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# CURRENT ROLE OF PNEUMATIC COMPRESSION THERAPY IN LYMPHEDEMA CARE: A SCOPING REVIEW OF PERSISTENT DEBATES AND NEW APPLICATIONS

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*ABSTRACT*

*Access to trained lymphedema care providers remains limited making patient-driven management solutions essential. One such option, sequential intermittent pneumatic compression (IPC), has gained traction as a supportive tool for lymphedema management. While newer IPC devices and innovative applications are being introduced to the market, questions regarding the safety and efficacy of this technology persist. This underscores the importance of reviewing current literature to understand IPC's evolving role in lymphedema care and to identify existing knowledge gaps. A scoping review of literature was conducted across various databases using PRISMA-ScR guidelines. The eligibility criteria included articles published in English language from database's inception to June 2023, discussing IPC's safety, and/or efficacy, and/or optimal modes and settings for lymphedema management. Review articles and case reports and original studies with unclear outcome measures were excluded. The review identified 49 eligible studies from an initial pool of 614 articles, consisting of 12 randomized controlled trials, 25 cohort studies, and 12 experimental studies. Most studies (44) focused on limb lymphedema, while five examined non-limb regions. Sample sizes varied widely, ranging from 10 to 718 participants, reflecting differences in studies' power. Minor adverse events were reported in six studies, including transient skin irritation, paresthesia, and rare cases of genital edema. Efficacy data indicated that IPC, whether used with or without manual lymphatic drainage (MLD), improved limb volume, quality of life, and reduced infection rates, although results varied according to treatment protocols and limb type. The addition of IPC improved compliance of decongestive therapy and increased patient satisfaction. IPC sessions ranged from 45 to 120 minutes per day, conducted 3 to 7 days per week, with pressures set at 60 to 120 mmHg for lower limbs and 25 to 60 mmHg for upper limbs. Higher pressures were associated with more significant limb volume reduction in the lower limbs. A cost analysis indicated that IPC could potentially lead to healthcare savings by reducing infections and hospital admissions. IPC application also showed promising results in head and neck lymphedema, though results for trunk lymphedema were equivocal. Future research should aim to refine IPC protocols in different regions of the body and ascertain its long-term benefits.*

**Keywords:** Intermittent Pneumatic Compression, Lymphedema, Best Practices, Safety, Review

**Lymphedema is characterized by chronic accumulation of lymphatic fluid, fat, and fibrosis which presents a complex therapeutic**

challenge. Complete decongestive therapy (CDT), encompassing manual lymphatic drainage (MLD), compression, exercise, and skin care, remains the cornerstone of conservative management. Although there have been significant advancements in lymphatic surgery, elevating the goals of modern lymphedema management, access to these specialized surgical interventions, as well as to trained lymphedema therapists remains limited. This dual constraint necessitates patient-driven self-management. Intermittent pneumatic compression (IPC) pump has emerged as a viable at-home supplement to traditional lymphedema treatments, empowering patients with greater control over their condition (1). The market offers a variety of IPC devices, each differing in sleeve and pump design, configuration, programmability, chamber count, inflation/deflation cycles, maximum pressure, and pressure gradient. The advent of new compression modes, such as those mimicking MLD, further complicates the landscape. Recently, IPC usage has expanded to include other body areas, such as the head and neck, highlighting the need for comprehensive review. Recent innovations have further expanded IPC capabilities, including applications for non-limb areas such as the head and neck and introduction of new compression modes. While previous reviews have explored IPC effectiveness, they haven't addressed the recent advancements. Also, experimental studies using imaging to optimize compression settings have not been reviewed (2-5). This literature review aims to fill these gaps by synthesizing current evidence on IPC usage in lymphedema management and identifying areas requiring further research.

## *METHODS*

### *Search Strategy and Information Sources*

We conducted a scoping literature review following PRISMA-ScR guidelines utilizing Ovid MEDLINE, PubMed, EMBASE, and the Cochrane Library databases covering the period from their inception to June 2023 (6). The search was limited to articles published in English language. Keywords and MeSH terms included "intermittent pneumatic compression", OR "compression therapy", OR "compression pumps", OR "sequential compression" AND "lymphedema" OR "lymphatic flow". Cross references of the selected articles were screened for any relevant articles and included in the search results.

### *Eligibility Criteria*

Inclusion criteria included studies evaluating safety and/or efficacy and/or optimal machine settings of IPC in lymphedema patients. Eligible studies encompassed both pediatric and adult patients with lymphedema affecting the extremities, trunk, or head/neck. Primary outcomes of interest were imaging findings, changes in limb volume or circumference, patient-reported outcomes, quality of life assessments, and adverse events. Case reports, literature reviews, and studies with unclear outcome measures were excluded. Also, studies focusing on non-lymphedema patients, or animal studies, were eliminated.

### *Study Selection and Data Extraction*

Four independent reviewers conducted a screening process of titles, abstracts, and full texts using a web-based tool, Covidence (Melbourne, Australia). Studies that met the eligibility criteria were identified individually and any discrepancies were resolved through consensus. Data extraction was carried out using a standardized form generated in Covidence, capturing information on study design, study aim, cohort characteristics, sample size, lymphedema etiology, affected regions, outcome measures, treatment protocols, IPC device specifications, duration of study, and key findings.

### *Synthesis of Results*

We categorized the outcomes into following domains – safety, efficacy, optimal device settings, and cost effectiveness. The efficacy results were subcategorized based on evaluation methodology, the treated region,

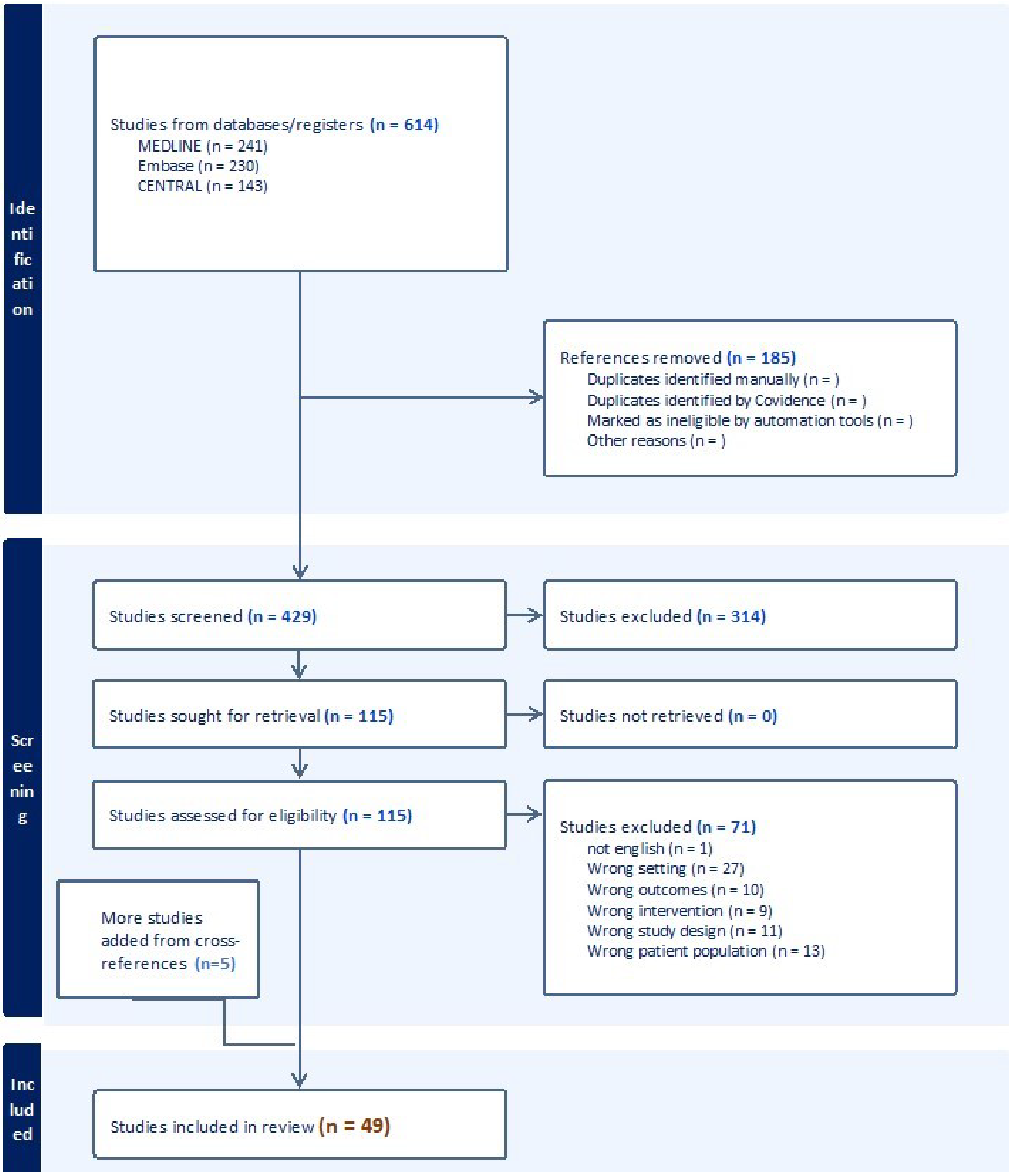


***Fig. 1.*** *PRISMA diagram detailing study flow from initial manuscripts to final 49 utilized for the scoping review.*

and any special situations. Evidence for sustainability of effects, variations based on the affected limb, and efficacy of new compression modes were also reviewed.

*RESULTS*

*Study Characteristics*

The search yielded 614 articles, of which 49 studies satisfied eligibility criteria (*Fig. 1*). *Table 1* (larger version in supplementary materials) presents the characteristics of the included studies. These encompassed 12 randomized controlled trials, 18 observational studies, 7 case series and 12 experimental studies. Forty-four articles focused on lymphedema in the limbs, while five studies explored non-limb regions, including the head, neck, and trunk. The sample sizes in the studies varied significantly, ranging from 10 to 718 patients, reflecting the diversity in the power of the studies. The findings of the studies are presented below.

*Safety*

IPC is contraindicated in patients with underlying peripheral arterial disease, active deep venous thrombosis, active infections, and/or evidence of cancer recurrence (2). There is lack of consensus on the safety of IPC in patients with cardiac failure where the severity of cardiac dysfunction should be considered to weigh the risks and benefits. Vigilant monitoring is essential to circumvent potential cardiac decompensation in patients with severe disease as a result of augmented venous return (7).

We screened all selected studies for report on adverse events associated with IPC use in patients with lymphedema. Only six studies provided information on adverse events in their study population (1,8-12). In these studies, minimal effects like transient skin irritation, paresthesia, mild pain (25% patients), muscle cramps, and limb erythema were noted. Patient discomfort attributable to IPC was ameliorated by modulation of the applied pressures (9). Rare events included headache, nausea, and dizziness (10). One particular study highlighted a significant disparity in genital edema incidence, registering a 43% occurrence with IPC intervention as opposed to a 3% occurrence without IPC (12). The duration for which the genital edema lasted was not delineated in the study. No other study reported increase in genitalia swelling although mild groin and knee swelling was reported in another study which was transient and could be mitigated by additional groin compression (13). In aggregate, the studies under review did not report any major complications ensuing from IPC treatment.

*Efficacy*

Total 37 studies examined the efficacy of IPC using various strategies. The efficacy of IPC in limb lymphedema was assessed in comparison to manual lymphatic drainage (MLD), as an adjunct to MLD, or as a standalone treatment (no MLD). All studies examining the absolute benefit of IPC as a standalone therapy allowed patients to continue using compression garments by default, hence was not in effect a solitary management tool. The most common outcome measure used for determining efficacy was limb circumference or volume change. Patient-reported outcomes, such as change in symptoms, range of motion, quality of life, reduction in cellulitis episodes, and hospital admission rates was utilized by several studies (*Table 1*). Six experimental studies used imaging techniques including ICG lymphography or lymphoscintigraphy to objectively study the immediate effects of pneumatic compression on lymphatic flow after a single treatment session (14-18). The only prospective clinical study that utilized imaging was conducted in head and neck lymphedema cohort, using ICG lymphography before and after two-weeks of IPC therapy (19).

*IPC*

Eight studies evaluated IPC as a standalone therapy (without MLD but with compression garments) for primarily lower limb (7 studies, primary and acquired disease) or

# TABLE 1
## Detailed Manuscript Information Grouped into 4 Groups used for Analysis (Limb Lymphedema, Special Situations, Non-Limb Lymphedema, and Relevant Compression Pressure Studies)

| Aim | Research focus | Author, Year | Title | Summary of Outcomes | Salient point | Sample size | Etiology | Region | Total Duration of Use | Duration per Day | Max Follow up period | Frequency | Compression Cycles | IPC Pressure | Device name | Study Design | Outcome measures | Adverse events |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A). LIMB LYMPHEDEMA | | | | | | | | | | | | | | | | | | |
| IPC without MLD | Efficacy | Freyne 2022 | Severe lymphoedema in gynaecological cancers: | Following IPC participants showed a significant improvement in mean global | IPC improves all patients' functional and symptom scores, except sexual function | 12 | secondary | LE | 8w | 1h | N/A | daily | N/A | 100 mmHg | N/A | Prospective cohort study | Quality of life scores and history of hospital | |
| | Efficacy | Maldonado 2021 | Assessment of quality of life changes in patients with | IPC treatment significantly improved LYMQOL scores, physical component of | The Flexitouch APCD showed a significant limb girth reduction as early as 12 weeks | 74 | secondary, primary | LE | 52w | 45m | 52 weeks | 5 days per week | N/A | N/A | Flexitouch | Prospective cohort study | The primary endpoints: QOL change at 12 weeks, | |
| | Efficacy, Cost | Desai 2019 | Superior Clinical, Quality of Life, Functional, and Health | IPC resulted in a 28% decrease in absolute limb volume, decreased body mass index | IPC improves clinical outcomes, quality of life, and function for UE and LE secondary | 117 | secondary | UE, LE | 52w | 1h | | twice daily | 18 s per chamber | 40 or 50 mmHg | Metrum Cryoflex | Prospective cohort study | Absolute limb volume, BMI, SF-36 quality of life, and leg | |
| | Safety, Efficacy | Blumberg 2016 | Pneumatic Compression Improves Quality of Life in | The study showed a significant decrease in ankle and calf limb girth, as well as the | IPC improves symptoms of LE lymphedema | 100 | secondary, primary | LE | 57w | 45m | | 5 to 7 days per week | N/A | N/A | N/A | Prospective cohort study | Episodes of cellulitis, number of ulcers, venous | |
| | Efficacy, Cost | Brayton 2014 | Lymphedema prevalence and treatment benefits in cancer: impact of a | The use of IPC was associated with a significant decrease in rates of hospitalizations, outpatient hospital visits, | Lymphedema is common among cancer survivors, and IPC is valuable in treating lymphedema | 1065 | secondary | N/A | N/A | N/A | | N/A | N/A | N/A | N/A | Retrospective cohort study | Rates of hospitalizations, outpatient hospital visits, cellulitis diagnoses, and | |
| | Safety, Efficacy, Settings | Zaleska 2014 | The Effectiveness of Intermittent Pneumatic Compression | The limb circumference decreased or did not further increase, elasticity of tissues increased or was maintained. No | The first one hour IPC showed: decrease in circumference of lower parts of the calf and thigh with increase below knee and in the | 18 | secondary, primary | LE | 2 to 3 years | 45 mins | | | | 80 to 120 mmHg | N/A | prospective cohort study | limb circumference, tissue Tonometry | Transient increase in groin and knee swelling, although calf and thigh reduced. No |
| | Efficacy, Safety | Muluk 2013 | Pneumatic compression device treatment of lower | In patients treated with APCD, 90% experienced a significant reduction in limb | The APCD treatment was associated with significant reductions in LV and showed | 196 | secondary, primary | LE | N/A | N/A | 4 to 9 weeks | N/A | N/A | 80 to 110 mmHg | N/A | Prospective cohort study | Reduction in limb volume (LV), clinician and patient- | Four adverse events were recorded for these subjects. |
| | Efficacy | Modaghegh 2010 | A newly designed IPC device for management of lymphoedema | IPC at high pressure was effective in reducing affected lower limb edema by a mean of 75% in lymphedema patients, | Introduction of a new mode for IPC which allows unidirectional forward lymph flow and is well-tolerated in chronic cases of the | 43 | secondary, primary | LE | 2 days | 8h | single in hospital treatment | daily | N/A | 80 to 120 mmHg | N/A | Experimental study, single session | Limb circumference | |
| | Safety | Borris 1998 | The risk of genital edema after external pump | Of the 128 patients with lower limb lymphedema, 75 received no pump | IPC can increase proximal swelling, no mention on the duration for which the | 128 | secondary, primary | LE | | | | | | | N/A | | | Genital swelling |
| | Efficacy | Gozza 1996 | Pneumatic compression vs | After 9 weeks of treatment, mean delta | IPC may have limited clinical value | 67 | secondary | UE | 9w | 2h | | N/A | N/A | 60 mmHg | N/A | RCT | Limb circumference before | |
| IPC vs MLD | Efficacy | Sanal-Toprak 2019 | The efficacy of intermittent pneumatic compression as a | No significant difference bw the two gps in the extent of improvement in | IPC treatment can be substituted for MLD in CDT due to its easier accessibility and | 46 | secondary | UE | 5w | 30 mins | 3 months | 3 days per week | Sequential | 50-80 mm Hg | N/A | RCT | circumference, shoulder pain and ROM | |
| | Efficacy | Gurdal 2012 | Comparison of intermittent pneumatic compression with | Both treatment modalities, namely IPC + Self Lymphatic Drainage (SLD) and | Manual lymphatic drainage and compression bandages may perform | 30 | secondary | UE | 6w | 45m | | 3 days per week | N/A | 25 mmHg | N/A | NRCT | Limb circumference before and at the 1st, 3rd, and 6th | |
| | Efficacy | Forner-Cordero 2021 | Physical therapies in the decongestive treatment of lymphedema: A | Group A (control group): manual lymphatic drainage + Intermittent Pneumatic Compression + | IPC and bandages is not inferior to IPC + manual lymphatic drainage + bandages | 182 | secondary, primary | UE; LE | 4w | 30m | 2 months | 5 days per week | N/A | 50 to 80 mmHg | N/A | RCT | Limb volume before and after treatment | discomfort and lymphangitis |
| | Efficacy | Johansson 1998 | A randomized study comparing manual lymph | Arm volume, mobility, strength and symptoms improvement not sig different in | IPC is as efficacious as MLD in BCRL | 28 | secondary | UE | 2w | 2 hrs | | 5 days per week | | 40-60 mm Hg | N/A | RCT | arm volume, level of mobility and strength | |
| IPC + MLD | Efficacy | Soran 2022 | Adding Pneumatic Compression Therapy in | IPC significantly reduces infection rates, hospital admissions, and physical therapy | Compliance improved with IPC | 69 | secondary, primary | LE | 78w | N/A | | N/A | Sequential | N/A | N/A | NRCT | Rate of infection, number of hospital admissions, and | |
| | Efficacy | Szolonsky 2022 | IPC acts synergictically with MLD in complex decongestive phsiotherapy | Arm volume and symptoms significantly improved in both gps at therapy end, at 1 month and at 2 months. Volume reduction | Excellent discussion about fears of using IPC and the different pressures. | 27 (13 CDT, 14 CDT + IPC) | secondary | UE | 2w | 60 mins MLD vs 30 mins MLD + 30 mins IPC | 2 months | 5 days/Wk | | 50 mm Hg | Lympha-mat | RCT | Limb volume, symptoms questionnaire | |
| | Efficacy | Tastaban 2020 | Role of intermittent pneumatic compression in the treatment of breast | IPC seems to add no benefit when combined with CDT for lymphedema, but, may be functional in reducing the | | 76 (38 CDT, 38 CDT +IPC) | secondary | UE | 4w | 60 mins MLD vs 60 mins MLD + 30 mins IPC | | 5 days per week | | 30-40 mmHg | Pulse press | RCT | Percentage reduction of excess volume (PREV), symptoms of pain, | |
| | Efficacy | Uzkeser 2015 | Efficacy of manual lymphatic drainage and | All tested parameters of limb volume, circumeference and dermal thickness | no additional benefit of adding IPC to CDT for BCRL | 31 | secondary | UE | 3w | 45 mins | | 6 days per week | | 40 mmHg | N/A | RCT | Limb circumference measurements, volume | |
| | Efficacy | Uzkeser 2013 | Intermittent pneumatic compression pump in upper | Significant improvements were observed in the function (ADL) and ROM of the | no additional benefit of adding IPC to CDT for BCRL | 25 | secondary | UE | 3w | N/A | | 5 days per week | | 60 mmHg | N/A | RCT | ROM of UE jts | |
| | Efficacy | Haghighat 2010 | Comparing two treatment methods for post | The study showed that both the use of CDT alone and in combination with IPC | CDT alone provided better results in reducing limb volume than when combined | 112 | secondary | UE | 12w | 1h | 12w | 5 days per week | N/A | 40 mmHg | N/A | RCT | The volume reduction of the upper limb measured by | |
| | Safety, Efficacy | Szuba 2002 | Decongestive lymphatic therapy for patients with | The addition of IPC to standard therapy led to a significant increase in mean volume | | 23 | secondary | UE | 26 - 52 weeks | 30 to 60 minutes | | N/A | Sequential | 40 to 50 mmHg | N/A | RCT | Volume- water displacement | No adverse effects on skin elasticity and joint range of |
| | Pressures | Taradaj 2015 | Comparison of efficacy of the intermittent pneumatic | IPC at 120 mmHg led to the greatest reduction of edema compared to lower | | 81 | Phlebolymph edema | LE | 4w | 45m | | N/A | Sequential | 60 or 120 mmHg | N/A | NRCT | | |
| | Frequency of use | Keeley 2023 | A Prospective Preliminary Study Examining the Physiological Impact of Pneumatic Compression Dosing in the Treatment of Lower Extremity Lymphedema | Limb volume measurements demonstrated no potential benefit of increasing IPC duration more than 1 hour per day during 5 days of treatment | No benefit of > 1 hr per day IPC in short FU | 21 | primary> secondary | LE | 5 days or 12 days | Group A: 1 hour. Group B: 1 hour (but twice per day, so 2 hours total). Group C: 2 hours (but twice per day, so 4 hours total). | 5 days | Group A: Once per day. Group B: Twice per day. Group C: Twice per day. | N/A | 55 mm Hg distal to 30 mm Hg proximal | N/A | Prospective cohort study | Changes in limb volume (LV), tissue fluid, tissue tone, and patient-reported outcomes (PROs)--> only volume and BIS were reliable | |
| | Compression modes | Dunn 2022 | Intermittent Pneumatic Compression for the | The study found that the LymphAssist group exhibited no significant volume | The improvement in limb volume and quality of life for patients with LE | 40 | secondary, primary | LE | 5w | N/A | | twice daily | N/A | 40 mmHg | LymphAssist | RCT | Bilateral leg volume (with circumference) and quality | |
| | Compression modes | Kim 2022 | Home-Based Intermittent Pneumatic Compression Therapy: The Impact in Chronic Leg Lymphedema in Patients Treated for Gynecologic Cancer | The use of a home-based IPC device alongside a routine self-maintenance program of short-stretch bandages in stage 3 chronic leg lymphedema patients resulted in a lower limb-volume difference ratio and higher quality of life compared to using a home-based IPC device alone. | The IPC device has a distinct mode designed to imitate the manual lymphatic drainage (MLD) technique, aiming to gently aid lymphatic draining of the proximal extremities. This study shows that using such an IPC device with an MLD-mimicking program can be beneficial in maintaining limb volume and enhancing the QOL for patients with stage 3 chronic leg lymphedema during their maintenance phase. | 30 | secondary | LE | N/A | 1h | 4 weeks. | twice a day for 4 weeks | MLD-mimicking mode: 3 s inflation, 1 s holding time, 7 s deflation and resting time; conventional mode: 6 s inflation, 1 s holding time, 7 s deflation time for each chamber | MLD-mimicking mode: 40-60 mmHg; conventional mode: 80-100 mmHg | N/A | NRCT; Prospective cohort study | Limb-volume measurement, quality of life (QOL), satisfaction, and safety of the IPC device. | |
| | Programmability | Karaca-Mandic 2017 | A comparison of programmable and nonprogrammable | Dynamic pressure programmable devices demonstrated better lymphedema-related health outcomes compared to | The study compared the clinical and health utilization outcomes between two types of PCDs (NP-PCD and P-PCD) in patients | 1731 | secondary, primary | unspecified | 12 months | N/A | 12 months | N/A | N/A | N/A | N/A | Retrospective cohort study | Rates of lymphoedema-related cellulitis, manual therapy use, outpatient | |

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| **Device Settings and modes - Clinical studies** | Comparing 2 devices | Fife 2012 | A randomized controlled trial comparing two types of pneumatic compression for breast cancer-related lymphedema treatment in the home | The APCD-treated group showed a significant 29% reduction in edema compared to a 16% increase in the IPC group, with a 5.8% reduction in mean TDC values for the APCD group and a 1.9% increase for the IPC group, indicating that adjuvant treatment with an APCD provides better outcomes than with an IPC, and both groups demonstrated very good device compliance. | Advanced IPC as an adjuvant treatment may be better than standard IPC devices for treating BCRL. Seven pts had adverse events, more in the Std gp. | 36 | secondary | UE | 12w | 1h | | N/A | 18 s per chamber (std) sequentially inflated ending with all inflated vs 1 to 3 secs per chamber (only one inflated at a time) | 30 mmHg (standard) or n 9.0± 4.2 mmHg and 13.7±4.8 mmHg (Advanced) | N/A | RCT | Limb volume (with circumference) and tissue water measurement (with Moisture meter) at Week 0 and 12 | Seven patients had adverse events, more in the standard group. |
| | Trunk compression preceding arm compression | Ridner 2012 | A randomized clinical trial comparing advanced pneumatic truncal, chest, and arm treatment to arm treatment only in self-care of | When comparing experimental truncal/chest/arm advanced pneumatic compression therapy to arm-only pneumatic compression (control), there were no statistically significant changes in | | 42 | secondary | UE | 30 days | 1h in UE + trunk gp, 36 mins in UE only gp | | 7 days per week | N/A | 9.0 ± 4.2–13.7 ± 4.9 mm Hg | N/A | RCT | LSIDS-A score, arm circumference, trunk circumference, (FASQ score, bioimpedence | |
| | No. of chambers and cycle time | Pilch 2009 | Influence of compression cycle time and number of sleeve chambers on upper extremity lymphedema | IPC is an effective method of volume reduction in women with postmastectomy arm lymphedema regardless of cycle times and number of sleeve chambers. Two | | 57 | secondary | UE | 5w | 1h | | 5 days per week for 5 weeks | N/A | 30 to 50 mmHg | N/A | RCT | Limb volume | |
| | Comparing 2 devices | Mayrovitz 2007 | Interface pressures produced by two different types of lymphedema therapy devices | Significant differences in pressure timings, patterns, and magnitude were found after comparing the Lympha Press and Flexitouch devices. In terms of timing, the duration of pressure pulses in the Flexitouch device were significantly shorter than that of the Lympha Press. Due to this quick application of pressure, the | There were significant differences between the Flexitouch and Lympha Press devices. During inflation cycles, the pressures exerted by the Lympha Press were higher and were sustained for longer periods of time. However, the Flexitouch differed drastically by displaying quick rise and fall progressions. | 10 | N/A | UE | Single session for each device (at least 48 hours between each device assessment) | Single session for each device | N/A | Single session for each device | Sequential | 45mmHg for the Lympha Press and the "standard" setting for Flexitouch | Lympha Press; Flexitouch | Experimental study | Interface pressures applied to left forearm (used 256-pressure sensor array) over 0.1 second intervals for at least 2 cycles of each device | |
| | No. of chambers | Bergan 1998 | A comparison of compression pumps in the treatment of lymphedema | One and three chamber garments were less effective than 10 chamber garment in reducing swelling | multi chamber sequential compression more effective than fewer chambers | 35 | secondary, primary | UE, LE | N/A | 2 hrs | N/A | | Sequential or non sequential | 50 mmHg in one or 3 chambers, 80 to 30 mmHg gradient in ten chambered. | | | Limb volume (water displacement) | |
| **Experimental Studies** | Imaging for Efficacy, Best settings | Zaleska 2019 | The Effectiveness of Intermittent Pneumatic Compression in Lymphedema of Lower Limbs:Methods of Evaluation and Results | Adjustment of compression parameters to tissue stiffness, fluid accumulation volumes, and fluid movement ability (hydraulic conductivity of tissues) at various limb levels is indispensable for effective therapy. They recommended differential compression pressures and prolonged timings at various limb levels | | 52 | secondary, primary | LE | 1 hr | | | | 5 secs inflation, 5 sec deflation for each chamber, total 40 sec period for 1 cycle. | The sleeve inflation pressure at foot level was 120 mmHg, gradually de-creasing in the groin by 20%. | N/A | Experimental study, single session | tissue stiffness, fluid pressure, flow volume, LSG, ICGL | |
| | Efficacy, Best settings | Bok 2018 | Evaluation of Stiffness in Postmastectomy Lymphedema Using | After a single session of IPC, using a pressure of 35 mmHg resulted in the largest improvement in proximal upper arm | IPC reduces stiffness and subcutaneous tissue thickness of UE in patients with BCRL | 45 | secondary | UE | single session | N/A | | N/A | N/A | 25, 35, and 45mmHg | N/A | Experimental study, single session | UE subcutaneous tissue thickness, circumference, and stiffness | |
| | Imaging for Efficacy | Aldrich 2017 | Effect of pneumatic compression therapy on lymph movement in | The study demonstrated improved lymph movement during and after IPC in all affected legs of the subjects tested, with | IPC improves lymphatic function either by mobilizing fluid through lymph vessels or through interstitial channels. | 4 | secondary, primary | LE | single session | 1h | | N/A | N/A | 45 distal to 30 mmHg proximal | N/A | Experimental study, single session | ICGL before (15 mins after injection), during and after IPC using compression | |
| | Imaging for Efficacy | Kitayama 2017 | Real-Time Direct Evidence of the Superficial Lymphatic Drainage Effect of Intermittent Pneumatic | Different inflation/deflation modes and two different pressures evaluated (45 and 90 mmHg) using quantitative ICGL and software-assisted video analysis. ICG | Preop severity grading done with LSG and those with dermal backflow in leg and foot were excluded (only mild cases included). | 25 ( 8 control, 17 affected limbs) | secondary | LE | single session | single session | | single session | | 45 mmHg and 90 mm Hg | N/A | Experimental study, single session | ICGL- lymph velocity, real time with transparent compression sleeve, during IPC | |
| | Best settings | Zaleska 2013 | Pressures and timing of intermittent pneumatic compression devices for | The study points to the necessity of applying high pressures (120 mm Hg) at ankle with 20 % proximal pressure gradient | The pneumatic devices were set at three different inflation times 5, 20, or 50 sec in each chamber of the eight chambers, and | 18 | secondary, primary | LE | single session | | | | | | N/A | Experimental study, single session | subcut pressure | |
| | Efficacy, MOA | Olszewski 2011 | Tissue fluid pressure and flow during pneumatic compression in lymphedema of lower limbs | The skin's rigidity (fibrosis) and the dissipation of applied compression force to proximal noncompressed limb regions resulted in a high pressure gradient through | Tissue fluid pressures generated by a pneumatic device were found lower than in the compression chambers. The obtained results point to the necessity of applying | 15 | N/A | LE | single session | single session | N/A | single session | sequential, distal most chamber was not deflated | 50 to 120 mmHg | Biocompression | Experimental study, single session | Continuous Tissue pressure, and girth (plethysmograph attached to starin gauges applied at different limb | |
| | Imaging for Efficacy | Olszewski 2011 | Pathways of lymph and tissue fluid flow during intermittent pneumatic | The study utilized LSG to demonstrate the movement of subcutaneous fluid and static lymph propelled towards the groin after | The study finds that while intermittent pneumatic compression can effectively push mobile tissue fluid towards the groin, | 15 | secondary | LE | single session | N/A | N/A | N/A | N/A | 50 to 125 mmHg | N/A | Experimental study, single session | LSG- The primary outcomes are the pathways and destinations of fluid moved | One patient experienced muscle cramps and a second reported increased limb |
| | Imaging for Efficacy | Adams 2010 | Direct evidence of lymphatic function improvement after advanced pneumatic | Improvement defined as proximal movement of dye after therapy. Lymphatic function improved in all control subjects | IPC was effective in stimulating the lymphatic function locally and systemically. | 3 controls, 6 with BCRL | secondary | UE | single session | single session. An hour-long IPC (30 mins trunk and proximal arm basins | | single session | | NA | Flexitouch | Experimental study, single session | ICGL same and contralateral side , Lymphatic propulsion rate, apparent lymph | |
| **B). SPECIAL SITUATIONS** | | | | | | | | | | | | | | | | | | |
| | Efficacy in filariasis | Manjula 2002 | Evaluation of sequential intermittent pneumatic | 12 patients with grade II filarial lymphoedema had >26% reduction in | | 28 | secondary | LE | 4w | | 6 months | | | | | | volume (with water displacement) | |
| | Efficacy in children | Hassall 2001 | A Retrospective Study of the Effects of Lymphapress Pump on Lymphedema In A | In this retrospective study of 16 children with lymphedema of the upper or lower extremities, the Lymphapress pump | pressure required decreased over time in the same pt | 16 | secondary, primary | UE; LE | N/A | N/A | N/A | N/A | N/A | N/A | Lymphapress | Retrospcetive cohort study | Volume and circumference of upper or lower limbs before and after treatment | |

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| | Combined with Lymphatic Surgery | Zelikovski 1983 | The sequential pneumatic compression device in surgery for lymphedema in the limbs | IPC used before, during and after surgery. Aids intraop lymphatics visualization for LVA and maintains anastomosis patency, reduce wound complications and pain in excisional surgeries. | Higher pressure used for the more severe case 1, preoperatively. | 3 | secondary LE, UE | 1 UE, 2 LE | Case 1 (LE)- 36 hrs continuously pre skin and subcut resection, 3 days postop 6 hrs/Day, Case 2 (LE)- introp for dilating groin lymphatics for LVA, postop for 12 hrs, Case 3 (UE) intraop for propelling blue dye, skin and subcut resection and LVA done. | | | | Sequential | case 1 - 130 mm Hg preop, 80 mm Hg postop, case 2- 80 mm Hg | Lymphpress | case series | wound complications and pain in excisional surgeries. | |
| **C). NON LIMBS LYMPHEDEMA** | | | | | | | | | | | | | | | | | | |
| | Safety, Efficacy | Ridner 2021 | Advanced pneumatic compression for treatment of lymphedema of the head and neck: a randomized wait list controlled trial | Patients who received advanced pneumatic compression device (AIPC) care for lymphedema showed significant improvements in their perceived ability to control lymphedema, patient-reported outcomes, visible external swelling, and reported pain compared to those who | significantly enhanced patient perception regarding their ability to control their lymphedema ,potentially reducing patient distress. | 43 | secondary | H&N | 8w | 23 to 45 minutes | | prescribed twice daily, 7 days per week, but most pts used once a day | N/A | N/A | N/A | RCT | Symptoms (including paraesthesia, pain, heaviness), function (cervical motion, speech), swelling internal and external | |
| | Safety, Efficacy | Gutierrez 2019 | Head and Neck Lymphedema: Treatment Response to Single and Multiple Sessions of Advanced Pneumatic Compression Therapy | The study evaluated ICGL-dermal backflow area in 10 patients before and after IPC completion, finding a reduction in backflow in 6 out of 8 subjects, and demonstrated improved facial composite measurements scores and self-reported outcomes in all 10 subjects with no adverse events reported. | The use of near-infrared fluorescence lymphatic imaging (NIRFLI) to visually assess the impact of the pneumatic compression therapy on lymphatic drainage and the ability to observe enhanced lymphatic uptake and drainage, as well as changes in areas of dermal backflow, in subjects after the treatment. | 10 | secondary | H&N | 2 weeks. | 32m | 2 weeks. | 7 days per week | N/A | N/A | Flexitouch | Prospective cohort-Observational study where subjects were imaged using NIRFLI before and after the initial treatment, and then again after 2 weeks of daily treatment. | external swelling (measured using facial composite scores), and subject-reported improvements. | No adverse events were reported |
| | Imaging for Efficacy | Rasmussen 2019 | Imaging the Lymphatic Response to Manual Lymphatic Drainage and | Both MLD and IPC showed improvement in lymph velocity, and enhanced lymphatic uptake in both control and symptomatic | The only study that used imaging after a sustained us of IPC | 69 | secondary | H&N, limbs | 2 weeks. | N/A | | daily for 2 weeks | N/A | N/A | N/A | NRCT-conference abstract | ICGL before and 2 weeks after +/- during IPC/MLD | |
| | Safety, Efficacy, Best Settings | Mayrovitz 2018 | Usability of advanced pneumatic compression to treat cancer-related head and | The majority of patients found APCD to be comfortable, effective, and well-tolerated, with one treatment showing statistically | The treatment was found to be safe, easy to use, and well-tolerated, showing edema reduction after just a single initial treatment | 44 | secondary | H&N | Single session | 32m | N/A | once | N/A | N/A | N/A | NRCT; Prospective cohort study | Patient-reported comfort, feelings post-treatment, and likelihood of home use, | |
| | Safety, Efficacy | Ridner 2010 | Advanced pneumatic therapy in self-care of | Significant reduction in overall symptoms but the reduction in trunk circumference | 100% compliance with IPC, Flexitouch used, study period was short | 12 | secondary | Trunk | 10 days | 1h | | 7 days per week | N/A | N/A | Flexitouch | Prospective cohort study | Patient reported symptoms, and trunk circumference | |
| **D). SUPPORTIVE STUDIES ON COMPRESSION PRESSURE** | | | | | | | | | | | | | | | | | | |
| | Efficacy, best settings | Zaleska 2017 | Indocyanine green near-infrared lymphangiography for evaluation of | Realtime movement of edema fluid observed using various compression modalities. Threshold pressures necessary | Determined sleeve pressure required for moving fluid proximal 40 mm Hg in the tissues which can be generated with was | N/A | | UE, LE | single session | | | | | 50 to 120 mm Hg gradient | N/A | Experimental study, single session | ICGL before and after, also measured tissue pressure using four different | |
| | Other | Partsch 2011 | Dose finding for an optimal compression pressure to reduce chronic edema of the extremities | The study examines the change in limb volume and circumference after 2 hours of using compression garments with different pressures, revealing that the upper limit for | Indirect estimate of required compression pressure | 36 arm patients and 42 leg patients | secondary | UE; LE | N/A | N/A | | N/A | N/A | | N/A | Prospective cohort study | Limb volume and circumference before and after treatment | |

ADL, activities of daily living; AE, adverse events; APCD, advanced pneumatic compression device; ASES, American Shoulder and Elbow Surgeons; BCRL, breast cancer-related lymphedema; CB, compression bandages; CDT, complex decongestive therapy, CL, contralateral; ; FU, follow up; gps, groups; h/hr, hour; H&N, head and neck; ICG, indocyanine green; ICGL, indocyanine green near-infrared lymphography, IPC, intermittent pneumatic compression; jts, joints; LE, lower extremity, LLCS, leg lymphedema complexity score; LYMQOL, Lymphedema Quality of Life scores; LSG, lymphoscintigraphy, LV, limb volume; LVA, lymphatic venous anastomosis; m, minutes; MLD, manual lymphatic drainage; MOA, mechanism of action; NIRFLI, near-infrared fluorescence lymphatic imaging; NP-PCD, nonprogrammable pneumatic compression device; NRCT, non-randomized control trial; PC, pneumatic compression; PCD, pneumatic compression device; PCT - pneumatic compression therapy; PMLE, post mastectomy lymphedema; P-PCD, programmable pneumatic compression device; PREV, percentage reduction in edema volume; pts, participants; QOL, quality of life; RCT, randomized control trial; ROM, range of motion; s seconds; IPC, intermittent pneumatic compression; SF-36, short form 36; SLD, self lymphatic drainage; SPC, sequential pneumatic compression; TDC, tissue dielectric constant; TF, tissue fluid; UE, upper extremity, USG, ultrasound sonography test; w, weeks; yr, year;

upper limb (1 study, acquired disease) lymphedema on a sample size ranging from 12 to 1065 patients (1,10,13,20-24). The treatment sessions varied from 45 minutes to 1 hour/day for 5-7 days a week and patients continued to use compression garments in between sessions. Peak IPC pressures used were 80 to 120 mm Hg in lower limbs and 60 mm Hg in the upper limb. In one study, 74 patients experienced significant reductions in ankle and calf circumference, a decrease in cellulitis rates from 32% to 12%, and enhanced quality of life scores after 12 weeks of daily 1-hour IPC sessions, with the benefits sustained at 1 year (20). After at least 3 months of IPC treatment all patients experienced symptoms improvement and 54% experiencing substantial quality of life enhancements and significant reductions in limb girth and infection episodes (21).

Prolonged use of IPC (more than 8 weeks) was associated with improved quality of life, limb volume reduction, and enhanced limb function in two other studies (1,21). Improved tissue elasticity besides significant reductions in limb circumference was observed in 18 patients with lower limb lymphedema over a three-year period (13). Improved skin fibrosis and reduced limb pain and was reported in majority of the participants with lower extremity lymphedema in another study, although only a third of the patients showed >10% volume reduction (10).

The only study that exclusively studied utility of IPC without MLD in upper limbs randomized the postmastectomy arm lymphedema patients into study and control groups but used shorter treatment period. After two cycles of 2 hours per day of 2 weeks treatment, the mean volume change was significantly more in the IPC group (p=0.009) compared to the control (p=0.3), although no difference in the number of patients who achieved > 20% reduction was observed (22-25).

These studies collectively indicate that IPC when used over several weeks can be effective as a standalone therapy for managing lower extremity lymphedema. However, the undisclosed variation in the duration and strength of the compression garments is a potential confounder. While volume reduction was frequently noted as significant, only a few studies reported precise percentage reductions. Additionally, the lack of a control group in most of the above studies limits the interpretation of results. Due to paucity of studies, effectiveness of IPC alone for managing arms lymphedema cannot be determined.

*IPC vs MLD*

In the comparative analysis between IPC and MLD, four studies examined treatments for upper (3 studies) or both upper and lower limbs (1 study) (26-29). The duration of IPC treatments ranged from 30 minutes to 2 hours for 3 -5 days a week, using compression pressures of 25 mm Hg to 80 mm Hg. These investigations reported that IPC and MLD resulted in similar decreases in limb volume as well as improvement in pain levels, range of motion, and patient-reported symptoms over the study period of 2-6 weeks in 28 to 182 subjects (27). Volume reduction was more pronounced in the lower limbs as compared to arms using either therapy. Self-lymphatic drainage was permitted along with IPC in one study making the findings less reliable (27). Overall, the results of rest of the included studies indicated that both treatment approaches yielded comparable outcomes in terms of volume reduction and symptomatic relief, although the time and cost consumption for MLD was higher and compliance was lower (28).

*IPC and MLD vs. MLD*

Seven prospective studies examined IPC as an adjunct to MLD, of which six studies focused on arms lymphedema and only one studied lower limbs. In the context of lower extremity lymphedema, two studies indicated that combining high-pressure IPC (120 mm Hg) with MLD led to greater reductions in limb volume compared to MLD alone (30,31). Furthermore, incorporation of IPC into CDT was associated with improved compliance and significantly lower rates of infection (16.9% vs 29.2%), hospital admissions (13.6% vs 29.2%), and fewer physical therapy sessions over 18 months among 62 patients (30). In contrast, six studies investigating upper extremity lymphedema produced variable results (31-36). Two studies found that combining MLD + IPC at 40-60 mmHg pressure for 30-60 minutes daily for 2 to 52 weeks, resulted in superior volume reduction and/or limb function improvement compared to MLD without IPC (32,33). However, the remaining four studies did not observe significant benefits which could be related to lower pressure levels (30-40 mmHg), shorter treatment durations (30 minutes), or limited sample size in these studies (31,34-36).

*IPC as an adjunct to Surgical Treatment*

One study investigated the perioperative application of IPC to improve outcomes of lymphatic surgery (37). The study involved 15 patients undergoing lymphaticovenular anastomosis, during which the use of IPC enhanced the visualization of lymphatic vessels intraoperatively. The IPC was continued postoperatively to promote flow through the anastomoses. When used prior to excisional lymphatic surgeries, authors observed a decrease in wound complications and a reduction in postoperative pain. These findings suggest the potential of utilizing IPC for improving lymphatic surgery outcomes and further research may be steered in this direction.

*Application in Head and Neck*

Four studies evaluated use of IPC for management of head and neck lymphedema (19,38-40). Mayrovitz et al reported high levels of patient satisfaction and notable reductions in facial and neck lymphedema following a single session of IPC lasting 32 minutes (38). Gutierrez et al documented a decrease in dermal backflow as shown by indocyanine green lymphography in 6 out of 8 patients, following two weeks of daily treatment sessions of the same duration (39,41). Ridner et al and Rasmussen et al further corroborated these outcomes, with patients reporting swelling reduction, improved symptoms and enhanced quality of life following 2 to 3 months of daily IPC application (19,40).

*Application in Trunk and Chest*

Only one study was found that specifically evaluated role of IPC in managing trunk lymphedema. All 12 patients reported improved symptoms but there was no significant reduction in the trunk volume after 10 days of 1-hour daily IPC treatment (42).

*Factors Influencing the Effectiveness of IPC Treatment*

In a cohort of 56 patients, Forner-Cordero et al found that similar to other decongestive therapies, lower limb lymphedema and less advanced disease showed more notable improvements with IPC as compared to upper limbs and advanced lymphedema (28). Conversely, in a larger cohort of 208 patients, Muluk et al did not find an inverse relationship between disease severity and volume reduction (10). This conflicting evidence regarding the correlation between disease severity and response to IPC mirrors findings reported for CDT (43,44). High BMI, which has been linked to poorer responses to CDT, has yet to be thoroughly evaluated for its impact on IPC outcomes.

*Durability of Treatment Results*

Sixteen studies investigated the longevity of results post IPC treatment, with follow-up periods extending up to one year. It was generally noted that volume reductions achieved with IPC require ongoing use of compression garments. The outcomes tend to diminish once IPC is discontinued (11,45). For example, Johansson et al reported a 31% reduction in lower limb volume at the conclusion of the IPC treatment period, which declined to a 25% reduction after one month of stopping the treatment (26). These findings are similar to other decongestive therapies and underscore the importance of continued self-care with IPC for maintaining lymphedema reduction (11,26,32,46).

*Machine Settings*

*Pressure Setting for Lower Extremity*

In their investigation to determine adequate compression, Olszewski et al and Zaleska et al conducted tissue pressure measurements during IPC treatments (13,47-52). Effective therapeutic subcutaneous pressures greater than 40 mmHg and improved proximal fluid movement on lymphoscintigraphy were achieved with IPC machine pressures of 80–120 mmHg for durations exceeding 60 seconds (11,16). The authors concluded that higher interface pressure is necessary as the severity of lymphedema increases due to greater tissue stiffness (48,50). Furthermore, using a combination of ICG lymphography and tissue pressure measurements, Zaleska et al found that IPC pressures below 80 mmHg were insufficient for lymph clearance in advanced stages of the disease. Supporting these findings, Taradaj et al demonstrated in a clinical study that limb volume reduction in patients treated with IPC at 60 mmHg did not statistically differ from the no-IPC group but was significantly less than in the group treated with higher pressure (120 mmHg) (31).

*Pressure Setting for Upper Extremity*

Bok et al conducted a comparison of IPC pressures of 25, 35, and 45 mmHg in a cohort of 40 patients (53). Utilizing ultrasound and acoustic radiation force impulse imaging, they assessed change in tissue thickness and stiffness with IPC. The findings indicated that the 35-mmHg pressure setting was optimal, as it provided significant volume reduction while maintaining a balance between patient comfort and treatment efficacy.

*Compression Cycle*

Most current IPC machines are designed so that the distal chamber remains inflated while the other chambers sequentially inflate and deflate during the compression cycle (50). Zaleska found that to generate effective tissue pressures for lymphatic outflow, high-pressure cuffs should remain inflated for more than 50 seconds (50). Additionally, Pilch et al studied the effects of different inflation/deflation cycles (60/60 seconds versus 90/30 seconds) in a cohort of 81 patients and found no significant differences in outcomes between the two settings (54). One study evaluated the benefit of MLD mimicking truncal compression prior to limb compression as compared limb pneumatic compression alone and did not find significant difference in the outcomes (55).

*Treatment Duration*

The treatment periods used in the published studies have ranged from 30 mins to 2 hours per day for 3 to 7 days per week. Keeley et al randomized 21 patients to receive 1 hour of IPC once daily, twice daily, or 2 hours twice daily over a span of 5 days (56). The study concluded that extending IPC beyond 1 hour daily does not yield additional reduction in limb volume or tissue extracellular fluid percentage.

*Cost Effectiveness*

The economic impact of IPC was explored in six studies. Lerman et al benchmarked IPC against other compression therapies in a group of 138 patients, identifying significant cost savings over 18 months attributed to fewer complications and hospital stays (57). IPC users experienced a reduction of 66% in emergency department visits and 69% in hospitalizations. Desai et al reported substantial savings, amounting to $3,200 per patient annually (23). Meanwhile, Karaca-Mandic et al presented IPC as a cost-effective solution when considering quality-adjusted life years, with an incremental cost-effectiveness of $1,400 (58). The amount of cost-benefit of IPC devices varied depending on device pricing and the extent of insurance coverage.

*DISCUSSION*

The evolution of Intermittent Pneumatic Compression (IPC) technology provides a therapeutic opportunity for personalized, patient-centered care. As lymphedema remains a chronic, often debilitating condition, the diversification of IPC devices – with their varied pressure settings, sleeve designs, and compression modes – reflects a broader trend of tailoring treatment to individual patient needs. Our review illuminates the complex landscape of IPC, where the multitude of device configurations and operational parameters mirrors the heterogeneity of lymphedema presentations and patient experiences. Despite the availability of numerous studies, lack of standardized protocols and conflicting evidence continues to obscure the optimal application of IPC, necessitating further research to unify these disparate threads into a coherent clinical strategy.

It is important to note that although many studies compared outcomes of IPC with reference to MLD, the efficacy of MLD as part of CDT itself has remained questionable (59). Central to the value of IPC is its capacity to empower patients, offering a semblance of control over their condition. This autonomy is especially critical given the limitations in access to specialized lymphedema services and trained therapists. The convenience and adaptability of IPC facilitate consistent self-management, potentially enhancing adherence to therapeutic regimens and improving long-term outcomes.

The efficacy of IPC, however, is not universally consistent across different patient populations and lymphedema manifestations. Our review suggests a greater benefit in lower extremity lymphedema, possibly due to greater struggle for patients to mobilize the lymphedema fluid against gravity in this region. The nuanced interplay between IPC treatment parameters and patient-specific factors – such as disease severity, and body mass index – highlights the importance of individualized treatment protocols. The optimal IPC settings, notably pressure and duration, should be tailored based on comprehensive assessments including imaging studies and tissue pressure measurements, to maximize therapeutic efficacy and patient comfort. An interesting trend shows that recommended pressure settings have decreased over time, with European studies typically using higher pressures than U.S. studies – possibly because of difference in the disease severity. The presence of lipodystrophy and fibrosis would require higher pressure settings for efficacy, which although would increase patient discomfort and reduce compliance. While there are several studies evaluating pressure settings for leg lymphedema (which generally recommend high pressure), there is limited research on optimal pressure settings for arm lymphedema.

From a mechanistic perspective, IPC acts on both lymphatic and interstitial fluid dynamics, yet the relative contributions of these pathways remain poorly understood (15,48). Imaging studies during IPC sessions have shown enhanced lymphatic propulsion, suggesting a direct effect on the lymphatic system. However, the long-term implications of these acute changes, particularly regarding the sustainability of lymphatic function improvement, are yet to be fully explored. This gap underscores the need for longitudinal research to elucidate the mechanisms underlying IPC's therapeutic benefits and to define its role within the broader spectrum of lymphedema management strategies.

The application of IPC extends beyond routine outpatient care, showing potential in perioperative settings to enhance surgical outcomes in lymphedema treatment. Preliminary evidence indicates that IPC can improve lymphatic vessel visualization during surgery, reduce postoperative complications, and facilitate quicker recovery. Additionally, emerging studies highlight the utility of IPC in managing truncal and head/neck lymphedema, areas that have historically received less attention in lymphedema research. These findings point to a promising avenue for expanding IPC's clinical utility, warranting more comprehensive investigations to validate these initial observations and refine treatment protocols.

## *CONCLUSION*

IPC emerges as a safe and economical option for management of extremities' lymphedema, aligning well with patient-led care approaches. Future research should aim to refine IPC protocols and ascertain its long-term benefits and its integration into contemporary lymphedema treatment regimes.

*CONFLICT OF INTEREST AND DISCLOSURE*

All authors declare that no competing financial interests exist in products or devices mentioned in the manuscript.

*AUTHOR CONTRIBUTIONS*

Sonia Pandey coordinated the study and composed the original manuscript. Berk Ozmen, Suat Morkuzu, Ying Xiong, Elise Kemp assisted with the articles screening and manuscript drafting. Wei F. Chen conceptualized the project and edited the manuscript.

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# TABLE 1
## Detailed Manuscript Information Grouped into 4 Groups used for Analysis (Limb Lymphedema, Special Situations, Non-Limb Lymphedema, and Relevant Compression Pressure Studies)

| Aim | Research focus | Author, Year | Title | Summary of Outcomes | Salient point | Sample size | Etiology | Region | Total Duration of Use | Duration per Day | Max Follow up period | Frequency | Compression Cycles | IPC Pressure | Device name | Study Design | Outcome measures | Adverse events |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A). LIMB LYMPHEDEMA** | | | | | | | | | | | | | | | | | | |
| **IPC without MLD** | Efficacy | Freyne 2022 | Severe lymphoedema in gynaecological cancers: | Following IPC participants showed a significant improvement in mean global | IPC improves all patients' functional and symptom scores, except sexual function | 12 | secondary | LE | 8w | 1h | N/A | daily | N/A | 100 mmHg | N/A | Prospective cohort study | Quality of life scores and history of hospital | |
| | Efficacy | Maldonado 2021 | Assessment of quality of life changes in patients with | IPC treatment significantly improved LYMQOL scores, physical component of | The Flexitouch APCD showed a significant limb girth reduction as early as 12 weeks | 74 | secondary, primary | LE | 52w | 45m | 52 weeks | 5 days per week | N/A | N/A | Flexitouch | Prospective cohort study | The primary endpoints: QOL change at 12 weeks, | |
| | Efficacy, Cost | Desai 2019 | Superior Clinical, Quality of Life, Functional, and Health | IPC resulted in a 28% decrease in absolute limb volume, decreased body mass index | IPC improves clinical outcomes, quality of life, and function for UE and LE secondary | 117 | secondary | UE, LE | 52w | 1h | | twice daily | 18 s per chamber | 40 or 50 mmHg | Metrum Cryoflex | Prospective cohort study | Absolute limb volume, BMI, SF-36 quality of life, and leg | |
| | Safety, Efficacy | Blumberg 2016 | Pneumatic Compression Improves Quality of Life in | The study showed a significant decrease in ankle and calf limb girth, as well as the | IPC improves symptoms of LE lymphedema | 100 | secondary, primary | LE | 57w | 45m | | 5 to 7 days per week | N/A | N/A | N/A | Prospective cohort study | Episodes of cellulitis, number of ulcers, venous | |
| | Efficacy, Cost | Brayton 2014 | Lymphedema prevalence and treatment benefits in cancer: impact of a | The use of IPC was associated with a significant decrease in rates of hospitalizations, outpatient hospital visits, | Lymphedema is common among cancer survivors, and IPC is valuable in treating lymphedema | 1065 | secondary | N/A | N/A | N/A | | N/A | N/A | N/A | N/A | Retrospective cohort study | Rates of hospitalizations, outpatient hospital visits, cellulitis diagnoses, and | |
| | Safety, Efficacy, Settings | Zaleska 2014 | The Effectiveness of Intermittent Pneumatic Compression | The limb circumference decreased or did not further increase, elasticity of tissues increased or was maintained. No | The first one hour IPC showed: decrease in circumference of lower parts of the calf and thigh with increase below knee and in the | 18 | secondary, primary | LE | 2 to 3 years | 45 mins | | | | 80 to 120 mmHg | N/A | prospective cohort study | limb circumference, tissue Tonometry | Transient increase in groin and knee swelling, although calf and thigh reduced. No |
| | Efficacy, Safety | Muluk 2013 | Pneumatic compression device treatment of lower | In patients treated with APCD, 90% experienced a significant reduction in limb | The APCD treatment was associated with significant reductions in LV and showed | 196 | secondary, primary | LE | N/A | N/A | 4 to 9 weeks | N/A | N/A | 80 to 110 mmHg | N/A | Prospective cohort study | Reduction in limb volume (LV), clinician and patient- | Four adverse events were recorded for these subjects. |
| | Efficacy | Modaghegh 2010 | A newly designed IPC device for management of lymphoedema | IPC at high pressure was effective in reducing affected lower limb edema by a mean of 75% in lymphedema patients, | Introduction of a new mode for IPC which allows unidirectional forward lymph flow and is well-tolerated in chronic cases of the | 43 | secondary, primary | LE | 2 days | 8h | single in hospital treatment | daily | N/A | 80 to 120 mmHg | N/A | Experimental study, single session | Limb circumference | |
| | Safety | Borris 1998 | The risk of genital edema after external pump | Of the 128 patients with lower limb lymphedema, 75 received no pump | IPC can increase proximal swelling, no mention on the duration for which the | 128 | secondary, primary | LE | | | | | | | N/A | | | Genital swelling |
| | Efficacy | Gozza 1996 | Pneumatic compression vs | After 9 weeks of treatment, mean delta | IPC may have limited clinical value | 67 | secondary | UE | 9w | 2h | | N/A | N/A | 60 mmHg | N/A | RCT | Limb circumference before | |
| **IPC vs MLD** | Efficacy | Sanal-Toprak 2019 | The efficacy of intermittent pneumatic compression as a | No significant difference bw the two gps in the extent of improvement in | IPC treatment can be substituted for MLD in CDT due to its easier accessibility and | 46 | secondary | UE | 5w | 30 mins | 3 months | 3 days per week | Sequential | 50-80 mm Hg | N/A | RCT | circumference, shoulder pain and ROM | |
| | Efficacy | Gurdal 2012 | Comparison of intermittent pneumatic compression with | Both treatment modalities, namely IPC + Self Lymphatic Drainage (SLD) and | Manual lymphatic drainage and compression bandages may perform | 30 | secondary | UE | 6w | 45m | | 3 days per week | N/A | 25 mmHg | N/A | NRCT | Limb circumference before and at the 1st, 3rd, and 6th | |
| | Efficacy | Forner-Cordero 2021 | Physical therapies in the decongestive treatment of lymphedema: A | Group A (control group): manual lymphatic drainage + Intermittent Pneumatic Compression + | IPC and bandages is not inferior to IPC + manual lymphatic drainage + bandages | 182 | secondary, primary | UE; LE | 4w | 30m | 2 months | 5 days per week | N/A | 50 to 80 mmHg | N/A | RCT | Limb volume before and after treatment | discomfort and lymphangitis |
| | Efficacy | Johansson 1998 | A randomized study comparing manual lymph | Arm volume, mobility, strength and symptoms improvement not sig different in | IPC is as efficacious as MLD in BCRL | 28 | secondary | UE | 2w | 2 hrs | | 5 days per week | | 40-60 mm Hg | N/A | RCT | arm volume, level of mobility and strength | |
| **IPC + MLD** | Efficacy | Soran 2022 | Adding Pneumatic Compression Therapy in | IPC significantly reduces infection rates, hospital admissions, and physical therapy | Compliance improved with IPC | 69 | secondary, primary | LE | 78w | N/A | | N/A | Sequential | N/A | N/A | NRCT | Rate of infection, number of hospital admissions, and | |
| | Efficacy | Szolonsky 2022 | IPC acts synergictically with MLD in complex decongestive phsiotherapy | Arm volume and symptoms significantly improved in both gps at therapy end, at 1 month and at 2 months. Volume reduction | Excellent discussion about fears of using IPC and the different pressures. | 27 ( 13 CDT, 14 CDT + IPC) | secondary | UE | 2w | 60 mins MLD vs 30 mins MLD + 30 mins IPC | 2 months | 5 days/Wk | | 50 mm Hg | Lympha-mat | RCT | Limb volume, symptoms questionnaire | |
| | Efficacy | Tastaban 2020 | Role of intermittent pneumatic compression in the treatment of breast | IPC seems to add no benefit when combined with CDT for lymphedema, but, may be functional in reducing the | | 76 (38 CDT, 38 CDT +IPC) | secondary | UE | 4w | 60 mins MLD vs 60 mins MLD + 30 mins IPC | | 5 days per week | | 30-40 mmHg | Pulse press | RCT | Percentage reduction of excess volume (PREV), symptoms of pain, | |
| | Efficacy | Uzkeser 2015 | Efficacy of manual lymphatic drainage and | All tested parameters of limb volume, circumeference and dermal thickness | no additional benefit of adding IPC to CDT for BCRL | 31 | secondary | UE | 3w | 45 mins | | 6 days per week | | 40 mmHg | N/A | RCT | Limb circumference measurements, volume | |
| | Efficacy | Uzkeser 2013 | Intermittent pneumatic compression pump in upper | Significant improvements were observed in the function (ADL) and ROM of the | no additional benefit of adding IPC to CDT for BCRL | 25 | secondary | UE | 3w | N/A | | 5 days per week | | 60 mmHg | N/A | RCT | ROM of UE jts | |
| | Efficacy | Haghighat 2010 | Comparing two treatment methods for post | The study showed that both the use of CDT alone and in combination with IPC | CDT alone provided better results in reducing limb volume than when combined | 112 | secondary | UE | 12w | 1h | 12w | 5 days per week | N/A | 40 mmHg | N/A | RCT | The volume reduction of the upper limb measured by | |
| | Safety, Efficacy | Szuba 2002 | Decongestive lymphatic therapy for patients with | The addition of IPC to standard therapy led to a significant increase in mean volume | | 23 | secondary | UE | 26 - 52 weeks | 30 to 60 minutes | | N/A | Sequential | 40 to 50 mmHg | N/A | RCT | Volume- water displacement | No adverse effects on skin elasticity and joint range of |
| | Pressures | Taradaj 2015 | Comparison of efficacy of the intermittent pneumatic | IPC at 120 mmHg led to the greatest reduction of edema compared to lower | | 81 | Phlebolymphedema | LE | 4w | 45m | | N/A | Sequential | 60 or 120 mmHg | N/A | NRCT | | |
| | Frequency of use | Keeley 2023 | A Prospective Preliminary Study Examining the Physiological Impact of Pneumatic Compression Dosing in the Treatment of Lower Extremity Lymphedema | Limb volume measurements demonstrated no potential benefit of increasing IPC duration more than 1 hour per day during 5 days of treatment | No benefit of > 1 hr per day IPC in short FU | 21 | primary> secondary | LE | 5 days or 12 days | Group A: 1 hour. Group B: 1 hour (but twice per day, so 2 hours total). Group C: 2 hours (but twice per day, so 4 hours total). | 5 days | Group A: Once per day. Group B: Twice per day. Group C: Twice per day. | N/A | 55 mm Hg distal to 30 mm Hg proximal | N/A | Prospective cohort study | Changes in limb volume (LV), tissue fluid, tissue tone, and patient-reported outcomes (PROs)--> only volume and BIS were reliable | |
| | Compression modes | Dunn 2022 | Intermittent Pneumatic Compression for the | The study found that the LymphAssist group exhibited no significant volume | The improvement in limb volume and quality of life for patients with LE | 40 | secondary, primary | LE | 5w | N/A | | twice daily | N/A | 40 mmHg | LymphAssist | RCT | Bilateral leg volume (with circumference) and quality | |
| | Compression modes | Kim 2022 | Home-Based Intermittent Pneumatic Compression Therapy: The Impact in Chronic Leg Lymphedema in Patients Treated for Gynecologic Cancer | The use of a home-based IPC device alongside a routine self-maintenance program of short-stretch bandages in stage 3 chronic leg lymphedema patients resulted in a lower limb-volume difference ratio and higher quality of life compared to using a home-based IPC device alone. | The IPC device has a distinct mode designed to imitate the manual lymphatic drainage (MLD) technique, aiming to gently aid lymphatic draining of the proximal extremities. This study shows that using such an IPC device with an MLD-mimicking program can be beneficial in maintaining limb volume and enhancing the QOL for patients with stage 3 chronic leg lymphedema during their maintenance phase. | 30 | secondary | LE | N/A | 1h | 4 weeks. | twice a day for 4 weeks | MLD-mimicking mode: 3 s inflation, 1 s holding time, 7 s deflation and resting time; conventional mode: 6 s inflation, 1 s holding time, 7 s deflation time for each chamber | MLD-mimicking mode: 40-60 mmHg; conventional mode: 80-100 mmHg | N/A | NRCT; Prospective cohort study | Limb-volume measurement, quality of life (QOL), satisfaction, and safety of the IPC device. | |
| | Programmability | Karaca-Mandic 2017 | A comparison of programmable and nonprogrammable | Dynamic pressure programmable devices demonstrated better lymphedema-related health outcomes compared to | The study compared the clinical and health utilization outcomes between two types of PCDs (NP-PCD and P-PCD) in patients | 1731 | secondary, primary | unspecified | 12 months | N/A | 12 months | N/A | N/A | N/A | N/A | Retrospective cohort study | Rates of lymphoedema-related cellulitis, manual therapy use, outpatient | |

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| **Device Settings and modes - Clinical studies** | Comparing 2 devices | Fife 2012 | A randomized controlled trial comparing two types of pneumatic compression for breast cancer-related lymphedema treatment in the home | The APCD-treated group showed a significant 29% reduction in edema compared to a 16% increase in the IPC group, with a 5.8% reduction in mean TDC values for the APCD group and a 1.9% increase for the IPC group, indicating that adjuvant treatment with an APCD provides better outcomes than with an IPC, and both groups demonstrated very good device compliance. | Advanced IPC as an adjuvant treatment may be better than standard IPC devices for treating BCRL. Seven pts had adverse events, more in the Std gp. | 36 | secondary | UE | 12w | 1h | | N/A | 18 s per chamber (std) sequentially inflated ending with all inflated vs 1 to 3 secs per chamber (only one inflated at a time) | 30 mmHg (standard) or n 9.0± 4.2 mmHg and 13.7±4.8 mmHg (Advanced) | N/A | RCT | Limb volume (with circumference) and tissue water measurement (with Moisture meter) at Week 0 and 12 | Seven patients had adverse events, more in the standard group. |
| | Trunk compression preceding arm compression | Ridner 2012 | A randomized clinical trial comparing advanced pneumatic truncal, chest, and arm treatment to arm treatment only in self-care of | When comparing experimental truncal/chest/arm advanced pneumatic compression therapy to arm-only pneumatic compression (control), there were no statistically significant changes in | | 42 | secondary | UE | 30 days | 1h in UE + trunk gp, 36 mins in UE only gp | | 7 days per week | N/A | 9.0 ± 4.2–13.7 ± 4.9 mm Hg | N/A | RCT | LSIDS-A score, arm circumference, trunk circumference, (FASQ score, bioimpedence | |
| | No. of chambers and cycle time | Pilch 2009 | Influence of compression cycle time and number of sleeve chambers on upper extremity lymphedema | IPC is an effective method of volume reduction in women with postmastectomy arm lymphedema regardless of cycle times and number of sleeve chambers. Two | | 57 | secondary | UE | 5w | 1h | | 5 days per week for 5 weeks | N/A | 30 to 50 mmHg | N/A | RCT | Limb volume | |
| | Comparing 2 devices | Mayrovitz 2007 | Interface pressures produced by two different types of lymphedema therapy devices | Significant differences in pressure timings, patterns, and magnitude were found after comparing the Lympha Press and Flexitouch devices. In terms of timing, the duration of pressure pulses in the Flexitouch device were significantly shorter than that of the Lympha Press. Due to this quick application of pressure, the | There were significant differences between the Flexitouch and Lympha Press devices. During inflation cycles, the pressures exerted by the Lympha Press were higher and were sustained for longer periods of time. However, the Flexitouch differed drastically by displaying quick rise and fall progressions. | 10 | N/A | UE | Single session for each device (at least 48 hours between each device assessment) | Single session for each device | N/A | Single session for each device | Sequential | 45mmHg for the Lympha Press and the “standard” setting for Flexitouch | Lympha Press; Flexitouch | Experimental study | Interface pressures applied to left forearm (used 256-pressure sensor array) over 0.1 second intervals for at least 2 cycles of each device | |
| | No. of chambers | Bergan 1998 | A comparison of compression pumps in the treatment of lymphedema | One and three chamber garments were less effective than 10 chamber garment in reducing swelling | multi chamber sequential compression more effective than fewer chambers | 35 | secondary, primary | UE, LE | N/A | 2 hrs | N/A | | Sequential or non sequential | 50 mmHg in one or 3 chambers, 80 to 30 mmHg gradient in ten chambered. | | | Limb volume (water displacement) | |
| **Experimental Studies** | Imaging for Efficacy, Best settings | Zaleska 2019 | The Effectiveness of Intermittent Pneumatic Compression in Lymphedema of Lower Limbs:Methods of Evaluation and Results | Adjustment of compression parameters to tissue stiffness, fluid accumulation volumes, and fluid movement ability (hydraulic conductivity of tissues) at various limb levels is indispensable for effective therapy. They recommended differential compression pressures and prolonged timings at various limb levels | | 52 | secondary, primary | LE | 1 hr | | | | 5 secs inflation, 5 sec deflation for each chamber, total 40 sec period for 1 cycle. | The sleeve inflation pressure at foot level was 120 mmHg, gradually de-creasing in the groin by 20%. | N/A | Experimental study, single session | tissue stiffness, fluid pressure, flow volume, LSG, ICGL | |
| | Efficacy, Best settings | Bok 2018 | Evaluation of Stiffness in Postmastectomy Lymphedema Using | After a single session of IPC, using a pressure of 35 mmHg resulted in the largest improvement in proximal upper arm | IPC reduces stiffness and subcutaneous tissue thickness of UE in patients with BCRL | 45 | secondary | UE | single session | N/A | | N/A | N/A | 25, 35, and 45mmHg | N/A | Experimental study, single session | UE subcutaneous tissue thickness, circumference, and stiffness | |
| | Imaging for Efficacy | Aldrich 2017 | Effect of pneumatic compression therapy on lymph movement in | The study demonstrated improved lymph movement during and after IPC in all affected legs of the subjects tested, with | IPC improves lymphatic function either by mobilizing fluid through lymph vessels or through interstitial channels. | 4 | secondary, primary | LE | single session | 1h | | N/A | N/A | 45 distal to 30 mmHg proximal | N/A | Experimental study, single session | ICGL before (15 mins after injection), during and after IPC using compression | |
| | Imaging for Efficacy | Kitayama 2017 | Real-Time Direct Evidence of the Superficial Lymphatic Drainage Effect of Intermittent Pneumatic | Different inflation/deflation modes and two different pressures evaluated (45 and 90 mmHg) using quantitative ICGL and software-assisted video analysis. ICG | Preop severity grading done with LSG and those with dermal backflow in leg and foot were excluded (only mild cases included). | 25 ( 8 control, 17 affected limbs) | secondary | LE | single session | single session | | single session | | 45 mmHg and 90 mm Hg | N/A | Experimental study, single session | ICGL- lymph velocity, real time with transparent compression sleeve, during IPC | |
| | Best settings | Zaleska 2013 | Pressures and timing of intermittent pneumatic compression devices for | The study points to the necessity of applying high pressures (120 mm Hg) at ankle with 20 % proximal pressure gradient | The pneumatic devices were set at three different inflation times 5, 20, or 50 sec in each chamber of the eight chambers, and | 18 | secondary, primary | LE | single session | | | | | | N/A | Experimental study, single session | subcut pressure | |
| | Efficacy, MOA | Olszewski 2011 | Tissue fluid pressure and flow during pneumatic compression in lymphedema of lower limbs | The skin's rigidity (fibrosis) and the dissipation of applied compression force to proximal noncompressed limb regions resulted in a high pressure gradient through | Tissue fluid pressures generated by a pneumatic device were found lower than in the compression chambers. The obtained results point to the necessity of applying | 15 | N/A | LE | single session | single session | N/A | single session | sequential, distal most chamber was not deflated | 50 to 120 mmHg | Biocompression | Experimental study, single session | Continuous Tissue pressure, and girth (plethysmograph attached to starin gauges applied at different limb | |
| | Imaging for Efficacy | Olszewski 2011 | Pathways of lymph and tissue fluid flow during intermittent pneumatic | The study utilized LSG to demonstrate the movement of subcutaneous fluid and static lymph propelled towards the groin after | The study finds that while intermittent pneumatic compression can effectively push mobile tissue fluid towards the groin, | 15 | secondary | LE | single session | N/A | N/A | N/A | N/A | 50 to 125 mmHg | N/A | Experimental study, single session | LSG- The primary outcomes are the pathways and destinations of fluid moved | One patient experienced muscle cramps and a second reported increased limb |
| | Imaging for Efficacy | Adams 2010 | Direct evidence of lymphatic function improvement after advanced pneumatic | Improvement defined as proximal movement of dye after therapy. Lymphatic function improved in all control subjects | IPC was effective in stimulating the lymphatic function locally and systemically. | 3 controls, 6 with BCRL | secondary | UE | single session | single session. An hour-long IPC (30 mins trunk and proximal arm basins | | single session | | NA | Flexitouch | Experimental study, single session | ICGL same and contralateral side , Lymphatic propulsion rate, apparent lymph | |
| **B). SPECIAL SITUATIONS** | | | | | | | | | | | | | | | | | | |
| | Efficacy in filariasis | Manjula 2002 | Evaluation of sequential intermittent pneumatic | 12 patients with grade II filarial lymphoedema had >26% reduction in | | 28 | secondary | LE | 4w | | 6 months | | | | | | volume (with water displacement) | |
| | Efficacy in children | Hassall 2001 | A Retrospective Study of the Effects of Lymphapress Pump on Lymphedema In A | In this retrospective study of 16 children with lymphedema of the upper or lower extremities, the Lymphapress pump | pressure required decreased over time in the same pt | 16 | secondary, primary | UE; LE | N/A | N/A | N/A | N/A | N/A | N/A | Lymphapress | Retrospcetive cohort study | Volume and circumference of upper or lower limbs before and after treatment | |

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| | Combined with Lymphatic Surgery | Zelikovski 1983 | The sequential pneumatic compression device in surgery for lymphedema in the limbs | IPC used before, during and after surgery. Aids intraop lymphatics visualization for LVA and maintains anastomosis patency, reduce wound complications and pain in excisional surgeries. | Higher pressure used for the more severe case 1, preoperatively. | 3 | secondary LE, UE | 1 UE, 2 LE | Case 1 (LE)- 36 hrs continuously pre skin and subcut resection, 3 days postop 6 hrs/Day, Case 2 (LE)- introp for dilating groin lymphatics for LVA, postop for 12 hrs, Case 3 (UE) intraop for propelling blue dye, skin and subcut resection and LVA done. | | | | Sequential | case 1- 130 mm Hg preop, 80 mm Hg postop, case 2- 80 mm Hg | Lymphpress | case series | wound complications and pain in excisional surgeries. | |
| **C). NON LIMBS LYMPHEDEMA** | | | | | | | | | | | | | | | | | | |
| | Safety, Efficacy | Ridner 2021 | Advanced pneumatic compression for treatment of lymphedema of the head and neck: a randomized wait list controlled trial | Patients who received advanced pneumatic compression device (AIPC) care for lymphedema showed significant improvements in their perceived ability to control lymphedema, patient-reported outcomes, visible external swelling, and reported pain compared to those who | significantly enhanced patient perception regarding their ability to control their lymphedema ,potentially reducing patient distress. | 43 | secondary | H&N | 8w | 23 to 45 minutes | | prescribed twice daily, 7 days per week, but most pts used once a day | N/A | N/A | N/A | RCT | Symptoms (including paraesthesia, pain, heaviness), function (cervical motion, speech), swelling internal and external | |
| | Safety, Efficacy | Gutierrez 2019 | Head and Neck Lymphedema: Treatment Response to Single and Multiple Sessions of Advanced Pneumatic Compression Therapy | The study evaluated ICGL-dermal backflow area in 10 patients before and after IPC completion, finding a reduction in backflow in 6 out of 8 subjects, and demonstrated improved facial composite measurements scores and self-reported outcomes in all 10 subjects with no adverse events reported. | The use of near-infrared fluorescence lymphatic imaging (NIRFLI) to visually assess the impact of the pneumatic compression therapy on lymphatic drainage and the ability to observe enhanced lymphatic uptake and drainage, as well as changes in areas of dermal backflow, in subjects after the treatment. | 10 | secondary | H&N | 2 weeks. | 32m | 2 weeks. | 7 days per week | N/A | N/A | Flexitouch | Prospective cohort- Observational study where subjects were imaged using NIRFLI before and after the initial treatment, and then again after 2 weeks of daily treatment. | external swelling (measured using facial composite scores), and subject-reported improvements. | No adverse events were reported |
| | Imaging for Efficacy | Rasmussen 2019 | Imaging the Lymphatic Response to Manual Lymphatic Drainage and | Both MLD and IPC showed improvement in lymph velocity, and enhanced lymphatic uptake in both control and symptomatic | The only study that used imaging after a sustained us of IPC | 69 | secondary | H&N, limbs | 2 weeks. | N/A | | daily for 2 weeks | N/A | N/A | N/A | NRCT- conference abstract | ICGL before and 2 weeks after +/- during IPC/MLD | |
| | Safety, Efficacy, Best Settings | Mayrovitz 2018 | Usability of advanced pneumatic compression to treat cancer-related head and | The majority of patients found APCD to be comfortable, effective, and well-tolerated, with one treatment showing statistically | The treatment was found to be safe, easy to use, and well-tolerated, showing edema reduction after just a single initial treatment | 44 | secondary | H&N | Single session | 32m | N/A | once | N/A | N/A | N/A | NRCT; Prospective cohort study | Patient-reported comfort, feelings post-treatment, and likelihood of home use, | |
| | Safety, Efficacy | Ridner 2010 | Advanced pneumatic therapy in self-care of | Significant reduction in overall symptoms but the reduction in trunk circumference | 100% compliance with IPC, Flexitouch used, study period was short | 12 | secondary | Trunk | 10 days | 1h | | 7 days per week | N/A | N/A | Flexitouch | Prospective cohort study | Patient reported symptoms, and trunk circumference | |
| **D). SUPPORTIVE STUDIES ON COMPRESSION PRESSURE** | | | | | | | | | | | | | | | | | | |
| | Efficacy, best settings | Zaleska 2017 | Indocyanine green near-infrared lymphangiography for evaluation of | Realtime movement of edema fluid observed using various compression modalities. Threshold pressures necessary | Determined sleeve pressure required for moving fluid proximal 40 mm Hg in the tissues which can be generated with was | N/A | | UE, LE | single session | | | | | 50 to 120 mm Hg gradient | N/A | Experimental study, single session | ICGL before and after, also measured tissue pressure using four different | |
| | Other | Partsch 2011 | Dose finding for an optimal compression pressure to reduce chronic edema of the extremities | The study examines the change in limb volume and circumference after 2 hours of using compression garments with different pressures, revealing that the upper limit for | Indirect estimate of required compression pressure | 36 arm patients and 42 leg patients | secondary | UE; LE | N/A | N/A | | N/A | N/A | | N/A | Prospective cohort study | Limb volume and circumference before and after treatment | |

ADL, activities of daily living; AE, adverse events; APCD, advanced pneumatic compression device; ASES, American Shoulder and Elbow Surgeons; BCRL, breast cancer-related lymphedema; CB, compression bandages; CDT, complex decongestive therapy, CL, contralateral; ; FU, follow up; gps, groups; h/hr, hour; H&N, head and neck; ICG, indocyanine green; ICGL, indocyanine green near-infrared lymphography, IPC, intermittent pneumatic compression; jts, joints; LE, lower extremity; LLCS, leg lymphedema complexity score; LYMQOL, Lymphedema Quality of Life scores; LSG, lymphoscintigraphy; LV, limb volume; LVA, lymphatic venous anastomosis; m, minutes; MLD, manual lymphatic drainage; MOA, mechanism of action; NIRFLI, near-infrared fluorescence lymphatic imaging; NP-PCD, nonprogrammable pneumatic compression device; NRCT, non-randomized control trial; PC, pneumatic compression; PCD, pneumatic compression device; PCT - pneumatic compression therapy; PMLE, post mastectomy lymphedema; P-PCD, programmable pneumatic compression device; PREV, percentage reduction in edema volume; pts, participants; QOL, quality of life; RCT, randomized control trial; ROM, range of motion; s seconds; IPC, intermittent pneumatic compression; SF-36, short form 36; SLD, self lymphatic drainage; SPC, sequential pneumatic compression; TDC, tissue dielectric constant; TF, tissue fluid; UE, upper extremity; USG, ultrasound sonography test; w, weeks; yr, year;