective cohort	87	ISL IIb–III	SAL + LVA; VLNT + LVA; Omental VLNT + LVA	≥12 months	SAL + LVA achieved greatest volume reduction	VLNT groups had greater QoL and BIS improvement	All surgical approaches improved edema and patient satisfaction

Table 5. Adjunctive Modalities, Measurement Studies, and Contextual Evidence:

Author (Year)	Study Design	Sample (n)	Focus	Outcome Measures	Main Findings	Role in Review
Selçuk Yılmaz & Ayhan (2023)	RCT	45	LLLT vs Kinesio taping vs MLD	Arm volume, Quick DASH, LYMQOL	All reduced volume; Kinesio taping superior to MLD	Supports adjunctive modalities as alternatives to MLD
Horbal et al. (2019)	Methodological study	15	Measurement comparison	Tape vs morphomics	Strong agreement ($R^2 > 0.94$)	Supports validity of tape-based volume measures
Jang et al. (2015)	Cross-sectional	47	Shoulder pathology	Ultrasound, DASH	Longer BCRL duration linked to rotator cuff tears	Demonstrates progressive functional pathology
Ramirez-Parada et al. (2023)	Cross-sectional	30	Disability vs QoL	DASH, QoL scales	Disability more strongly predicts QoL than volume	Highlights the importance of functional outcomes

DISCUSSION:

This systematic review summarized evidence relating to conservative, exercise-based, surgical, and adjunctive therapies on breast cancer-related lymphedema (BCRL) to fill the gap in the literature regarding the lack of comparisons between different therapies based on their mechanism of action. This review offers an overview of the treatment efficacy, safety, and methodological limitations along the spectrum of BCRL management by relating the results directly to prespecified objectives.

Effectiveness of Conservative Physical Therapy and Elements of Complex Decongestive Therapy:

The results of this review prove that the Complex Decongestive Therapy (CDT) is the mainstay of conservative treatment of established BCRL. Regularly, observational and interventional studies showed that limb volume and functional outcomes and quality of life, as well, were reduced in the short term after CDT (Kavak & Unver, 2024; Kuzmanovic & Mustur, 2025). These gains were not only in relation to volumetric changes but also related to a decrease in

pain, frailty, and upper-limb disability, demonstrating the multidimensional advantage of CDT.

The evidence on the independent effect of the manual lymphatic drainage (MLD) was, however, not all alike. Devoogdt et al. (2011) ran a big randomized controlled trial and showed that MLD as an addition of guideline-based care and exercise, did not lower the rates of BCRL, which does not support its systematic application as a compulsory intervention. On the other hand, Kasseroller and Brenner (2024) noted that intensive MLD in CDT regimens led to a reduction of volumes in the short term and volume increase in the non-treatment intervals. Altogether, these results indicate that the effectiveness of CDT as a multimodal intervention is consistent, though the activity of MLD might depend on the circumstances, i.e., on the stage of the disease, the intensity of treatment, or patient-specific features.

Effect of Exercise modalities on BCRL Results:

In line with the second objective, the safety and functional advantages of exercise in patients with BCRL are well supported by the reviewed evidence. Randomized trials proved that resistance and aerobic exercise did not worsen limb volume and were linked with the existence of increasing muscular strength, endurance, and health-related quality of life (Buchan et al., 2016). Likewise, Pilates based exercise programs enhanced functional capacity, fatigue, depressive symptoms, and quality of life with no negative effects on limb swelling (Eyigor et al., 2010).

The physiological evidence on which these findings were obtained is the mechanism of skeletal muscle contraction which greatly increases the lymphatic flow by the extrinsic pumping mechanisms (Havas et al., 1997). Such mechanistic understanding brings the biological plausibility of the clinical safety of exercise, as well as describes how the recovery of function and improvement of the quality of life may be improved without deteriorating edema. On balance, the evidence suggests that exercise cannot be considered a risk factor in the development of lymphedema but, on the contrary, it is a part of the BCRL rehabilitation.

Surgical Intervention Stability and Clinical Outcomes:

Surgical procedures showed the greatest and most sustained volume losses of the limb, especially among patients with moderate to severe BCRL. Chang et al. (2023) confirmed that combined liposuction and lymphovenous anastomosis (LVA) resulted in significant and permanent volume reduction, a lower proportion of occurrence of cellulitis, and less use of compression therapy. These results indicate the usefulness of integrating reductive and physiological processes to overcome both adipofibrotic tissue alterations and lymphatic flow dysfunction.

Myung et al. (2023) also demonstrated comparative analysis results that support this claim, showing that results depend on the surgical strategy. Suction-assisted lipectomy netted the largest volume reduction and vascularized lymph node transfer (VLNT)-based suction methods were linked to more patient-reported outcomes and bioimpedance changes. These findings highlight the need to consider surgical selection on an individual basis depending on the stage of disease, tissue composition, and patient priorities. However, the variability in staging systems, outcome measures, and postoperative practices makes it impossible to draw conclusive results about long-term better performance of particular surgical methods.

Added Value of Adjunctive Physical Agent Modalities:

There is limited evidence on adjunctive modalities, which indicates that it is potentially beneficial. In this case, Selcuk Yilmaz and Ayhan (2023) showed that low-level laser treatment and Kinesio taping had the same or even a better effect on limb volume reduction than MLD did in patients with stage II BCRL. Although the findings suggest that adjunctive modalities can be used to complement the standard care or be offered as an alternative in some cases, the number of trials and the limited duration of follow-ups do not allow making strong recommendations. Adjunctive therapies must however be viewed as complimentary but not replacive until more high quality comparative studies are done.

Patient Education and Self-management:

Patient education and self-management are two aspects of BCRL care that are commonly acknowledged to be critical but the standalone efficacy of these factors has not been thoroughly studied. The randomized studies including education in the CDT protocols have always reported positive results on functional outcomes and quality of life (Kavak and Unver, 2024; Kuzmanovic and Mustur, 2025), but none of them had a specific education as an independent intervention. These results indicate the necessity of carefully formulated trials, which compare structured self-management programs, especially in terms of long-term maintenance and avert disease course.

Methodological Quality and Research Gaps:

The review found a high heterogeneity of methodology, especially in the definition of lymphedema, staging, and methods of outcome measurements. The validity of commonly used clinical measures was shown by measurement studies that showed a high level of agreement between tape-based and morphomic volume measurements (Horbal et al., 2019), but comparability was weak due to variability in thresholds and reporting formats. Observational studies also indicated that the limb volume is not necessarily proportional to functional impairment and quality of life, and this issue requires a thorough outcome evaluation (Jang et al., 2015; Ramirez-Parada et al., 2023).

Lack of standardized core outcome sets, lack of long-term follow-up and underrepresentation of patient-reported outcomes are the key obstacles in the synthesis of evidence. The gaps need to be filled to further the comparative effectiveness research and guide clinical decision-making.

Practice Recommendations and Clinical Implications:

Following the synthesized evidence, it is possible to make the following recommendations that would be practice-oriented:

1. Complex Decongestive Therapy must be the initial intervention in the treatment of known BCRL with compression, exercise, and patient education being the most important elements.
2. Regular prescription of structured exercise programs should be done which are safe with no extra grandiosity on limb volume, they enhance bodily workings and life quality.
3. Manual lymphatic drainage is not mandated, and indeed to be used selectively especially during intensive therapy, and not throughout.
4. Refractory or advanced stage BCRL should have surgical interventions with the choice of procedures to be used based on the stage of disease, tissue composition and patient objectives.
5. Adjunctive modalities could be employed as additional therapy, however, it should not substitute evidence-based conservative or surgical treatment.
6. Clinically meaningful benefits should be meaningfully gauged by measuring the functional outcomes and the quality of life, as well as the limb volume.

Discussion Summary (PRISMA-Aligned):

As per PRISMA 2020 recommendations, this systematic review is a synthesis of evidence, deriving 13 studies into a clear, well-organized contrast of the use of conservative, exercise-based, surgical, and adjunctive interventions in lymphedema caused by breast cancer. On the whole, the results reveal a consistent relationship between conservative multimodal management, especially Complex Decongestive Therapy, and organized exercise interventions and volume increase, physical functioning, and health-related quality of life, without harm. Surgical procedures provide significant and lasting advantages to patients with advanced or refractory disease that is selected, whereas adjunctive strategies can offer additional short-term advantages in a given clinical situation. Nonetheless, there was a great deal of heterogeneity in study design, intervention protocols, outcome definitions, and the duration of follow-up, constraining quantitative synthesis and highlighting the necessity of standardized lymphedema definitions and essential outcome sets. When combined, the evidence confirms an individualized, stage-specific, and multidisciplinary management of BCRL and areas of priority against which future high-quality comparative trials can be conducted to make the evidence base strong and to provide clinical direction.

CONCLUSION:

Overall, the current evidence on the interventions to address lymphedema caused by breast cancer in a synthesis is comprehensive and clinically meaningful, as this systematic review includes both conservative, exercise-based, surgical, and adjunctive methods of treatment within the framework of one study. The results confirm Complex Decongestive Therapy and systematic exercise as the main, evidence-based treatment methods capable of enhancing the volume, importance of limb function, as well as the quality of life, and proving the safety of the modern forms of exercise which should be actively included into survivorship management. The experiences and outcomes of surgical interventions, especially combined physiological and reductive therapy provide significant and long-term effectiveness to the chosen patients with advanced or refractory disease, which supports the significance of stage-specific and individualized treatment directions. Nevertheless, the review also indicates the endemic lack of heterogeneity of methodology, irregular reporting of outcomes, and limited data on the long term, all of which limit conclusive comparative findings. These gaps should be filled using standard definitions of lymphedema, core outcome sets, and the well-designed comparative trials to promote the application of evidence-based practicing. Finally, the multidisciplinary approach that focuses on functional recovery, patient-reported results, and tailored care must be considered to

optimise the results in individuals with BCRL throughout the spectrum of breast cancer survivorship.

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