Novelty Journals

ISSN 2394-7330

International Journal of Novel Research in Healthcare and Nursing
Vol. 3, Issue 1, pp: (61-65), Month: January-April 2016, Available at: www.noveltyjournals.com

Intermittent Pneumatic Compression for Breast-Cancer Associated Lymphedema: A Controlled Study

[1]Prabhjot Kaur Gambhir, [2]Sakshi Jain, [3]Alakananda Banerjee

[1]Occupational Therapist, Max Super Specialty Hospital, Saket, Delhi, India
[2]Physical Therapist, Max Super Specialty Hospital, Saket Delhi, India
[3]Head of Department, Physiotherapy and Rehabilitation, Max Super Specialty Hospital, Saket, Delhi, India

Abstract: **The combination of axillary radiation therapy and axillary surgery substantially increases the risk of arm edema in breast cancer patients. This may be caused by disruption of lymphatic pathways which produces fibrosis. Among the many treatment techniques suggested for arm edema, intermittent pneumatic compression (IPC) has been recommended at low pressures as single or multi-chamber pumps as part of the multimodal program. To study the effect of addition of IPC pumps in the rehabilitation of arm edema, this study was devised as a comparative study. Females who developed arm edema within a year of breast cancer surgery were included and compared for effects of multi – modal program with or without IPC pump use. Assessments were made using circumferential measurements.**

Keywords: **ALND, arm edema, breast cancer, IPC pump, lymphedema, pneumatic compression.**

1. INTRODUCTION

Arm edema in the breast cancer patient is caused by interruption of the axillary lymphatic system by surgery or radiation therapy, which results in the accumulation of fluid in subcutaneous tissue in the arm, with decreased distensibility of tissue around the joints and increased weight of the extremity. Chronic inflammatory changes result in both subcutaneous and lymph vessel fibrosis (1). Patients with arm edema secondary to breast cancer therapy experience a substantial degree of functional impairment, psychological morbidity, and diminished quality of life (2).

Mortimer et.al stated that prevalence of arm edema increases over time after radiation therapy compared to patients who have undergone surgery alone (3). Patients who receive axillary node dissection (ALND) and/or axillary radiation therapy for breast cancer are at particular risk for the development of lymphedema as well as other arm morbidities, such as pain, paresthesias, weakness, and impaired shoulder function (1,4). Maunsell et.al concluded in their study that women who have undergone axillary dissection had significantly more self-reported arm problems (24-64%) than women who had not undergone axillary dissection (5).

The prevention of breast cancer associated lymphedema has been categorized as avoidance of trauma/injury, prevention of infection, avoidance of arm constriction, and use and exercise of the limb. The most commonly used treatment modalities include manual lymphatic drainage (MLD), exercise, non-elastic wrappings and compression garments, and meticulous skin care.

Along with these treatments, intermittent pneumatic compression (IPC) pumps have been widely used. The initial IPC pumps had a single chamber pressure cuff that applied a uniform level of compression to the entirety of the limb. Segmental compression devices were developed in the 1970s with pressure in the distal chamber higher than in the proximal chambers (6).

Research findings are somewhat lacking in terms of the reported physiological effects of pumps and support for the optimal application parameters for pump use. Data from studies of skin microcirculation show that ischemic skin damage may occur from high levels of compression applied for long periods. A sustained pressure of 60-70 mm Hg may be considered as the maximum upper limit (6). This relatively low pressure avoids collapse of the superficial lymphatics.

The current study aimed at learning the effectiveness of multimodal treatment for breast cancer associated lymphedema comparing the effects of MLD, exercise, non-elastic wrappings and compression garments with IPC pumps added to the treatment regime.

2. METHODOLOGY

The study undertaken was a prospective experimental study. Subjects were included in the study based on the selection criteria: females of any age group with clinically diagnosed unilateral breast cancer (irrespective of stage or affected side) who have undergone surgery with or without neo-adjuvant or adjuvant chemotherapy and/or radiation therapy with development of lymphedema within an year after surgery, referred by the concerned oncologist for the treatment of the same. Any comorbities like cellulitis, any other active infection, or deep vein thrombosis (DVT) were excluded from the study as IPC pumps are contraindicated in the same (7).

The subjects were evaluated on the basis of circumferential measurement taken from the affected as well as normal side at the following levels:

- 3, 5 and 7 inches above lateral epicondyle of humerus
- 3, 5 and 7 inches below lateral epicondyle of humerus
- 2 inches below radial styloid process

The circumferential measurements were used to assess extent of lymphedema at baseline level and after 4 weeks of treatment. This method of assessment was used as circumferential measurement has been shown to be highly correlated (r = 0.93-0.98) with the results of the more exact water displacement method (8). At baseline, differences of greater than 2 cm between the affected and normal arms were considered to be clinically significant (9).

The treatment program included an experimental group receiving a multimodal program of MLD, exercise, non-elastic wrappings and compression garments with IPC pumps whereas the control group treatment excluded the use of IPC pumps. The entire treatment program was explained to the subjects and the ones who voluntarily refused for pneumatic compression treatment were placed in the control group. Thus the experimental group comprised 16 subjects while the control group included 18 subjects.

IPC pumps were used at a sustained pressure of 60-70 mm Hg and adjusted according to the tolerance of the patient. Such an IPC wave provides sequential compression directed centripetally, but starts in the distal parts of an extremity.

The treatment was provided for 7 days, which included 45 minutes of MLD and exercise. In case of experimental group, 20 minutes of additional pneumatic compression was given. Non elastic wrappings were used at the end of treatment session and home program for use of compression garments was explained.

The measurements were taken at the 7 levels and converted into percentage scores according to the following formula:

$$\text{Percentage score} = \frac{VA\,1 - VA\,2}{VA\,1 - VU} \times 100$$

Where, VA 1 - volume of affected limb pre intervention

VA 2 - volume of affected limb post intervention

VU - volume of unaffected limb

The percentage scores were used to synchronize readings taken from the subjects with respect to circumferential measurements.

Statistical analysis was done using SPSS for Windows, version 13.0. Unpaired T-test was used for the comparison of percentage scores of the experimental and control group at each level of measurement. P value less than or equal to 0.05 was considered statistically significant.

3. RESULTS

TABLE I: The demographic characteristics of the experimental and control group

	Experimental group	Control group
Mean Age (in years)	54.2	52.3
Affected side	Right - 5 Left – 11	Right – 10 Left – 8
Mean duration since surgery (in months)	5.25	6.8

TABLE II: The comparison of mean of experimental and control groups and the level of significance at the 7 levels of measurement

	Experimental (mean)	Control (mean)	P value
Above LE 3”	51.8	38.7	0.18
Above LE 5”	73.5	32.8	0.0002*
Above LE 7”	67.1	47.8	0.131
Below LE 3”	55.5	36.7	0.0735
Below LE 5”	55.5	37.2	0.1037
Below LE 7”	57.8	39.2	0.093
Below styloid 2”	80.3	33.8	0.0011*

*(LE- lateral epicondyle ; *- statistically significant)*

The mean scores in the experimental group reveal marked improvement at all levels compared to the control group. However, only 2 levels actually showed statistically significant results ($p<0.05$) i.e.5” above lateral epicondyle of humerus and 2” below radial styloid process. This indicates that the addition of IPC pumps may further result in reduction of volume in arm edema patients.

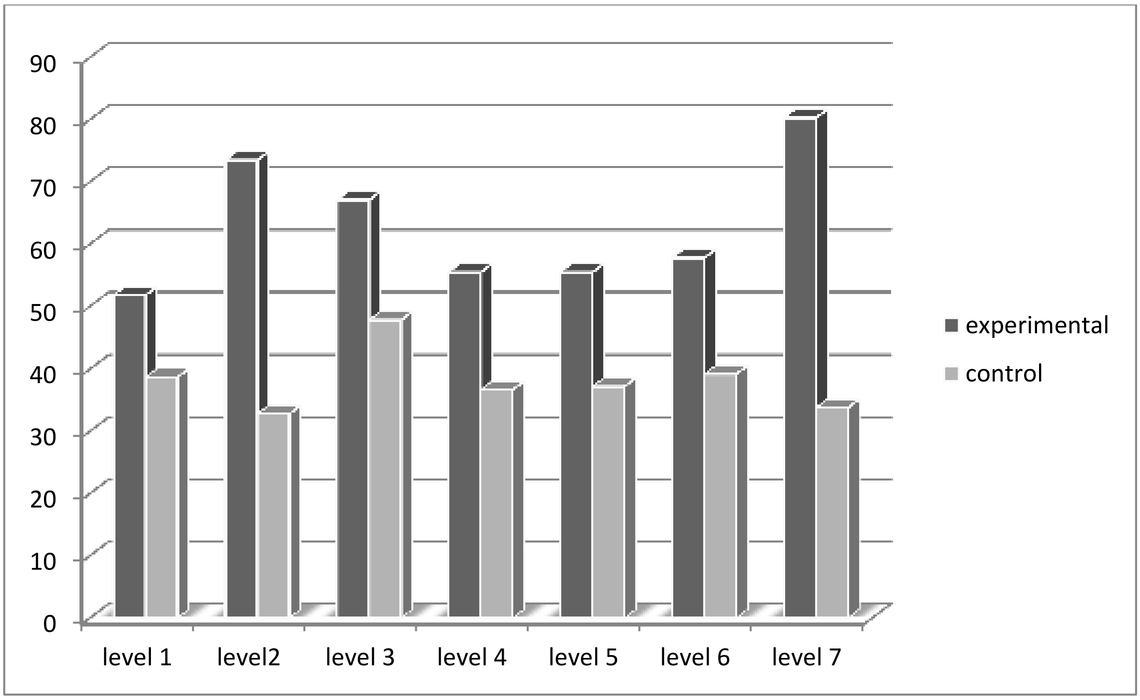

FIG 1. Comparison of means of experimental and control groups

4. DISCUSSION

Breast cancer surgery with or without radiation therapy may lead to lymphedema, which is accumulation of tissue fluid as a consequence of impaired lymphatic drainage. The combination of axillary radiation therapy with axillary surgery substantially increases the risk of arm edema.

Multimodal programs for treatment of breast-cancer associated lymphedema have been emphasized by researchers. This treatment including MLD, sequential pneumatic compression, compression bandaging and exercise has been known to decrease the degree of lymphedema as well as need for physical assistance, and strength of extremity thus improving the quality of life of an individual (10). Multi chamber pumps have been found to be more effective as they produce a linear pressure wave from distal to proximal portion of the limb thus reducing the tendency of fluid to collect in the hand (11). Although IPC has been acknowledged as a potential component of the multidisciplinary therapeutic approach to treating patients with breast cancer carcinoma associated lymphedema, conclusive, prospective documentation of the beneficial role of this modality has not been provided.

On a physiological level, IPC may contribute both to inappropriate tissue retention of interstitial protein, leading to an excess of cutaneous fibrosis, and to a reduction in joint mobility (2).

In the present study, the use of multimodal approach for the treatment of breast cancer associated lymphedema showed improvement at 2 levels in the circumferential measurement- 5" above lateral epicondyle of humerus and 2" below radial styloid process. The mean values in the experimental group showed better improvement compared to the control group, though not all levels showed statistically significant results (TableII). Such volume reductions have been noted in earlier studies (12, 13, 14, 15).

IPC acts as a 'muscle pump' which facilitates the flow of lymph in lymphedema. During compression, the lymph vessels collapse and their content is shifted toward proximal parts of the extremity while the release of compression during a compression interval allows refilling if lymph vessels with lymph (6).

There is evidence to suggest tissue fluid transport is not associated with transport of macromolecules (i.e. protein) from the interstitial tissue. This may raise questions as to the effectiveness of IPC as a stand-alone modality that promotes substantial limb volume congestion. Therefore, a multimodality approach is necessary (16, 17).

The statistically significant results were evident only at 2 levels over a 7-day treatment period making it necessary to provide treatment for a longer duration. Also, follow up studies over at least 6- month period may provide an insight into the long- term effects of the multimodal treatment program.

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