ATENA JOURNAL OF PUBLIC HEALTH

https://atenajournals.com

Received: **02/03/2022.** Accepted: **01/05/2022.** Published: **08/05/2022**

Extracorporeal shock wave therapy versus intermittent pneumatic compression therapy in post-mastectomy lymphedema

Z. Mowafy Emam Mowafy[1], Khadra M. Ali[1], Khaled M. Hassan[2], Hend R. Saleh[3*]

[1] Department of Physical Therapy for Surgery, Faculty of Physical Therapy, Cairo University, Egypt.

[2] Department of Plastic Surgery, Faculty of Medicine, Minia University, Egypt.

[3] Department of Physical Therapy for Surgery, Faculty of Physical Therapy, Deraya University, Egypt.

* Correspondence: Hend R. Saleh; Asmaa.Elbandrawy@gmail.com

ABSTRACT

Objectives: To evaluate and compare the effect of extracorporeal shock wave therapy and intermittent pneumatic compression in the treatment of forty-five post-mastectomy female patients.

Methods: The study included 45 women with breast cancer (35-65 years old), recruited from Minia Oncology Center and assessed immediately after mastectomy following successful primary therapy (radiation and chemotherapy). Participants were randomly assigned to three equal groups of 15. Group A received shock wave therapy combined with complex decongestive physical therapy, Group B received intermittent pneumatic compression therapy combined with complex decongestive physical therapy, and Group C received complex decongestive physical therapy alone, including bandaging, compression garments, manual lymphatic drainage, exercise, and self-care.

Findings: It was found that the application of shock wave therapy and pneumatic compression therapy, each with complex decongestive therapy, was effective in decreasing the arm segment volume (ASV) in post-mastectomy upper limb lymphedema, as evidenced by a highly significant decrease in the ASV. However, the pneumatic compression therapy with complex decongestive therapy was found to be more beneficial than the shock wave therapy.

Conclusions: Shock wave therapy and pneumatic compression therapy, each combined with complex decongestive therapy, were effective in decreasing the arm segment volume (ASV) in post-mastectomy upper limb lymphedema, as evidenced by a highly significant reduction in ASV.

KEYWORDS: Lymphedema; Intermittent Pneumatic Compression; Extracorporeal Shockwaves; Breast Cancer

1. INTRODUCTION

Breast cancer is the most common type of cancer among women all over the world, and it is also the leading cause of cancer-related deaths in women, accounting for 23 percent of all cancer diagnoses and 14 percent of cancer deaths. In 2008, the World Health Organization (WHO) estimated that 114,898 cases of breast cancer were diagnosed in South America. For instance, approximately 5,000 new cases are detected in Colombia every year. Nonetheless, over the last decades, breast cancer mortality rates have dropped due to significant improvements in screening techniques, diagnosis, and treatment.

Lymphedema (LE) is, unfortunately, a notable long-term consequence of breast cancer therapy that causes severe physical, mental, and emotional problems for patients [1]. It is a degenerative disorder caused by a lymph node dysfunction or injury, and it is characterized by an abnormal increase of tissue proteins, oedema, persistent irritation, and fibrosis. Multiple factors that can lead to lymphatic obstruction, such as tumour lymph node invasion, lymph node excision, radiation therapy, trauma, and infection, result in subsequent lymphedema [2].

Upper limb lymphedema occurs in 24 percent to 49 percent of patients with complete mastectomy, and in 2.4 percent to 49 percent of cases with axillary surgical removal. Lymphedema arises when there is an asymmetry resulting from reduced lymph circulation capabilities, leading to the accumulation of interstitial fluid and protein [3]. The subsequent multiplication of monocytes, macrophages, and fibroblasts, along with collagen build-up, results in prolonged aggravation and fibrosis. Pain, oedema, limited range of motion, fever, and allergic reactions are all consequences of LE [4].

Complex decongestive physiotherapy (CDPT) is one of the most widely used therapy methods for treating lymphedema, while extracorporeal shock wave therapy (ESWT) is currently being utilised with more frequency to manage orthopaedic diseases, and it has been approved for the management of calcification shoulder tendonitis, tennis elbow, and calcaneal spurs. Several human clinical studies have been conducted, as well as in vivo experiments on animals that have shown that low-intensity ESWT can promote healing, increase perfusion, and aid lymphangiogenesis by modulating vascular permeability and platelet-derived growth factor [5]. Another well-established, safe, and effective approach to treating LE is intermittent pneumatic compression treatment (IPCT). Through the consecutive inflation and deflation of a cuff placed on the affected upper limb, it has been proven to increase venous and lymphatic circulation by pressurizing the tissues and driving the liquid beyond the

targeted region [6].

2. METHODS

2.1. Participants

Forty-five women with breast cancer were recruited from Minia Oncology Center. These patients were undergoing successful primary therapy (a combination of radiation therapy and chemotherapy) and were seen immediately after mastectomy.

The experimental protocol was thoroughly explained to each patient before the initial assessment, and a written consent form was signed by each patient prior to the study. Patients were instructed to report any potential side effects that might arise during the treatment sessions.

The study participants were randomly assigned into three groups of equal size, with each group consisting of fifteen female patients:

- **Group A:** Participants received shock wave therapy along with complex decongestive physical therapy.
- **Group B:** Participants received intermittent pneumatic compression therapy along with complex decongestive physical therapy.
- **Group C**: Participants received only complex decongestive physical therapy, which included bandaging, compression garments, manual lymphatic drainage, exercise, and self-care.

2.2. Measurement Procedures

2.2.1. Arm limb volume measurement: $V = h(C_1^2 + C_1C_2 + C_2^2)/12\pi$

The volume of each upper limb was computed with the equation $V = h(C_1^2 + C_1C_2 + C_2^2)/12\pi$, used to calculate the volume of a truncated cone. Where V is the segment's volume, C_1 and C_2 are the segment's circumferences at the ends, and h is the space that separates them (segment length). The value was calculated by adding the volumes of the proximal and distal segments of the upper extremity. Measurements were taken twice — before and after the two weeks of therapy [7].

2.3. Therapeutic Procedures

All patients in Groups A, B, and C received the same complex decongestive therapy, nursing care, and prescribed diet [8].

2.3.1. Therapeutic Procedures for Group A (Shock Wave Therapy and Complex Decongestive Physical Therapy)

The shock wave therapy was applied to the intervention locations (10 cm below the shoulder tip as the proximal portion, and 10 cm above the elbow level as the distal part, with a segment length *h* of 13 cm), twice a week for two weeks using specialized therapeutic equipment. In each session, 2,000 impulses were delivered, depending on the patient's sensitivity, with the energy level set at 0.056-0.068 mJ/mm^2. The researcher applied 1,000 impulses to the most fibrotic lesion, while the remaining 1,000 times were delivered to a less fibrotic area [9].

2.3.2. Therapeutic Procedures for Group B (Intermittent Pneumatic Compression)

Each female participant in Group B received intermittent pneumatic compression twice — before and after the two weeks of treatment. All subjects were instructed to lie comfortably in a relaxed supine position with the head of the bed raised 15°. The pressure sleeve was adjusted to the affected upper limb, starting from just above the fingers to the shoulder tip. All knobs of the auto pulse compression machine were set in the zero position. The machine applied compression for one minute at an inflation pressure of 60 mmHg, followed by one minute of rapid deflation at a pressure of 20 mmHg, with a programmable automatic pump, for a total of one hour 23 minutes. The primary functional purpose of the device was to push the blood from the underlying deep veins, assuming that the valves were working properly. When the inflatable sleeves deflated, the veins would refill with blood. The intermittent compressions of the sleeves ensured the movement of venous blood [10].

2.3.3. Therapeutic Procedures for Group C (Complex Decongestive Physical Therapy)

Patients in Group C underwent CDPT immediately after being diagnosed with lymphedema. They received CDPT twice — before and after the two weeks of treatment. Treatment included skin and nail care, manual lymphatic drainage, a multilayer compression bandage, and therapeutic exercise to manage the oedema in the affected upper limb. Once it reached a measurement plateau, the patient was discharged from active treatment and transitioned to a maintenance phase. The volume of the affected limb was assessed before and after the two weeks of treatment [11].

2.4. Statistical analysis

In this study, the mean, standard deviation, and standard error were calculated for all patients. Mean and standard deviation were used as measures of central tendency to describe a group of individuals with a single measurement (descriptive statistics). The values used to describe the groups are the most utilised methods as statistical tools and the most important measurements of variability. Standard deviation uses the mean of the distribution as a reference point and measures variability by

considering the distance between each score and the mean. Mean, standard deviation, and range were used as a primary source to find relationships among parameters. Standard error was used to measure the standard distance between a sample mean and a population mean, making it an appropriate measure of variability. Independent *t* test was used to compare control and study groups, while paired *t* test was used to compare before and after treatment within a same group. A *p* value of less than 0.05 was considered statistically significant [12].

3. RESULTS

3.1. Comparison of the mean arm segment volume (ASV) in litres among the three groups in pre-treatment measurements

As observed in Table 1, there were non-significant differences in the first pre-treatment measurements of the arm segment volume (ASV) in litres: between Group A (shock wave therapy) and Group B (pneumatic compression therapy) with $P > 0.05$; between Group A (shock wave therapy) and Group C (complex decongestive therapy only) with $P > 0.05$; as well as between Group B (pneumatic compression therapy) and Group C (complex decongestive therapy only) with $P > 0.05$.

Table 1. Mean, standard deviation, standard error, *t* value, probability values, and level of significance of pre-treatment measurements of ASV in litres for the three groups

	Group B	**Group A**	**Group C**	**Group A**	**Group C**	**Group B**
Mean in litres	8.403	8.413	8.427	8.413	8.427	8.403
± Standard deviation	0.835	0.783	0.784	0.783	0.784	0.835
Standard error	0.215	0.202	0.202	0.202	0.202	0.215
Mean difference	-0.010		0.014		0.024	
t value	-0.03		0.05		0.08	
p value	0.973		0.961		0.936	
Level of significance	Non-significant		Non-significant		Non-significant	

3.2. Comparison of the mean arm segment volume (ASV) in litres among the three groups in post-treatment measurements

As shown in Table 2, there was a highly significant decrease in post-treatment measurements of ASV: between Group A (shock wave therapy) and Group B (pneumatic compression therapy) with $P < 0.0001$; between Group A (shock wave therapy) and Group C (complex decongestive therapy only) with $P < 0.0001$; as well as between Group B (pneumatic compression therapy) and Group C (complex decongestive therapy only) with $P < 0.0001$.

Table 2. Mean, standard deviation, standard error, *t* value, probability values, and level of significance of post-treatment measurements of ASV in litres for the three groups

	Group B	**Group A**	**Group C**	**Group A**	**Group C**	**Group B**
Mean in litres	6.737	7.418	8.353	7.418	8.353	6.737
± Standard deviation	0.396	0.814	0.353	0.814	0.353	0.396
Standard error	0.163	0.210	0.201	0.210	0.201	0.163
Mean difference	-0.681		0.935		1.616	
t value	-2.91		4.08		11.80	
p value	0.009		0.001		0.0001	
Level of significance	Highly significant decrease		Highly significant decrease		Highly significant decrease	

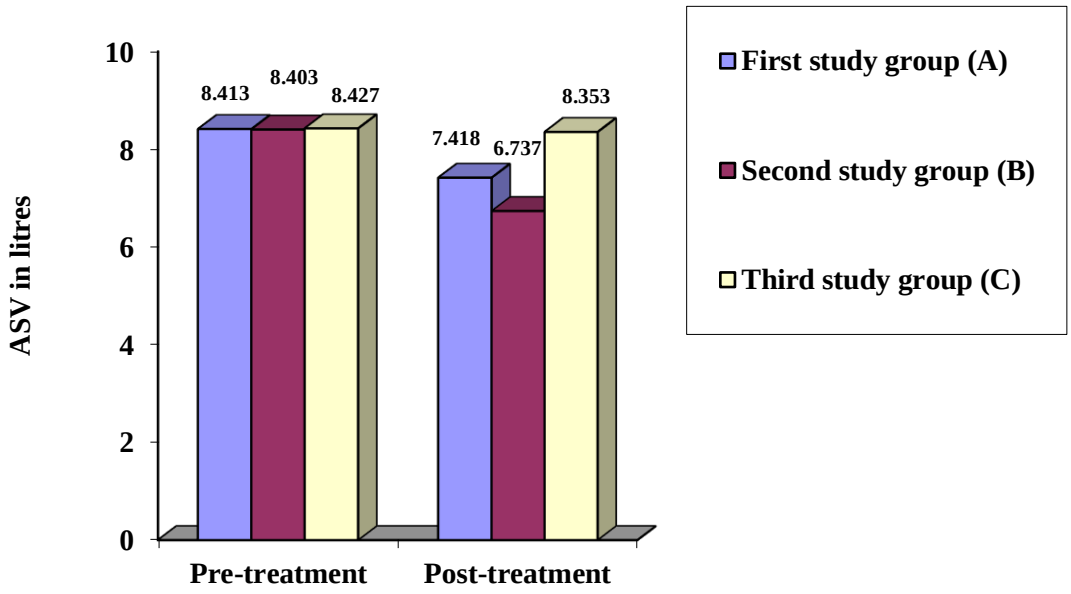

Figure 1. Bars representing the mean values of the arm segment volume (ASV) in litres for the pre- and post-treatment measurements in the three groups

4. DISCUSSION

The findings of the present study showed that there was a highly significant decrease in ASV between the means of the second measurement (Table 2), which were obtained after two weeks of applying shock wave therapy in addition to complex decongestive physical therapy, and the first measurement taken prior to the application of shock wave therapy with complex decongestive physical therapy ($P < 0.0001$). Comparison between the means of the pre-treatment measurements of the arm segment volume (ASV) in litres in the three groups revealed that there were non-significant differences: between Group A (shock wave therapy) and Group B (pneumatic compression therapy) with $P > 0.05$;

between Group A (shock wave therapy) and Group C (complex decongestive therapy only) with $P > 0.05$; as well as between Group B (pneumatic compression therapy) and Group C (complex decongestive therapy only) with $P > 0.05$. Conversely, comparison between the means of the post-treatment measurements of the arm segment volume (ASV) in litres in the three groups showed that there was a highly significant decrease in ASV: between Group A (shock wave therapy) and Group B (pneumatic compression therapy) with $P < 0.0001$; between Group A (shock wave therapy) and Group C (complex decongestive therapy only) with $P < 0.0001$; as well as between Group B (pneumatic compression therapy) and Group C (complex decongestive therapy only) with $P < 0.0001$. These significant differences observed after the treatment, with a highly significant decrease in ASV, were consistent with those observed and recorded by previous studies [2, 13, 14].

5. CONCLUSIONS

After a thorough discussion of the results and according to the reports of previous investigations in related fields, it can be concluded that the application of shock wave therapy and pneumatic compression therapy, each complemented with complex decongestive therapy, were effective in reducing the arm segment volume (ASV) in patients with post-mastectomy upper limb lymphedema, as evidenced by the highly significant decrease in ASV. However, pneumatic compression therapy with complex decongestive therapy was found to be more effective than shock wave therapy with complex decongestive therapy.

6. REFERENCES

1. Abeloff MD, Lichter AS. Breast clinical oncology. 3rd ed. Churchill Livingstone Inc; 2009. p. 131–51.
2. Armer JM, Stewart BR. Post-breast cancer lymphedema: incidence increases from 12 to 30 to 60 months. Lymphology. 2010;43(3):118–27.
3. Beenken SW, Winger EE, Bland KI. History of the therapy of breast cancer. In: Bland KI, Copeland FM, editors. The breast: comprehensive management of benign and malignant diseases. 3rd ed. Saunders; 2004. p. 4–13.
4. Cheville A, Packel LB. Cancer. In: Frontera WR, Silver JK, editors. Essentials of physical medicine and rehabilitation. 1st ed. Hanley & Belfus; 2002. p. 494–8.
5. Buch M, Siebert W. Shockwave treatment for heel pain syndrome: a prospective investigation. In: Coombs R, Schaden W, Zhou SS, editors. Musculoskeletal shockwave therapy. Greenwich Medical Media; 2000. p. 73–7.
6. Rinehart-Ayres M, Fish K, Lapp K, Brown CN, Rucker B. Use of compression pumps for treatment of upper extremity lymphedema following treatment for breast cancer: a systematic review. Rehabil Oncol. 2010;28:10–8.

7. Taylor R, Jayasinghe UW, Koelmeyer L, Ung O, Boyages J. Reliability and validity of arm volume measurements for assessment of lymphedema. Phys Ther. 2006;86(2):205–14.
8. Olszewski WL, Jain P, Ambujam G, Zaleska M, Cakala M, Gradalski T. Tissue fluid pressure and flow in the subcutaneous tissue in lymphedema—hints for manual and pneumatic compression therapy. Phlebolymphology. 2010;17(3):144–50.
9. Hammer DS, Rupp S, Kreutz A, Pape D, Kohn D, Seil R. Extracorporeal shockwave therapy (ESWT) in patients with chronic proximal plantar fasciitis. Foot Ankle Int. 2002;23(4):309–13.
10. Brennan MJ, Garden FH. Postmastectomy shoulder pain and lymphedema. Arch Phys Med Rehabil. 2006;10:55–67.
11. Melam GR, Buragadda S, Alhusaini AA, Arora N. Effect of complete decongestive therapy and home program on health-related quality of life in post-mastectomy lymphedema patients. BMC Womens Health. 2016;16:23.
12. Pipkin FB. Medical statistics made easy. Churchill Livingstone Inc; 1984.
13. Benedetti FM, Cavalla AR, Ruffini EG. Postmastectomy pain control and Pain Gone Pen. Surg Gynecol Obstet. 2011;126131.
14. Adams KE, Rasmussen JC, Darne C, et al. Direct evidence of lymphatic function improvement after advanced pneumatic compression device treatment of lymphedema. Biomed Opt Express. 2010;1:114–25.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

FUNDING

This research received no external funding.

COPYRIGHT