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Original Research

The Efficacy of Pneumatic Compression Devices in the Treatment of Patients with Lymphedema after Mastectomy

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ABSTRACT

Objective: The aim of the present study was to compare the efficacy of compression bandage and compression device in the treatment of patients with breast cancer with mild to moderate upper extremity secondary mastectomy with secondary lymphedema.

Methods: The present study was conducted on 80 female patients with unilateral upper extremity lymphadenopathy diagnosed postoperatively in women with breast cancer who underwent mastectomy. Only bandage was applied to the control group (n=40); intermittent pneumatic compression (IPC) and bandage (n=40) were applied to the treatment group. All patients received treatment for a total of 15 sessions for 5 weeks, 3 days/week. After all the patients' age and body mass index (BMI) were recorded, the shoulder joint range of motions (ROMs) were measured by goniometer, circumferential measurements were measured by tape measure 4 times and on days 5, 10, and 15, and the Q-DASH functional disability scale was evaluated. The SPSS 22.0 package program was used for statistical analyzes. A p value <0.05 was accepted as statistically significant.

Results: The average age of the patients was 54.80±10.36 years, and BMI was 28.78±4.65 kg/m^2. When the circumferential and ROM measurements of the patients were examined, improvement was observed in both groups, but only the bandaged group was better than the IPC group (p=0.030, 0.019, 0.044, < 0.001, and < 0.001). In case of functional status assessments, improvement was observed only in patients who received bandages (p<0.001).

Conclusion: As a result of the present study, there was no significant difference between compression bandage and intermittent compression device applications in the treatment of patients with lymphedema after mastectomy. Even in some measurements, it was seen that there was more improvement in patients who had only bandages applied.

Keywords: Lymphedema, mastectomy, pneumatic compression

INTRODUCTION

Breast cancer is one of the most common types of cancer among women and can lead to high morbidity and mortality rates. Surgeries performed as part of breast cancer treatment include mastectomies and conservative surgeries. Independently of what type of surgery is performed, these techniques can be accompanied by axillary lymph node drainage, which may cause upper limb lymphedema (1). Lymphedema affects up to 50% of all breast cancer survivors. It is a condition resulting from lymphatic dysfunction in which persistent swelling exists due to an abnormal accumulation of protein-rich fluid in an extremity or other body region and is accompanied by marked subcutaneous and skin changes as the condition worsens (2). The incidence of breast cancer-related lymphedema increases dramatically from 3% to 15% after sentinel node biopsy, 10% to 20% after complete axillary dissection, and 30% to 50% with subsequent radiotherapy (3-5). As a part of treatment, physiotherapy plays a role in postoperative physical rehabilitation, prevention and treatment of complications, such as lymphedema, decrease movement range of upper limb joints, correction of postural misalignment, and sensitive alterations, thus promoting functional recovery and a better quality of life (6).

Complex decongestive therapy (CDT) is a method that combines manual lymphatic drainage (MLD), compression bandages, myolymphokinetic exercises, skin care, and precautions during daily activities. MLD alone is not effective for lymphedema treatment either, and the best results are achieved when associated with compression. Moreover, according to recent studies, compression bandages have been reported to be more effective in reducing edema than MLD (7). Compressive bandaging not only maintains but also increases lymphatic absorption, thereby stim-

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ulating lymphatic functioning. Compression bandages act by modifying the capillary dynamics of veins, lymph vessels, and tissues. They can be applied through functional compressive bandaging or elastic containment (sleeve). They promote increased interstitial pressure and increased efficacy of muscle and joint pumping (8).

Pressure therapy is a technique that consists of compressed air pumps, aimed at pressuring the limb with edema. Pneumatic compression (PC) devices utilize an air compressor unit that attaches to a garment or series of garments. It is composed of different forms of air chambers (gloves or boots). Basically, two types of compression pump exist: segmental, also called sequential or dynamic, and static or nonsegmental. Static PC involves the affected limb with a single continuous high-pressure chamber, which compresses the entire limb at once. This form of compression is out of use as it promotes the collapse of lymph vessels and impairs the venous system (9). Dynamic pressure therapy contains a number of individually regulable compartments or not. Usually, there are at least three compartments that fill up separately, producing a pressure level that goes from distal to proximal, turning fluid drainage more efficient. PC can lead to complications if the upper lymph conduits have not been emptied and stimulated first. Lymphatic capillaries are small and fragile, with possible injuries and breakdown due to high pneumatic pressure. In case of insufficient deep drainage, the body region above the pneumatic chamber becomes congested, which can cause a new lymphedema area and reduce lymph collection capacity even further (10).

The aim of the present study was to compare the efficacy of compression bandage and compression device in the treatment of patients with breast cancer with mild to moderate upper extremity secondary mastectomy with secondary lymphedema.

METHODS

The present study was conducted on 80 female patients with unilateral upper extremity lymphadenopathy diagnosed postoperatively in women with breast cancer who underwent mastectomy operation in the Department of Physiotherapy and Rehabilitation of Florence Nightingale Hospital. The study was approved by the ethics committee of İstanbul Bilgi University (no: 2017-40016-18, date: 07.11.2017), and voluntary approvals were received from the patients. Oral and written consents were obtained from the patients prior to treatment. Inclusion criteria are woman between 40 and 70 years old, at least 6 months after breast cancer treatment, lymphedema for a maximum of 8 years, unilateral lymphedema, and at least 2 cm diameter difference in at least one region in arm–hand circumference measurements compared with the normal side. Exclusion criteria are male patients, local or distant relapse due to breast cancer, active infection or deep venous occlusion, additional disease or psychiatric disorder affecting the study, and having undergone bilateral mastectomy. Patients were divided into 2 groups of 40 people. Only bandage was applied to the control group, and intermittent pneumatic compression (IPC) (40 minute) and bandage were applied to the treatment group. All patients received treatment for a total of 15 sessions for 5 weeks, 3 days/week. After all the patients' age, height, weight, and body mass index (BMI) were recorded, the shoulder joint range of motions (ROMs) (flexion, extension, and abduction) were measured by a goniometer, circumferential measurements (wrist circumference and 4, 12, 20, 28, 36, and 44 cm above the wrist) were measured by tape measure 4 times and on days 5, 10, and 15 after the treatment, and the short form—arm–shoulder–hand disability questionnaire (Q-DASH) functional disability scale was evaluated.

It has taught the essentials to be aware of in all sick skin care. When compression bandage is applied, care is taken to ensure that the skin is slightly moist. Then, the patient was first wrapped in multilayered cotton on a sock prepared for the appropriate length for the arm, and the latest rigid compression bandage was wrapped from the distal to the proximal using the spiral winding technique. This pressure is reduced to 75%, 50%, and 25% by increasing the proximal pressure to 100% pressure from the distal side of the bandage to make the edema better. There was no overpressure when passing through the elbow, and the dressing was performed when the elbow was in the semi-flex position. At the end of the band under the arm, the winding was finished with a pressure of approximately 0% so that the lymph flow was not blocked.

The other group was IPC therapy with Jobs Phalebo Press (Lympha Press) 701-E serial no. 01451 PC device with 40–60 mmHg pressure four-chamber sleeve for 40 min. Thereafter, multilevel lymphedema bandage was applied to this group. The inflation/deflation cycle for each chamber is 1–3 s in duration.

Upper limb edema was investigated by measuring the circumference of both upper limbs at 7 areas with a retractable, fiberglass, 150 cm measuring tape and calculating the difference. Measurements were made at the wrist joint and 4, 12, 20, 28, 36, and 44 cm above the wrist. All measurements were made by the same investigator (a physiotherapist) who used the same procedure at all times.

The range of flexion, extension, and abduction in the affected shoulder joint was measured by a standard goniometer (based on degree) by the same researcher in all women. Flexion, extension, and abduction were measured with the patient in the standing position to ensure accuracy.

Upper extremity functional assessment was performed with a Q-DASH scale. Q-DASH is a regional outcome measure that includes a sports and musician module that evaluates the entire upper extremity function developed for upper extremity musculoskeletal system disorders and includes 11 questions. At least 10 out of 11 questions are required to calculate the scoring scale reported to be used in place of DASH, and it must be answered. Each question is scored on a 5-point scale, and the total score is calculated from 0 (no disability) to 100 (severe disability). The scale has validity and reliability in Turkish. Completion time is approximately 3–4 min, and the ease of scoring is medium. Higher scores show more disability. Reasons for selection of the Q-DASH questionnaire in our study are the Turkish cultural adaptation of the questionnaire, the measurement of the characteristics of

Table 1. Demographic characteristics of the patients

	IPC + bandage group (n=40) Mean±SD	Bandage group (n=40) Mean±SD	z	p
Age (year)	57.00±10.62	52.60±10.15	−0.908	0.364
BMI (kg/m^2)	28.04±3.95	29.51±5.37	−0.454	0.650
Time since mastectomy (month)	11.00±3.16	11.55±2.40	−0.467	0.640

Mann–Whitney U test
IPC: intermittent pneumatic compression; BMI: body mass index; SD: standard deviation

the test, the fact that it is a questionnaire on the upper limb, and the idea of the entire upper extremity functioning. The questionnaire's score is obtained by dividing the total score of the marked items by the number of marked items and subtracting 1 and multiplying the resulting score by 25. It is normal between 0 and 20 points, mild between 21 and 40 points, moderate between 41 and 60 points, and severe disability between 61 and 80 points. Q-DASH's business model questionnaire also contains four questions to assess the difficulties that one has on his/her way while doing his/her job. The difficulty level is scored between 1 and 5. The total score of the items marked in the scoring is calculated by dividing by 4, subtracting by 1, and multiplying by 25 (11).

Statistical Analysis

Statistical Package for the Social Sciences 22.0 program (SPSS IBM Corp.; Armonk, NY, USA) was used for data analysis. Descriptive statistic variables were recorded. Mann–Whitney U test was used for comparison of nonparametric data between the two groups. Kruskal–Wallis test was used for comparison of nonparametric data between >2 groups. Friedman K test was used for pretreatment and posttreatment comparisons. A p value <0.05 was considered significant.

RESULTS

The demographic characteristics of the patients are shown in Table 1. There was no statistically significant difference between the groups with regard to age, BMI, and lymphedema development (p>0.05) (Table 1). Of all 80 patients, 80% have developed lymphedema in the right arm.

Compared with the patients' environmental measurements, there was a significant improvement in all the measurement levels of all patients (p<0.001 and <0.001), whereas the wrist circumference was 4 cm above the wrist, and the circumference above 44 cm showed more improvement in the control group (p=0.030, 0.019, 0.044, and <0.001) (Table 2).

When the shoulder joint ROM measurements were compared, there was a statistically significant improvement in shoulder flexion and abduction of the IPC therapy group (p=0.023 and 0.046); there was a statistically significant improvement in the control group in shoulder flexion, extension, and abduction at the end of the treatment (p<0.001, 0.032, and <0.001) (Table 3).

When the functional status of the patients was compared, there was a mild to moderate functional disability in all patients before the treatment, and there was no improvement observed in the IPC therapy group at the end of treatment (p=0.753 and p=0.014). There was a statistically significant improvement in the control group at 10 and 15 seasons of treatment for intergroup comparisons (p=0.43 and 0.019) (Table 3).

DISCUSSION

Lymphedema is a debilitating condition manifesting in excess lymphatic fluid and swelling of subcutaneous tissues due to obstruction, destruction, or hypoplasia of lymphatic vessels and is one of the great challenges in plastic surgery, where a satisfactory solution has not yet been found (12). As a result of the present study, there was no significant difference between compression bandage and intermittent compression device applications in the treatment of patients with lymphedema after mastectomy. The PC device has not shown any additional benefit in improving edema.

Compression therapy (1) reduces effective ultrafiltration pressure, (2) increases venous and lymphatic drainage, (3) improves venous pump function, (4) helps maintain therapeutic results, and (5) loosens tissues with fibrotic changes. Compression therapy can be performed with compression bandages, compression stockings or clothing, compression pads, PC devices, or special compression garments (13). IPC has been used in lymphedema reduction treatment, and it was concluded that no difference in reduction occurred in comparison with the control group.

After mastectomy, the damaged lymph nodes cannot carry enough lymph fluid, the fluid accumulation in the lymphatic vessels as a pressure increases in the opposite direction to the periphery, and the deterioration of the working mechanism of the valves that provide different directional circulation in the lymph vessels causes lymphedema to develop. Although the flow direction of the lymph fluid in the lymphatic vessels progresses from the periphery to the center, it acts as a circulant to not follow a fixed straight path. However, the lymphatic vessels immediately run superficially in the subcutaneous tissue and have an extremely slow flow rate. Therefore, by exerting pressure exerted externally through the lymphatic intravascular pressure, fast, constant pressure in the same direction, it can cause the veins in the veins to be ponded especially in the joint regions. The compression applied to provide drainage of the edema must be precisely adjustable according to edema density and amount. For this reason, the compression device can be applied mechanically and constantly, which can be explained as the reason for not pro-

Table 2. Comparison of intergroup and intragroup circumferential measurements of the patients

	IPC + bandage group (n=40) Mean±SD	Bandage group (n=40) Mean±SD	p
Wrist 1	19.25±3.33	17.85±1.81	0.158[k]
Wrist 2	17.85±1.39	16.95±1.27	0.108[k]
Wrist 3	17.75±1.20	16.55±1.25	0.030[k*]
Wrist 4	17.45±1.06	16.20±1.05	0.019[k*]
p	0.002[f**]	< 0.001[f**]	
Above 4 cm 1	20.70±1.76	20.25±1.94	0.542[k]
Above 4 cm 2	20.90±1.30	19.4 ±1.60	0.044[k*]
Above 4 cm 3	20.35±1.22	19.20±1.51	0.068[k]
Above 4 cm 4	19.95±1.03	18.90±1.55	0.067[k]
p	< 0.001[f**]	< 0.001[f**]	
Above 12 cm 1	23.00±3.37	22.80±1.41	0.565[k]
Above 12 cm 2	23.80±5.73	21.80±1.65	0.403[k]
Above 12 cm 3	22.20±2.86	21.10±2.07	0.403[k]
Above 12 cm 4	21.80±2.35	20.80±2.13	0.424[k]
p	< 0.001[f**]	< 0.001[f**]	
Above 20 cm 1	23.25±3.89	22.80±3.02	0.623[k]
Above 20 cm 2	22.50±3.53	21.40±2.68	0.448[k]
Above 20 cm 3	22.10±3.50	20.75±2.31	0.324[k]
Above 20 cm 4	21.20±3.11	20.00±2.54	0.303[k]
p	< 0.001[f**]	< 0.001[f**]	
Above 28 cm 1	27.85±3.49	28.90±3.68	0.448[k]
Above 28 cm 2	27.20±3.62	27.35±3.39	0.820[k]
Above 28 cm 3	26.60±3.45	26.55±3.60	0.879[k]
Above 28 cm 4	25.60±3.05	25.20±3.78	0.649[k]
p	< 0.001[f**]	< 0.001[f**]	
Above 36 cm 1	30.55±3.50	30.80±3.93	1.000[k]
Above 36 cm 2	29.50±3.05	29.75±3.52	0.970[k]
Above 36 cm 3	28.95±3.26	28.95±3.26	0.790[k]
Above 36 cm 4	28.10±3.20	28.10±3.20	0.703[k]
p	< 0.001[f**]	< 0.001[f**]	
Above 44 cm 1	33.70±3.95	33.70±3.95	0.382[k]
Above 44 cm 2	32.50±3.43	32.50±3.43	0.649[k]
Above 44 cm 3	31.55±3.33	31.55±3.33	0.733[k]
Above 44 cm 4	30.50±3.24	30.50±3.24	< 0.001[k**]
p	< 0.001[f**]	< 0.001[f**]	

**p<0.001; *p<0.05
[k]Kruskal–Wallis test; [f]Friedman K test
1: Pretreatment; 2: 5th session of treatment; 3: 10th session of treatment; 4: post–treatment
IPC: intermittent pneumatic compression; Q–DASH: short form—arm–shoulder–hand disability questionnaire; SD: standard deviation

Table 3. Comparison of intergroup and intragroup joint range of motion and functional status of the patients

	IPC + bandage group (n=40) Mean±SD	Bandage group (n=40) Mean±SD	p
Shoulder flexion 1	143.50±11.55	140.50±11.65	0.560[k]
Shoulder flexion 2	148.00±11.83	155.50±7.97	0.129[k]
Shoulder flexion 3	153.00±12.73	163.50±12.03	0.071[k]
Shoulder flexion 4	157.50±10.86	170.50±12.12	0.023[k*]
p	< 0.001[f**]	< 0.001[f**]	
Shoulder extension 1	15.00±5.00	10.00±5.00	0.261[k]
Shoulder extension 2	16.33±3.21	16.67±7.63	1.000[k]
Shoulder extension 3	17.00±2.64	23.33±10.40	0.500[k]
Shoulder extension 4	18.00±2.00	38.33±2.88	0.046[k*]
p	0.120	0.032[f*]	
Shoulder abduction 1	148.50±8.51	135.50±14.99	0.051[k]
Shoulder abduction 2	154.00±9.06	151.50±10.01	0.640[k]
Shoulder abduction 3	158.50±9.44	160.00±12.01	0.565[k]
Shoulder abduction 4	162.50±9.50	167.50±15.50	0.120[k]
p	< 0.001[f**]	< 0.001[f**]	
Q–DASH 1	18.29±8.63	17.21±11.60	1.000[k]
Q–DASH 2	19.14±7.52	12.38±6.31	0.237[k]
Q–DASH 3	18.42±8.66	6.64±5.38	0.043[k*]
Q–DASH 4	14.78±4.48	3.41±4.35	0.019[k*]
p	0.753[f]	0.014[f*]	

**p<0.001; *p<0.05
[k]Kruskal–Wallis test; [f]Friedman K test
1: Pretreatment; 2: 5th session of treatment; 3: 10th session of treatment; 4: post–treatment
IPC: intermittent pneumatic compression; Q–DASH: short form—arm–shoulder–hand disability questionnaire; SD: standard deviation

viding additional benefit in treatment. Since the lymphatic vessels have a very sensitive flow, manual therapy methods that are much slower, softer, and more applicable to the flow of lymphatic valves may be more beneficial (14, 15). Some studies associated components of CDT with PC (16, 17). There are contradictory ideas in the literature. Some studies report that PC devices are useful, but some studies also mention that they do not provide any additional benefit. In a systematic review, treatment methods applied to 172 patients with lymphedema after mastectomy were compared. Only patients treated with IPC after 4 weeks of treatment showed a recovery of 37.7%, whereas patients treated with electrotherapy and magnetotherapy with IPC reported an improvement of 76.3% (18). Therefore, these results should be interpreted with caution. IPC lacks the ability to be a standalone

therapy since it only stimulates the lymphatic drainage in working collectors. Therefore, IPC has a limited effect on the resorption of interstitial edema fluid. In a review study, a group of 24 women with lymphadenopathy performed MLD with only IPC, other group with only IPC and 75 mL reduction in patients with IPC + MLD when only 25 mL of edema volume was observed in patients in the IPC group (19). Ridner et al. (20) performed IPC for 40 min on 42 women with post-mastectomy lymphedema and found no improvement.

According to the results from randomized controlled trials, IPC effect sizes from the pre to post designed studies showed no benefit on volume reduction. Especially for IPC, the results demonstrated a very low effect size, confirming that IPC is not a standalone therapy (21-23). A randomized study involving 23 patients with lymphedema without previous treatment compared 2 interventions: CDT + PC and CDT alone. In this group, greater climb volume reduction was achieved when applying PC, and this result continued on further evaluations. In the same study, PC was combined with self-massage and sleeve use in 27 previously treated patients with chronic lymphedema, and volume reduction occurred in this group, as opposed to the group that was not submitted to PC (24). In this study, it can be considered that PC is applied to decrease edema due to the addition of the group of self-drainage techniques. In this study, IPC was not used alone, suggesting that improvement was observed in patients when applied with MLD and bandage.

Shao et al. (25) conducted a systematic review and meta-analysis and showed no significant differences in the percent of volume reduction and subjective symptoms (heaviness, pain, paresthesia, or tension) between decongestive lymphatic therapy (DLT) (also known as CPT + IPC) and DLT groups. Li et al. (26) thought that IPC may also not be associated with the addition of effectiveness to CPT. In our study, we found a decrease in the environmental measures of the patients in each of the two groups, but this improvement was more in the bandage only group. Haghighat et al. (27) concluded that compression bandage alone or in combination with compression pumping reduces the limb volume significantly, but compression bandage alone exhibits better results. Moattari et al. (28) found that a group of 21 patients with upper limb lymphedema have only one group of CDTs and the other group only has IPCs, and that arm circumference and shoulder ROMs have more improvement in the CDT group after treatment. In our study, we found that patients who underwent IPC improved 9.79% in shoulder flexion and 9.45% in shoulder abduction and who had only bandage improved 21.42% in shoulder flexion, 23.70% in shoulder abduction, and 62% in shoulder abduction in patients. Therefore, it was determined that there was more improvement only in patients in the bandage-treated group.

Johansson performed IPC at 40–60 mmHg pressure for 2 h and reported that patients do not benefit from edema quantities and arm use in daily living activities (29). Uzkeser et al. (30) have applied CDT to a portion of 31 patients who developed lymphedema after mastectomy and IPC in addition to the other part. They reported that the administration of IPC in the environment, volume measurements, and functionality do not contribute to healing in addition to the treatment they were given for 5 days/week for 3 weeks. When we examined the upper extremity functionalities of the patients, we found that patients treated with IPC improved 22.23%, and only 82.36% of patients treated with bandage had improvement. Although mild to moderate functional impairment in both groups of patients continued with mild deficits in patients with IPC prior to treatment, there was a near improvement in functional status of only bandaged patients. The fact that PC devices do not provide additional benefit in treatment can be attributed to the constant pressure of the patient giving a constant pressure without distinguishing the amount of skin and edema. Concurrently, treatments, such as radiotherapy, can lead to skin lesions when applied in sensitive areas after treatment.

CONCLUSION

The present study contributes to the clarification of ideas on the effectiveness of PC devices by contributing to the unclear information in the literature. Compression bandage and compression bandage together with the PC device showed that the healing was the same in all patients, but in some of the measurements, only better bandage patients were treated. Thus, PC devices were found to have no additional benefit on lymphocyte reduction. Therefore, it is considered that the use of treatment devices in the treatment programs will not have benefit because the compression devices applied to the disease will cause time and societal cost loss, as well as the loss of time and the increase of the patients' edemas, as well as the decrease in their functional activities.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of İstanbul Bilgi University (no: 2017-40016-18, date: 07.11.2017).

Informed Consent: Written and verbal informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Conflict of Interest: The author has no conflicts of interest to declare.

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